INTERACTIONS BETWEEN BLACK-TAILED DEER AND INTENSIVE FOREST MANAGEMENT

PROBLEM ANALYSIS

INTEGRATED WILDLIFE INTENSIVE FORESTRY RESEARCH

BC

A cooperative project between the Ministries of Environment and Forests
INTERACTIONS BETWEEN BLACK-TAILED DEER
AND INTENSIVE FOREST MANAGEMENT

Problem Analysis

R.S. McNay and R. Davies

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Research Branch
Ministry of Forests
1450 Government Street
Victoria, B.C.
V8W 3E7

Wildlife Branch
Ministry of Environment
Parliament Buildings
Victoria, B.C.
V8V 2X5

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This problem analysis was requested by the Technical Working Group (TWG) directing the Integrated Wildlife-Intensive Forestry Research (IWIFR) program on Vancouver Island. The rationale for the request originates with the TWG's desire to produce sound, well-organized research relevant to the problems of integrating wildlife and forest management.

The IWIFR program began during 1980 and Phase I is scheduled to run through 1985 with an allocated budget of $1.6 million. Phase II, although not confirmed, is intended to run an additional 5 years. The program goal is to carry out a co-ordinated research program that will provide information needed for the effective integration of forest and wildlife (deer and elk) management on Vancouver Island. To promote participation and information exchanges with public and private interests, the TWG directing the study includes representatives of forest industry and public conservation groups, as well as staff from the two sponsoring ministries and the University of British Columbia. Further information on the IWIFR program is available in annual reports and in progress reports for component studies, available from Research Branch, B.C. Ministry of Forests or Ministry of Environment, Victoria.

This problem analysis deals specifically with the ways that intensive forestry treatments modify the manner in which Columbian black-tailed deer select, use, and respond to various habitats.

The objectives are: to define the problems associated with interactions between deer and intensive forestry; to review present knowledge about the problem and to identify information gaps related to it; to identify research topics; to suggest priorities for research; and to recommend approaches to high priority topics.

Readers are directed to Sections 1 and 2 for a detailed discussion of the rationale and objectives of this problem analysis, and to Section 3 for a description of the methods used to develop it.

All aspects of the general ecology and biology of deer and their response to habitat changes have been considered. Section 4 places the problem in perspective. Section 5 reviews general deer ecology, and introduces the important issues underlying both wildlife and forest management. In Sections 6 and 7 the information needs and research topics
required to help alleviate problems between deer and intensive forest management are identified, and recommendations made in Section 8.
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1 INTRODUCTION

The primary objective for black-tailed deer management on Vancouver Island is to provide a minimum annual harvest of 15,000 ± 5,000 deer (B.C. Ministry of Environment 1980). This objective, based on the perceived recreational demand for deer (average annual harvest, 1950-1980), requires that deer numbers be maintained at a population level of 150,000-200,000 deer. Such a requirement has important assumptions regarding the potential carrying capacity of Island watersheds for deer, and, in particular, the impact of forest management on that capacity. Concern surrounding forest management impacts on carrying capacity has been generated primarily from deer population declines of 50-80% subsequent to forest harvesting at some locations on Vancouver Island (Section 5.1.1). A need for increased co-operation and co-ordination between intensive forest management and black-tailed deer management is evident (Section 3).

Forest management is the most important land use activity directly and indirectly affecting deer carrying capacity. Any forestry operation that modifies the timber or the understory vegetation (or both) will also modify the area's ability to produce food and cover, the two key components of habitat (Figure 1). Forest management may indirectly affect other population regulating factors such as predation, competition, and the behavioural ecology of deer.

The objectives of forest management in British Columbia are derived primarily from criteria set out in the Forest Act (B.C. Ministry of Forests 1981). The level of harvest is determined by considering 1) the rate of timber production that may be sustained on the area (i.e., based on the composition of forest and its rate of growth, time to establish a new forest, silvicultural treatments expected, and standard of timber use); 2) the short- and long-term implications of alternate rates of timber harvest; 3) the production capabilities and timber requirements; 4) the economic and social objectives of the Crown; 5) any abnormal infestations or devastations of timber on the area; and 6) constraints due to use of an area for purposes other than timber production.

More specific policy objectives concerning wildlife were made explicit in the coastal logging guidelines (B.C. Ministry of Forests 1972). Provincial forests are to be managed for timber production; forage production and grazing by livestock and wildlife; forest oriented recreation; and water, fisheries, and wildlife resource purposes. The coastal logging guidelines
FIGURE 1. Relationship between timber and wildlife (deer) management (from Thomas et al. 1979).
explicitly state a commitment to the multiple use concept of forest management, as well as to the objective of sustained forest yield: "Wildlife and fish habitats of significance are to receive special consideration" (B.C. Ministry of Forests 1972). These forest management objectives come in the light of a radically changing forest management "climate" on Vancouver Island. The forest industry has undergone restraint during the recent economic recession and has had to adapt to a smaller, more unpredictable market place. The nature of supply is also changing. As old-growth, virgin timber is reduced, second-growth forests are comprising the annual allowable cut, which, concurrently, is being decreased. Most of the forest industry depends on intensive silviculture, better use, and conservation of the forest land base to help reduce the deficit caused by the switch from old-growth to second-growth timber.

Intensive silviculture is central to the future nature of forestry, but the best types of treatments and frequency and combination of their use are unclear. This uncertainty stems from changing forestry objectives caused by fluctuating markets and the variety of perspectives held by foresters about which silviculture regimes should be used to meet these objectives (Section 5.3.4). Furthermore, wildlife managers are not able to assess and adequately predict the ecological consequences of site-specific silvicultural practices. With deer, for example, managers are uncertain how forage quantity and quality would be modified, how shelter from predators and climate would be modified, or how an animal's social and reproductive behaviour would change given implementation of certain silvicultural regimes. Without an understanding of this ecological system, the managers are unable to prescribe mutually beneficial harvest patterns with certainty or to judge the effectiveness of alternative management strategies.

This dilemma was the principle force leading to the formation in 1980 of the Integrated Wildlife-Intensive Forestry Research (IWIFR) Program. The goal of this program is to develop and carry out an integrated and co-ordinated forestry-wildlife research program that provides information needed for the effective integration of intensive forest and wildlife management on Vancouver Island. The answer to three major questions are being sought:

1. What are the impacts of intensive silvicultural practices and regimes on wildlife habitat?
2. What are the responses of wildlife to these habitat alterations?
3. How can the information on these impacts and responses be usefully organized?

Three projects are now under way, investigating:

* effects of intensive silviculture on forest vegetation and climate, especially those elements relevant to deer and elk habitat (Nyberg 1985),
* the response of elk to intensive forestry (Janz et al. 1980), and
* the response of deer to intensive forestry (this project).

In addition, there are several smaller projects: an annotated bibliography of deer literature and related documents (Thompson 1981); a preliminary assessment of forestry practices on non-ungulate wildlife (Sadoway, in prep.); an evaluation of LANDSAT imagery to map habitat (Sadoway 1980); an assessment of the potential impact of wolf predation (Hatter 1982); a comparison of ecological classification systems (Stevenson 1982); the development of spatial analysis systems (Scoullar, in prep.); and program design (McNamee et al. 1981).

2 OBJECTIVES

The purpose of this report is to provide a problem analysis for the deer/intensive forestry problem in British Columbia, which can be used to guide research activities for the deer project of the IWIFR program. The analysis has the following specific objectives:

1. To define the problem of deer and intensive forest management relations with respect to deer management objectives, and the perceived impacts of forestry on habitat value, selection, and use by deer (Sections 4-5).
2. To review present knowledge on the problem and identify information gaps related to it (Section 6).
3. To identify research topics (Section 7).
4. To suggest priorities for research (Section 7).
5. To recommend approaches to key topics (Section 8).

Topics approved for study will be treated subsequently in separate working plans that will detail how the research is to be conducted.
3 METHODS

This investigation into the problem of deer and intensive forestry relations was accomplished largely through discussion with professional foresters and biologists, who have been or are currently involved with either of these two resources. The nature of these discussions ranged from individual interviews to group workshops. Many research projects regarding aspects of deer and intensive forestry relations in British Columbia have been in progress since the late 1960's. A review of the historical development of modern era deer research in the province was given by Bunnell (1979). Where possible, information and data from these research projects have been used in this report, and the individual researchers contacted for their perspectives on the problem. Appendix 1 lists the agencies, companies, and individuals interviewed during the initial phases of this document's preparation.

The basic objective in obtaining the professionals' perspectives was to gain a range of ideas concerning the problem definition, its scope, information needs, and potential research directions.

Concurrent with the interviews was the collection of literature pertinent to the problem. Participation in three projects (v. Shank and Bunnell 1982a; Shank and Bunnell 1982b; and Bunnell et al. 1985), as well as participation in the IWIFR technical working group, helped us to focus attention on management and research information needs.

4 PROBLEM SCOPE

The problem between black-tailed deer and intensive forestry activities is primarily a conflict in objectives between agencies concerned with management of these two resources. Forest managers, wildlife managers, and those people concerned with forest-wildlife research neither completely agree nor disagree in their perceptions regarding a solution to the current resource management problem. Most, but not all, agree on the geographic scope and the seriousness of the problem.

4.1 Perceptions Held by Forest Managers

The charge of managing the forest resource of British Columbia rests primarily with the B.C. Ministry of Forests (MOF). Because only 4% of the province's forested land is privately owned, it is assumed that management
efforts reflect the policy of the British Columbia Forest Service (BCFS) either directly, on Crown land, or indirectly, on leased Crown land. General policy information was presented in Section 1.

The general perceptions held by forestry proponents of the conflicts between intensive forestry and black-tailed deer management include the following:

Industry
1. Deer survival decreases with the occurrence of persistent severe winters except in those areas where old growth provides shelter from deep snow. A further decline of current deer populations is inevitable if old-growth forests are removed.
2. There is a lack of understanding concerning how and why deer depend on old growth as winter range.
3. How does intensive forestry modify critical components of winter range, and how can second-growth forests be modified to "mimic" old-growth winter range conditions? How can spring forage be produced?
4. Wolves are an important issue, but one which should have less research priority. If deer habitat research and management are to be justified, wolf management is needed to lower population levels and thus reduce the potential for predation.
5. The geographic scope of the problem exists only in the high snowfall areas of Vancouver Island.
6. The problem is ultimately the responsibility of BCFS, but there appears to be a lack of agreement between industry and BCFS regarding appropriate objectives.
7. The problem affects industry through loss of timber and the creation of difficulties in planning. Historically, constraints have been unanticipated by industry due to lack of "lead time."
8. Historic data on deer trends, forest harvesting, wolf indices, and climate need re-analysis.

British Columbia Forest Service (BCFS).
The BCFS perceives the problem in basically the same way as the forest industry does, with two major exceptions:
1. Wolves are considered more important than spring forage production.
2. The geographic scope of the problem extends throughout Columbian black-tailed deer range from southeast Alaska to the Olympic Peninsula in Washington.

4.2 Perceptions Held by Wildlife Managers

The charge of managing black-tailed deer in British Columbia rests with the Wildlife Branch within the B.C. Ministry of Environment. The policy of this public agency is to manage deer primarily as a game species. The emphasis in management is placed on providing a harvestable surplus in locations of high, or moderate to high, deer production capability and in those locations most accessible to hunters (B.C. Ministry of Environment 1980). The perspectives of the Wildlife Branch that concern interactions between intensive forestry and black-tailed deer are:

1. The present rate of harvesting old growth will prevent the Ministry of Environment from maintaining its objective of providing deer in sufficient abundance to meet the recreational and economic needs of society (see Section 1).
2. Recently, the problem of wolf predation on deer has become more clear as a factor limiting deer populations.
3. Second-growth timber up to 200 years old does not provide the same essential winter range characteristics as does old-growth timber. Silvicultural manipulations of second-growth will likely be uneconomical.
4. Currently there is a lack of research effort into the whole problem of deer management. There is a need to learn how deer cope.
5. Wolf predation has a short-term effect; winter range loss will last for over 200 years and thus is a long-term influence.
6. The problem exists from southeast Alaska to the Olympic Peninsula, but the high snowfall areas on Vancouver Island are the most important locations, representing 50% of the high capability land for deer on the Island.
7. Snow hardness is one of the most important characteristics of snow, but there is no way of managing or controlling this feature.
8. With wolves in the system, security cover deserves more attention than it has received in the past.
9. Manipulation of second growth is a questionable alternative to winter range production because winter ranges are diverse and such diversity would be difficult to simulate.

4.3 Perceptions Held by Academic Researchers

Research concerning declining black-tailed deer populations in British Columbia began in the late 1960's (Bunnell 1979). Studies during the 1970's that address the intensive forestry and black-tailed deer situation were implemented primarily in the Nimpkish Valley on Vancouver Island. In 1980, IWIFR was formed with the objective of initiating co-operative research through the governmental agencies of the B.C. Ministry of Forests and Ministry of Environment.

The following represent generalities of researchers' perspectives concerning the intensive forestry and black-tailed deer management problem:

1. Important issues in the past have been primarily associated with deer population declines, which have been a combination of severe winter concurrent with loss of winter habitat. Now wolf predation is also considered an important factor.

2. A lack of clarity exists concerning the target of various research approaches and their goals.

3. There is a need for more thorough analysis of the Vancouver Island data that has been collected on forest harvesting, climate, deer harvest, and predators with the intent of producing a more balanced approach at studying the problem.

4. The problem is restricted to areas of high snowfall within coastal black-tailed deer range in North America.

5. There is a need to continue collecting baseline data on the overall problem, but research should concentrate on gaining specific information for "process level" understanding.

6. Important focuses for winter range research are: i) winter range dynamics (controlled by climate), ii) vegetation and how it is influenced by snowpacks, and iii) snow in winter range.

4.4 Summary: Perspectives and Problem Location

Within the perceptions held by the agencies and forest companies polled, it is evident that historic trends in research have influenced current thinking. All interviewees believe winter range to be an important limiting
factor in deer populations on Vancouver Island. Most believe the problem to exist only in high snowfall areas, and the forest industry alone feels the problem is restricted to Vancouver Island.

In light of recent investigations (e.g., Jones and Mason 1983) most people are expanding their perceptions to include the importance of wolf predation on Vancouver Island deer. Admittedly, most still believe winter range to be the more critical question due to its longer-term influence. The forest industry is most interested in solving the winter range problem so that difficulties with planning and constraints on timber harvest may be minimized.

All people polled agree there is a need for productive research, but few agree on the appropriate research direction. Most agree that the first step is a more strict analysis of baseline data already gathered (Section 7).

In the following sections of this report the problem will be approached from an ecological viewpoint, with the aim of identifying information needs based on ecological principles (Section 5.1). Most attention is on the specific subject of deer response to habitat changes, but because the ecological community is interconnected, some attention will also be on deer habitat responses to forest management activity, and on the potential changing influences of predation and competition due to intensive forestry.

The problem extends throughout black-tailed deer range in British Columbia (Figure 2), which overlaps with two Coastal Biogeoclimatic Zones (Figure 3). Tables 1 and 2 provide details of the biotic and abiotic environments in the forest community within the area where intensive forestry and deer management are a problem.

5 THE PROBLEM DEFINITION

An overview of deer ecology is presented in Section 5.1. Following sections clarify characteristics of the problem between black-tailed deer management (Section 5.2) and forest management (Section 5.3).

5.1 Wildlife Ecology Context

Bunnell (pers. comm., Jan. 15, 1984) considered management of a species to be "the application of ecological principles within a particular socio-economic framework". In this analysis we explore the basic ecological principles associated with deer management.
FIGURE 2. Geographic range of (1) Rocky Mountain mule deer, (2) desert mule deer, (2a) Tiburon Island mule deer, (3) California mule deer, (4) Southern mule deer, (4a) Cedros Island mule deer, (5) peninsula mule deer, (6) Columbian black-tailed deer, and (7) Sitka black-tailed deer (from Wallmo 1981).
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<td>Red Cedar (Thuja plicata)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 From Hosie 1975.  
2 Browse species used to some extent by black-tailed deer (from Forbes 1975 and Rochelle 1980).  
3 Potential overlap during severe winters in north coastal range.
TABLE 2. Abiotic features of the Coastal Western Hemlock and Coastal Douglas-fir Biogeoclimatic Zones of British Columbia

<table>
<thead>
<tr>
<th>Abiotic feature</th>
<th>Biogeoclimatic zone¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coastal Western Hemlock</td>
</tr>
<tr>
<td>Number of frost-free days</td>
<td>170 - 344</td>
</tr>
<tr>
<td>January mean monthly (°C)</td>
<td>-10 - 5</td>
</tr>
<tr>
<td>July mean monthly (°C)</td>
<td>13 - 19</td>
</tr>
<tr>
<td>Number of months above 10°C</td>
<td>4 - 7</td>
</tr>
<tr>
<td>Number of months under 0°C</td>
<td>0 - 3</td>
</tr>
<tr>
<td>Absolute maximum (°C)</td>
<td>26 - 43</td>
</tr>
<tr>
<td>Absolute minimum (°C)</td>
<td>-45 - -12</td>
</tr>
<tr>
<td>Annual mean total precipitation (mm)</td>
<td>737 - 6655</td>
</tr>
<tr>
<td>Annual mean snowfall (cm)</td>
<td>18 - 792</td>
</tr>
<tr>
<td>Elevation (m)</td>
<td>North: 0-300</td>
</tr>
<tr>
<td></td>
<td>South: windwardside: 0-900</td>
</tr>
<tr>
<td></td>
<td>leewardside: 450-1050</td>
</tr>
<tr>
<td>Major soils</td>
<td>Humo-Ferric and Ferro</td>
</tr>
<tr>
<td></td>
<td>Humic Podzols, Gleysols and organic soils</td>
</tr>
<tr>
<td></td>
<td>soils</td>
</tr>
</tbody>
</table>

¹ From Krajina et al. 1982.
5.1.1 Basic requirements from the physical environment

Deer respond to the constraints of the physical environment. Water, cover, energy, and chemical nutrients are the basic requirements for deer. Water is generally plentiful, although body need is affected by environmental factors such as temperature, humidity, forage succulence, and rate of food consumption.

5.1.1.1 Cover

Cover can mean several things to an animal, but generally it is a utility derived from the structure of the terrain and vegetation in which the animal lives. Northern deer use three types of cover: thermal cover, security cover (hiding and escape cover), and cover from deep snow depths in winter.

Thermal cover provides shelter from extremes in temperature and wind (Verme and Ozoga 1971; Beall 1974). A deer loses energy to the environment by convection, radiation, evaporation, and conduction. The rate of energy loss is a function of air temperature, radiant energy environment, and windspeed. Windspeed appears to be the most critical factor (Moen 1968b). Most researchers have attempted to test the effect of temperature and wind on thermoregulatory stress, but only in controlled chamber conditions. Only rarely have effects of these factors been evaluated in natural environmental conditions. Parker and Robbins (1984) found that temperature, wind, and radiation all significantly affect thermoregulation of mule deer, but suggested that these factors should be evaluated relative to broader energy trade-offs before being considered important to management of deer.

Microclimate, as a function of weather, topography, and vegetation, influences a deer's thermal costs. Managers tend to think of thermal cover in terms of site or stand characteristics that provide a thermal-neutral environment for deer during various weather conditions and/or weather changes.

Deer also use cover for resting, hiding, and perhaps escaping from predators and hunters. Thomas et al. (1979) referred to this cover as security cover (see Sections 5.1.2 and 5.1.4). Vegetation or topography may protect deer from predators or other disturbances while they are engaged in normal activities (such as foraging, resting, and reproduction). Peek (1980) suggested that environmental factors are a critical component in
predator-prey systems because environmental attributes are often the ultimate factor involved in predisposing prey to predators.

Cover from deep snow is particularly well documented as an important requirement for deer in eastern North America (Severinghaus 1947; Verme 1965). Edwards (1956) and Jones (1975) documented the need in western Canada. Snow affects ungulates by burying food and altering their efficiency of locomotion (i.e., movement through snow requires a considerable increase in energy expenditure). The latter affects not only the total energy expenditure, but ability to escape from predators as well. Energy expenditure is related to the depth to which animals sink in the snowpack (Heinonen et al. 1959; Ramaswamy et al. 1966; Jacobsen 1973). Actual energy expenditures in relation to snow depth have been measured for some ungulates (Mattfield 1974; Parker et al. 1984), and relationships between species, body measurements, and effects of snow depth on locomotion costs have been developed (Bunnell 1978; Pruitt 1979; Parker et al. 1984). The most recent quantitative report (Parker et al. 1984) indicates that locomotion in snow can increase energy expenditures by 5 times the basic metabolic rate (BMR).

The complexities among forest characteristics (i.e., cover characteristics), snowpack characteristics, and animal energy expenditures has been the subject of many reports (see Shank and Bunnell (1982a, 1982b) for annotations).

Depth, density, and hardness of snowpack appear to be the primary characteristics that determine the effect of snow on ungulates (Nasimovich 1955; Kelsall and Prescott 1971; Telfer 1971; Coady 1974; Bunnell 1978; Harestad and Bunnell 1979). Estimation of energy expenditure allows the evaluation of various deer habitats, in terms of the relative benefits and costs of differing habitat use.

5.1.1.2 Energy and chemical nutrients

Deer are generalist herbivores, which means that their diet is composed of a wide variety of plant species and plant parts (Nyberg 1985). Foods are selected largely by smell but taste and texture are also important (Short 1981). Physiologically, deer are adapted for foraging quickly and digesting the collected foodstuff at a later time. This affords them less chance of being located by predators, and makes the areal concentration of food sources important (Short 1981). Also important are digestibility and rate of
digestion, both influenced by cell structure and chemical composition of forage.

The nutrients required by deer include carbohydrates (cellulose, starches, and simple sugars), lipids, nitrogen, protein, vitamins, and minerals. Cellulose requires a lengthy fermentation time for digestion, whereas starches and sugars require shorter fermentation time and provide a higher energy value. Fats provide the highest caloric value per gram of any foodstuffs selected by deer but require a lengthy fermentation time. Deer are particularly efficient at maintaining the quality of their protein diet by protein synthesis, although the quantity of protein ingested can be a problem. Until the last decade protein levels in deer forage (diets) were often regarded as the limiting factors to animal condition and productivity (Einarsen 1946; Klein 1963, 1965). Deer require 16% protein in their diet and usually have low survival and low natality success with diets of 7% protein or less (Verme and Ullrey 1972). Other reports have indicated that crude protein levels in the 6-7% range are sufficient minimum levels for winter maintenance (Dietz 1965).

Most succulent and immature grasses, forbs, and browse leaves are all easily digested by deer and provide more energy than do diets high in cellulose, including mature grasses and forbs or woody twigs (Short 1981).

Short (1981) considered most vitamins and minerals to be plentiful enough to satisfy black-tailed deer. No history of mineral nor vitamin deficiencies has ever been reported in the Pacific Northwest, although iodine and selenium can present problems. Selenium, for example, can be deficient (causing nutritional muscular dystrophy) or at toxic levels (causing alkali disease). To our knowledge no clear evidence has ever been reported that proves either deficiency or toxicity problems in black-tailed deer.

The quality of food sources in terms of protein, energy, and other nutrient content, and in terms of their digestibility, governs the relative physical availability of food to the deer. In addition, the quality of the food in a deer's diet determines the actual amount of forage the deer can ingest, process, and pass in a certain time interval. Quality affects foraging efficiency or nutrient intake per time per habitat.

Energy and protein levels are usually considered to be the limiting factors of forage quality. Energy is needed to "fuel" the deer, and nitrogen is needed for protein synthesis to build body tissue (Hanley 1981).
Another factor affecting forage quality is the presence of plant secondary compounds such as plant toxins and other digestion-inhibiting compounds. The simplified end result is that actual availability of energy, protein, and other nutrients may be much less than what is indicated by current annual growth or chemical analysis of forage.

5.1.1.3 Temporal and spatial variation

Two other aspects of the physical environment to which deer respond are the temporal and spatial variation of food, cover, and water. We are particularly interested in spatial variation at two levels: 1) local variation caused by geological and topographical features (e.g., how areas of winter habitat and areas of spring forage production are located with respect to one another); and 2) the diversity of environments at a given place, resulting from physical and biological features (e.g., the variation in snow accumulation patterns and forage production within an old-growth forest).

The temporal variations of interest here are exemplified by habitat response to intensive silviculture practices and the timing of those practices (Nyberg 1985). Another example is deer population responses to the timing and extent of predation or hunter harvests.

5.1.2 Predation

The following description of predator-prey systems has been extracted primarily from Hatter (1982). Leopold (1933) and Holling (1959) stated that the effects of predation on prey depend on: 1) density of the prey population, 2) density of predator population, 3) defense or escape capability of the prey, 4) food preferences of predator as well as its ability to detect, capture and kill the prey, and 5) density and quality of alternative foods available to the predator. Within predator-ungulate systems, the predators may: 1) cause prey populations to be unstable and may drive them to extinction; 2) have a regulating effect; or, 3) just reduce rates of population growth. Predators affect prey populations by influencing morphological, physiological, and behavioural responses of prey to predators. Disturbance alters the behaviour of animals and may affect their physiology, population dynamics, and ecology. The unpredictability of a source of disturbance may cause loss of weight, loss of appetite, neurosis, susceptibility to predators, lower reproductive capacity, and even death. Theoretically, any disturbance has the undesirable effect of raising
metabolism and thus the "energy cost of living" (Geist 1971). Some habitat conditions lessen the risk of predation by offering the deer more security.

Connolly (1981) presented 15 case studies of predation on mule and black-tailed deer. The case histories involve predation by coyote, wolf, bear, and cougar. Two important points can be summarized from the review by Connolly (1981):

1. Deer are ultimately limited by quality and quantity of habitat. This means that if deer numbers exist below the level that can be supported by their habitat, then a release from predation could increase population size (Robinette et al. 1977). This is further explained by Messier (1981) as the "predator control" hypothesis. However, declines due to deterioration of habitat quality or quantity cannot be reverted by lowering predator numbers.

2. Two cases presented by Connolly (1981) were able to document predators as the major cause of deer decline. Predators do kill large numbers of deer (Merriam 1964; Knowles 1976) and, under particularly harsh circumstances for deer (such as severe winters), can be a serious limiting factor (Wallmo 1981; Jones and Mason 1983). Messier (1981) refers to this as the "environmental limitation" hypothesis.

5.1.3 Competition

Ricklefs (1973:867) defined competition as "a situation where the use of a resource -- food, water, or cover -- by one individual reduces the availability of that resource to other individuals, whether of same species or a different species". Within an ecosystem or an ecological community, each animal (or plant) becomes part of another's environment, and interactions automatically become part of the total dynamic process of population regulation (Mackie 1981). Within the context of this report, competition can take many direct or indirect forms but most are subtle and difficult to identify. Intra-specific competition is exemplified within deer wintering areas during severe winters. Weaker deer will die of malnutrition or starvation, leaving only the stronger competitors to survive. Less obvious is the indirect interspecific competition between wild ungulates. Gradual reduction in plant vigour, reduction or elimination of particular cover types, and general alteration and reductions in the kind, quality, and quantities of preferred plants have potential to cause severe indirect
competition between and among ungulate species on overlapping ranges (Mackie 1981).

Perhaps the most common and least obvious interspecific competition concerning deer is posed by man. The need for this report demonstrates how little is understood about competition between deer and man for a common resource base -- one which provides a habitat for deer and a potentially profitable resource base for man.

5.1.4 Social/behavioural implications: adaptive strategies

In every aspect of deer ecology one can recognize a strong link with behaviour. The way in which an animal perceives and reacts to its physical environment, its predators, its competitors, and its own species socially and reproductively, determines the animal's survival and transfer of genetic material to new generations. Thus, in an ecological and evolutionary way, animal behaviour is the most proximal tool an animal has to ensure its struggle for survival is successful.

Food habits

Deer exhibit a plasticity of food habits, allowing them to seek the most nutritious species throughout an annual cycle (Rochelle 1980). The physiological processes of deer appear to be adapted to seasonal changes in food availability and quality. Most deer exhibit characteristic annual cycles in metabolic rate, forage intake, body growth, and fat storage-depletion (Bandy et al. 1970).

During summer, deer are more active, their metabolic rate is high, and energy demands for growth and activity are high. At the same time, forage intake and digestibility are high, making the rate of energy and nutrient intake high. Typically, food intake (energy and nutrients) will exceed acquisition costs, and deer will grow and accumulate fat. An early starting and long lasting summer is the most beneficial for deer.

In fall, the basal metabolic rate (BMR) drops, but energy demands are higher due to higher thermoregulation costs and possibly to the increased activity costs associated with negotiating snow. Forage is less digestible and less abundant, and thus forage intake, and consequently energy intake, drop. Typically, except for rutting bucks, energy intake and expenditure are equal and body condition remains stable, relative to other seasons.
Two scenarios are possible during winter. First, in a mild winter with little snow, BMR drops again and deer are less active although thermoregulatory costs are higher. Forage is less abundant and is of much lower quality than in fall. Forage intake drops, thus energy intake drops. Typically, the deer uses its fat reserve over the winter. Second, in a severe winter with much snow, BMR drops still further and deer are less active, but thermoregulation costs and locomotion costs are potentially much higher due to cold temperatures and deep snow. The deer operates at a high energy deficit, depletes its fat reserves within a few weeks, and then starts to catabolize body tissue. If the severe period is too long the deer will die. Typically deer can exist 4-5 weeks without food by staying inactive and still recover, although this may have delayed costs in terms of survival of young born the following spring (DeCalasta et al. 1975).

In spring, the BMR increases. Energy and protein demands for replacement of depleted body reserves, growth, and gestation are high. Such demands require a high increase of forage intake. Forage digestibility and food passage rates are highest at this time allowing for high energy assets.

Regardless of season, however, food habits generally appear so plastic that Geist (1981) stated that a deer's diet is more a function of habitat preference than of forage preference. Moen (1968a) wrote much the same argument when he considered feeding and resting behaviour of deer to be primarily a function of weather. Arguments such as those presented by Geist and Moen lead to the suspicion that deer select habitat based on its cover characteristics or perhaps on their own learned behaviour, and then select forage items within the habitat they have chosen.

**Home Range**

To a large degree a deer's movements are confined to a limited area known as its home range. Typically, home ranges are defined as annual home ranges or seasonal home ranges, the latter being core areas of seasonal use within the annual home range. For any individual, the home range determines the array of habitat available and likely to be used.

The way in which deer establish their home ranges essentially determines the distribution of deer over the landscape. Home ranges for some deer, especially for females, apparently are learned in the first
year or two of life from association with their mothers (Dasmann and Taber 1956; Nelson and Mech 1981). For other deer, especially young males, home range locations may be established after dispersal. The proportion of "learners" versus "dispersers" in black-tailed deer populations is not known and the process of dispersal is not well understood (Bunnell 1979). From the little work that has been done on this topic, deer appear to disperse randomly (Bunnell and Harestad 1983). Further, for dispersal to have been retained in black-tailed deer populations it must be a relatively successful "life history strategy" with respect to survival and reproductive success.

Home range fidelity and home range size are two parameters of critical importance to the spatial management of both winter and spring range and the understanding of winter and early spring habitat selection. Because fidelity to home range appears to be high, and because quality of habitats is not uniform over the landscape, some deer will fare better than others (Hanley 1981). In fact, some studies have suggested that deer will starve to death on their traditional home ranges rather than move a short distance to areas of more abundant forage (Dasmann and Taber 1956).

**Anti-predator strategies**

A host of anti-predator strategies for deer have been documented. Deer can respond to predators (hunters included) by changing activity patterns, sociability and wariness, and, most importantly, habitat selection and use. Some behavioural anti-predator strategies (summarized from Hatter 1982) are freezing behaviour; stotting or bounding gait (adapted to broken terrain); herding in open habitats (which lessen vulnerability of an individual deer and confuses the search image of predators); yarding behaviour and "trailing" in wintering areas (to provide multiple escape routes); and modifying daily activity patterns (to minimize predator encounter). Additionally, habitat selection can change as a direct response to the need to hide or escape from a predator, or as a local change in deer distribution to avoid predation. Hoskinson and Mech (1976) documented a migration of deer into areas with high levels of human activity. They proposed that this occurred because the human activity excluded predators from the area. Nelson and Mech (1981) noted that deer set up their home ranges
within the periphery of wolf pack territories, although Messier and Barrette (1985) never observed that behaviour.

Sweeney et al. (1971) put forth the hypothesis that deer restrict their movements to areas of escape terrain. A stotting or bounding gait is used to give deer an advantage in rough terrain during vertical ascents (Eslinger 1976). The stotting gait also allows for unpredictable changes in direction (Geist 1981).

**General behaviour**

Deer respond to their thermal environment (temperature and/or wind induced) in both a physiological and behavioural manner. Various thermoregulatory responses include: vasoconstriction, piloerection, and actual reduction in heart rate accompanied by a decrease in surface body temperature (lethargy). Further, heat loss can also be reduced by changes in orientation, posture (such as bedding), and reduction in activity. Significant proportions of energy are exerted by both males and females during the fall courtship and reproductive periods. Males reduce food intake during the rut, and energy requirements are high for reproductively active bucks. Dominance displays by bucks, rut snorts, rubbing shrubbery, sparring, front leg kick, escorting, and dominance fights all increase visibility and thus vulnerability. These bucks deplete their fat reserves, and enter the winter in much poorer condition than does. Female requirements are highest during early spring for gestation and the early summer for lactation.

### 5.1.5 Population growth and regulation

Population growth in its simplest form is regulated by biotic potential. Age of first reproduction, breeding interval, and number of offspring produced all influence the biotic potential of a species. The level of population growth associated with deer biotic potential forms the basis of theoretical deer management, but has only a small place in practical deer management. In practice, managers deal with an "ecologically" limited deer population.

It is necessary to stress the importance of a systems approach to understanding ecological limiting factors. Weather, forage production, predation, inter- and intra-specific competition, deer behaviour, parasites and disease all form a dynamic composite that, when added to the basic biotic potential, creates an ecological potential.
The capacity of any ecological community to support an animal has often been discussed in terms of "carrying capacity." Definitions of "carrying capacity", or "K", are listed in Table 3.

The growth of the population can most simply be approximated as \( \frac{dN}{dt} = rN(K-N/K) \), where \( \frac{dN}{dt} \) is the population growth rate, \( r \) is the intrinsic rate of increase, \( N \) is the population size, and \( K \) is the maximum population possible (Pearl 1930).

The equilibrium (whether stable or unstable) to which this system settles unaided is defined as the "ecological carrying capacity." The mathematical relationship for a stable equilibrium is depicted in Figure 4.

Typically, managers' definitions of \( K \) are lower than ecological \( K \) (Figure 4, Table 3): they are functions of the ecological potential of the system and the manager's goals (Salwasser 1976). Deer managers are interested in having a deer herd that is healthy and fecund, that produces large numbers of deer for harvest, and that rebounds quickly from density-independent mortality. At maximum or ecological \( K \), the system is in balance such that births equal deaths. Productivity is close to nil and animal size and condition are depressed. Such a condition of stable equilibrium rarely exists in reality, if at all (see Section 6.2).

It seems least ambiguous to define these variations of carrying capacity as production objectives, than to confuse the concept of ecological carrying capacity. When carrying capacity or \( K \) is referred to henceforth, ecological carrying capacity is implied. Deer management is a function of both carrying capacity and the harvest objectives for management of an area. When a population begins to be harvested, the equilibrium density declines and traces an isoclinal curve that represents an equilibrium between vegetation density, animal density, and predator effects (rate of harvest). Along the isocline there will be progressive changes in the attributes of the vegetation (plant density, composition, annual growth removed) and changes in animal attributes (density, condition, fecundity, survival).

The success of a deer's strategies to exploit available habitats will be reflected in its population numbers (as determined by productivity and survival), distribution, and condition.

A different approach to explaining growth and regulation of populations is aimed at estimating net energy gain/loss at the individual animal level (Robbins 1973). The transformation of energy is necessary for sustaining life processes. Anything that an animal does costs something in terms of
TABLE 3. Definitions of carrying capacity

General ecological definitions with limited or no bounding criteria:

1. Weight of animals that can be supported on a given area (Sharkey 1970).

2. An equilibrium resulting from all natural factors (Leopold 1933).

"Food limited" definitions implying a deer/vegetation equilibrium with no external mortality and no predator influence:

3. Maximum population that a given environment can support indefinitely (Keeton 1972).

4. Maximum density of animals that can be sustained in the absence of hunting without inducing trends in vegetation (Caughley 1977).

5. Maximum density of deer that a range can support (Leopold 1933).

6. Greatest number of animals that can be supported on a strictly maintenance basis (Dasmann 1954).

Qualified definitions implying a deer/vegetation equilibrium, a certain standard of animal productivity and health, and harvest. All are lower than ecological K.

7. Optimum K: Stable number of animals that can be supported in good condition on a sustained basis with no range damage (Dasmann 1954).

8. Nutritional K: Size of a healthy and productive population that food resources of a land unit can maintain (Hanley 1981).

9. Economic K: Density of animals that will allow maximum sustained harvest. This is the optimum yield of Caughley (1976).
FIGURE 4. Ecological carrying capacity and deer management capacities: a) represents the point of maximum deer density that the environment will support, b) represents stabilized ecological "k", and c) represents maximum rate of production.
energy. The energy requirements of an individual animal is dependent on its basal metabolic characteristics, its activity, and the amount of production occurring (such as tissue growth, gestation, and lactation). The total daily energy requirement is composed of the energy requirements for each of these biological processes. The energy cost equation can be summarized in a variety of ways. Two examples (Moen 1973) are:

1. Total Daily Energy Req. = (basal metabolic energy expenditure) + (activity expenditure) + (production expenditure) + (additional costs to maintain homeothermy)

2. Total Daily Energy Req. = (sum of energy required for bedding) + (ruminating) + (standing) + (feeding) + (walking) + (running) + (breeding) + (social activity) + (production energy)

Energy expenditure for all activities can be compared with BMR and given a rate of energy expenditure expressed as a multiple of BMR, (e.g., running = 8 X BMR) (Moen 1973). When the daily proportion of time spent for each of these activities is considered, the total daily energy expenditure can be calculated. This is a gross simplification of a complex subject but does illustrate the basic approach.

The two approaches, a population carrying capacity and individual net energy acquisition, or some combination of the two, can be used to gauge population growth and regulation. Ultimately it would be those population variables which must be used to gain knowledge concerning deer response to habitat changes caused by intensive forest management. To date, the two approaches are theoretically sound but hard to apply in the field. Direct inventory of deer populations is rarely accomplished (see section 5.2.1) and energy acquisition and expenditure research requires much further effort before managers can use the approach. Trend data and productivity estimates for populations are available, and provided that sampling techniques such as night light counts are continued, rough estimates of population response could be obtained.

5.2 Wildlife Management Context

While Section 5.1 is a general account of deer biology and ecology, Section 5.2 is more specific to the Vancouver Island management situation.
The intent is to make the theory of Section 5.1 more specific to the Vancouver Island situation and then to combine this theory with the particular socio-economic framework of the Island.

5.2.1 Description of the resource

Wildlife populations, especially of coastal black-tailed deer, do not lend themselves to a quantitative inventory. Problems with visibility and high mobility of deer preclude the potential for absolute number estimates. Trend data obtained from reproductive parameters, from night counts, or from pellet group counts are more typical estimates of population status or population description. Although changes with these trend data help us to describe changes in deer numbers (but only in a relative sense), even in this way, the data may only be useful after habitat changes have occurred (MacNab 1983; Potvin and Huot 1983). Even changes in the habitat are hard to quantify and sometimes hard to identify. Managers must perceive changes in the same manner that deer perceive changes.

Ultimately, managers want to relate numbers of deer to quantity and classes of habitat. Traditional methods for attempting to describe the resource in this manner involve confounding factors (Potvin and Huot 1983). Given the scenario where a deer population has low reproductive rates, should the manager blame poor habitat (i.e., low carrying capacity) or overpopulation accompanied with range deterioration?

5.2.1.1 Deer populations: distribution and density

Historical data on black-tailed deer populations on Vancouver Island are meagre. At the turn of the century, Hudson Bay shipping records indicated that deer hides shipped from south Vancouver Island exceeded 20,000 annually. Cowan (1945) estimated deer densities in mature forest to be as low as one per square kilometre or less. This idea persisted till the early 1970's at which time data from numerous surveys in unlogged watersheds indicated mature to overmature forests can support substantial deer populations. There is no evidence to suggest that deer numbers were any different historically than they are today (wolf predation excepted) on the basis of individual habitat type alone (such as mature versus cutovers). Given the extensive logging in recent years (1940-1980), which has produced a higher proportion of young seral stages capable of supporting more deer, the total island population of deer may be greater than it was before logging.
The population of black-tailed deer on Vancouver Island was estimated in 1979 to be within the range of 150,000 to 300,000 (49% of the provincial deer herd). According to pellet group surveys, deer densities decreased by 50-80% in the Koprino, Nimpkish, Tsitika, Adam, and White river valleys between 1974 and 1980 (Table 4).

Based on all known data on deer populations, the past and present distributions and abundances of deer are illustrated in Figures 5 and 6. These figures compiled in the early 1970's (Figure 5) and 1980 (Figure 6) indicate that, while the overall distribution of the species remains unchanged, the abundance has varied. South Island numbers appear to be up (prior to the 1981/82 winter), probably due to the recent series of mild winters during 1976 to 1980, while North Island numbers are down due to wolf predation and possible habitat degradation (Hebert et al. 1981; Hatter 1982; Jones and Mason 1983).

Relative differences and changes in deer density have been measured almost entirely from pellet group surveys (Table 4). These surveys indicate densities in unlogged watersheds vary from less than one deer per square kilometre on the southwest coast to 12 deer per square kilometre in a number of unlogged watersheds on northern and central Vancouver Island (Table 4). Densities in partially logged watersheds have exceeded 20 deer per square kilometre. Generally, pellet group surveys indicated densities of deer in partially logged areas to be 50-100% greater than in unlogged areas (Nimpkish or Adam versus Tsitika). Further, densities in advanced second-growth forests, such as the Sayward Provincial Forest, tended to be 20-30% of densities in unlogged, old-growth forests (Table 4).

Densities of deer on Vancouver Island appear to be similar to those observed in Washington and Oregon, slightly lower than those in California, and higher than those in Alaska (Table 5). It is difficult to make realistic comparisons because observed deer density can vary tremendously with such factors as successional stage, amount of logging, severity of previous winter, hunting and predation pressure, and observer biases.

5.2.1.2 Deer habitat: present status and capability

The present status of deer habitat is known in general terms for most of the Island, but in specific terms for only a small proportion of it. The rate and wide extent of logging and other forestry activities make it difficult to keep an up-to-date inventory of habitat.
TABLE 4. Deer density in various Vancouver Island watersheds based on pellet group surveys. (Watershed unlogged = N, partially logged = L, advanced second growth = SG).

<table>
<thead>
<tr>
<th>Area</th>
<th>Watershed</th>
<th>Deer - years/km²</th>
<th>Percent change</th>
<th>Source(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Early 1970's</td>
<td>Late 1970's</td>
<td></td>
</tr>
<tr>
<td>North Coast</td>
<td>Klotchlimmis(N)</td>
<td>12</td>
<td>--</td>
<td>Townshend 1980</td>
</tr>
<tr>
<td></td>
<td>Koprino(N)</td>
<td>10</td>
<td>2</td>
<td>- 80% Davies 1975, 1978a</td>
</tr>
<tr>
<td></td>
<td>Stranby(N)</td>
<td>6</td>
<td>--</td>
<td>Davies 1974e</td>
</tr>
<tr>
<td></td>
<td>Wanokana(N)</td>
<td>--</td>
<td>2</td>
<td>Davies 1978b,c</td>
</tr>
<tr>
<td>N.W. Coast</td>
<td>Klaskish(N)</td>
<td>8</td>
<td>8</td>
<td>- 0% Davies 1974a, 1979</td>
</tr>
<tr>
<td></td>
<td>Quockjinish(N)</td>
<td>10</td>
<td>--</td>
<td>Townshend 1977a</td>
</tr>
<tr>
<td></td>
<td>Power(N)</td>
<td>--</td>
<td>20</td>
<td>Townshend 1977a</td>
</tr>
<tr>
<td></td>
<td>Tehsish(N)</td>
<td>8</td>
<td>--</td>
<td>Townshend 1975, 1977b</td>
</tr>
<tr>
<td></td>
<td>Tulpana(L)</td>
<td>10</td>
<td>--</td>
<td>van Drimmelen 1977</td>
</tr>
<tr>
<td></td>
<td>Zeballos(L)</td>
<td>12</td>
<td>--</td>
<td>Leigh-Spencer 1974</td>
</tr>
<tr>
<td>Nimpkish</td>
<td>Shoe/Cain Mountain(L)</td>
<td>9²</td>
<td>60%</td>
<td>Jones 1975,1978</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
<td>4</td>
<td>- 80% Davies 1980</td>
</tr>
<tr>
<td>N.E. Coast and Interior</td>
<td>Adam(L)</td>
<td>16</td>
<td>8</td>
<td>50% Davies 1978b,c</td>
</tr>
<tr>
<td></td>
<td>Claude Elliot(N)</td>
<td>12</td>
<td>4</td>
<td>70% Davies 1974a, 1978</td>
</tr>
<tr>
<td></td>
<td>Nisnack(N)</td>
<td>8</td>
<td>--</td>
<td>Davies 1974b,c</td>
</tr>
<tr>
<td></td>
<td>Tsitika(N)</td>
<td>12</td>
<td>4</td>
<td>Davies 1974d</td>
</tr>
<tr>
<td></td>
<td>White(L)</td>
<td>12</td>
<td>5</td>
<td>60% Moir 1979</td>
</tr>
<tr>
<td>Sayward Forest</td>
<td>Mohun/Campbell(SG)</td>
<td>3</td>
<td>--</td>
<td>Townshend 1980</td>
</tr>
<tr>
<td>East Coast</td>
<td>Northwest Bay(L)(SG)</td>
<td>25</td>
<td>10</td>
<td>60% Gates 1968</td>
</tr>
<tr>
<td></td>
<td>Nanaimo River(L)²</td>
<td>--</td>
<td>30</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Cowichan(SG)²</td>
<td>10</td>
<td>10</td>
<td>Townshend 1980</td>
</tr>
<tr>
<td>S.W. Coast</td>
<td>Clayoquot(N)</td>
<td>--</td>
<td>&lt;1</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Klunawa(L)</td>
<td>--</td>
<td>&lt;1</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Megin(N)</td>
<td>&lt;1</td>
<td>--</td>
<td>Davies 1974c</td>
</tr>
<tr>
<td></td>
<td>Nahmint(N)</td>
<td>&lt;1</td>
<td>--</td>
<td>Davies et al. 1976</td>
</tr>
<tr>
<td></td>
<td>Toquort(N)</td>
<td>&lt;1</td>
<td>--</td>
<td>Jans and Nyberg 1973</td>
</tr>
<tr>
<td></td>
<td>Walbran(N)</td>
<td>--</td>
<td>&lt;1</td>
<td>--</td>
</tr>
</tbody>
</table>

1 Deer - years/km² = # pellet groups X 10³ m² X 1 year X 1 deer-day

2 Pellet group surveys conducted on wintering areas only.
FIGURE 5. Estimated distribution and abundance of black-tailed deer on Vancouver Island (1968-1974).
FIGURE 6. Estimated distribution and abundance of black-tailed deer on Vancouver Island (1980).
TABLE 5. Densities of black-tailed deer in cutover habitats of the Pacific Northwest

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of deer per km²</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vancouver Island</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southeast Coast</td>
<td>19 - 23 (average)</td>
<td>Robinson (1958)</td>
</tr>
<tr>
<td>Northwest Bay</td>
<td>16 - 30 (average)</td>
<td>Gates (1968)</td>
</tr>
<tr>
<td></td>
<td>10 - 20 (average)</td>
<td>Kale (1976)</td>
</tr>
<tr>
<td>Nimpkish</td>
<td>15 - 20 (average)</td>
<td>Willms (1971)</td>
</tr>
<tr>
<td></td>
<td>40 - 80 (spring range)</td>
<td>Jones (1972)</td>
</tr>
<tr>
<td>Adam River</td>
<td>16 - 25 (average)</td>
<td>Davies (1974b)</td>
</tr>
<tr>
<td>White River</td>
<td>10 - 20 (average)</td>
<td>Davies (1974b)</td>
</tr>
<tr>
<td><strong>Washington</strong></td>
<td>19 - 20 (average)</td>
<td>Brown (1961)</td>
</tr>
<tr>
<td><strong>Oregon</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tillamook Burn</td>
<td>12 (average)</td>
<td>Einarsen (1946)</td>
</tr>
<tr>
<td></td>
<td>23 (average)</td>
<td>Crouch (1968)</td>
</tr>
<tr>
<td></td>
<td>21 (average)</td>
<td>Hines (1975)</td>
</tr>
<tr>
<td><strong>California</strong></td>
<td>17 - 31 (average)</td>
<td>Anderson et al. (1974)</td>
</tr>
<tr>
<td></td>
<td>37 (average)</td>
<td>Bonn (1967)</td>
</tr>
<tr>
<td><strong>Alaska</strong></td>
<td>5 - 10 (average)</td>
<td>Schoen and Wallmo (1978, 1979)</td>
</tr>
</tbody>
</table>
Cover

Forest harvesting on Vancouver Island directly modifies "cover" for black-tailed deer. The impact is usually in the form of large-scale clearcuts and as such would probably affect all three aspects of cover: thermal cover, security cover, and cover from deep snow.

On Vancouver Island, cold chilling conditions may be important. Bunnell (1979) suggested that deer on Vancouver Island bear no significant thermoregulation costs in winter. This simply means that thermoregularity costs over and above those that the deer can cope with are not a concern; and secondly, that deer do not appear to respond physiologically (with increased metabolic rate) unless the microclimate change is very severe. The combination of cold, wet spring weather, however, may provide a thermoregulatory problem for deer. The "effective temperature" is expected to be much lower due to the moisture.

How forest harvesting affects security cover is not known. Since wolf populations on Vancouver Island have increased concurrently with increased forest harvesting and decreasing deer populations, it is not known to what extent deer need security cover or even what constitutes security cover.

The fact that deer use old-growth forests for cover from deep snow is well documented for Vancouver Island (Jones 1974; Weger 1977; Harestad 1979) and for southeast Alaska (Bloom 1978, Wallmo and Schoen 1980). Prior to wolf population increases on Vancouver Island, shelter from snow was considered the primary limiting factor to island deer populations. Current research has followed a course from literature review and data synthesis (Shank and Bunnell 1982a, 1982b; Jones and Mason 1983; Bunnell et al. 1985; Nyberg 1985) to research proposals (Bunnell 1984; Nyberg et al. 1985a), and finally data collection which is currently in progress under Phase I of the IWIFR project (Section 1). Although other aspects of deer ecology are considered, the major goal of ongoing research directly addresses the issue of cover from deep snow (Nyberg et al. 1985a). General objectives are to understand when deer select cover from snow, what characteristics of cover appear most important, and, through adaptive management, how forestry practices modify those important aspects of cover (Nyberg et al. 1985a).
Nutrients

Food habits and forage selection are well documented for black-tailed deer on Vancouver Island. Generally, food habits vary tremendously between areas and seasons both in terms of species composition and relative proportion of species in the diet (see Section 5.1.2.5 for detail). Protein levels of deer forages on Vancouver Island (lichen excluded) range from 5-13% (Gates 1968; Rochelle 1980; Ellis 1984), and thus it would appear that at lower levels, protein content could be limiting. However, recent research on urea recycling in wild ungulates (deer and elk) (Robbins et al. 1974; Mould and Robbins 1982) has resulted in a decreased concern for protein as a limiting nutrient (modified from Nyberg 1985).

On Vancouver Island, estimates of forage availability for deer are limited to a few studies in two areas on Vancouver Island: the southeast coast (Cowan 1945; Gates 1968) and the Nimkpish Valley (Harestad 1979; Rochelle 1980). These studies provide estimates for old-growth and young seral stages, but little data on older regenerating stands. (For a review of forage production estimates, see Nyberg [1985]). The work and resultant estimates are only sufficient for making some broad generalizations about stand type and forage production (i.e., some old-growth stands provide more forage than some clearcuts and older regenerating stands appear to provide less forage than either old growth or clearcuts) (Nyberg 1985). Much more work, both on inventory and research, will be required to derive estimates sufficiently reliable to assess habitat quality on the basis of forage availability.

Over most of Vancouver Island forage availability is also influenced by snow. Dependent on regional climate and topography, snow accumulations restrict the availability of habitat during the winter season, and thus limit food availability. Snow also buries forage. The actual reduction in forage availability due to burial depends on both species composition and species growth forms in the understory (Harestad 1979). In some situations, forage species also differ in quality, with the shortest plants generally having higher quality. Burial by snow, therefore, can also cause a reduction in quality of the total forage. Elevation, slope, and aspect are important in determining deposition,
accumulation, and melt of snowpacks, thus indirectly influencing seasonal availability of range and seasonal distribution of deer.

Lichens have been identified as a major component of deer winter diets (Cowan 1945; Gates 1968; Jones 1975; Rochelle 1980). Cowan and Rochelle both reported values of lichen content being approximately 36% of rumen volume in winter. In mild winters Jones and Gates reported the content as 10-11% of the rumen volume. Although, managers recognize lichens as an important constituent of black-tailed deer winter range, it is not understood how lichen abundance could be managed in second-growth forests.

Stevenson (1978) assessed abundance of lichen biomass in old-growth stands on Vancouver Island. A visual estimate technique based on an estimate of lichen cover and crown length of trees provided a sufficient technique for coastal forests. Current efforts are aimed at: 1) evaluating lichen abundance and deer winter habitat selection; 2) reviewing inventory methods for quantifying lichen abundance; and 3) producing a problem analysis concerning the potential to introduce and propagate lichens in young, second-growth forests as an available winter forage for deer.

Temporal and spatial variation

Temporal and spatial variations in the physical environment were identified as potential influences on deer and deer populations (Section 5.1.1.3). The best discussions on this subject to date are provided by Wallmo and Schoen (1980) and Bunnell et al. (1985). Of primary concern is the inter- and intra-winter variation in weather. Spatial variation appears to be important at two levels: 1) the watershed level (e.g., proximity of spring forage areas to winter habitat; number and distribution of winter ranges; and 2) the seasonal habitat level (e.g., spatial distribution of snow in winter ranges).

Current information about spatial and temporal variations in a deer's physical environment for Vancouver Island is meagre and simply descriptive, centering exclusively around snowpack accumulation patterns.

The primary factors restricting the physical availability of habitats are snow (Section 5.1.1.3) and forestry activities, which can totally remove habitats (by harvest) or physically preclude their use because of debris barriers. Deer responses to these physical
restrictions on habitat availability are obvious: deer do not use the area, or they move away, a response which, if prompted by snowpacks, is observed as a seasonal movement or migration.

Below 300 m elevation on Vancouver Island, snow is ephemeral and the total range is available to deer except in the most severe winters. Above 1000 m deep snowpacks are present in most winters. Deer are restricted below this elevation for 3-6 months, most often below 800 m. Above 300 m is referred to as "mountainous", inferring frequent snow and an apparent need for winter range in the 300- to 1000-m elevation range.

Slope also influences snow depth (vertically) and thickness (perpendicular to slope) by its effect on the ratio of surface area to horizontal area (Bunnell 1978; Bunnell et al. 1985).

With increasing slope steepness, a given amount of snowfall is distributed over an increasingly large area, resulting in a greater proportion of the snowpack being exposed to air and radiant energy. All other things being equal, the rate of snow ablation (melt) will be proportional to surface area. Over the course of the winter, snow accumulation will generally be negatively related to slope angle.

Aspect is also very important. South aspects are exposed to more solar radiation than are north aspects. Radiation increases with steepness of slope on south aspects and decreases on north aspects. Snow ablation varies accordingly. Thus, it might be expected that steep south slopes are usable longer in fall, winter, and spring than are shallow south slopes or any north slopes.

Considering the low sun angle at northern latitudes during winter and the steep topography of much of Vancouver Island, shading of the slope by adjacent mountains is another factor to consider. Unshaded, south-facing slopes may have less snow than shaded slopes, and therefore could provide more accessible green forage.

In summary, on Vancouver Island, topography potentially can have a large influence on the distribution of winter snowpacks and the resultant restricted range available to deer. The distribution of winter deer use in high snowfall areas of Vancouver Island as determined from total watershed pellet group survey does indeed appear to be related to snowpack distribution. The highest deer use was found on steep, unshaded, southerly aspects (from surveys in Tsitika, White, Adam, Nisnack, Northwest Bay; see Table 4).
In the mountainous areas of Vancouver Island the winter snow accumulations would limit deer populations below forage carrying capacity. Many authors (Bunnell et al. 1978; Harestad 1979; Hanley 1981) have provided the following argument: If wintering capabilities of an area are modified adversely by timber harvesting, spatial patterns of deer habitat use may shift. Harvesting results in lowered quality of some areas and raises the relative quality of the remaining winter range areas. If the net effect is to concentrate deer to a density greater than the forage carrying capacity, then the relative value of the forage within winter ranges will decline.

Summary

The following summary describes the status of deer habitat in terms of general logging patterns for those parts of the Island where the expected demand for deer will be moderate to high (see Section 5.2.2). Expected low demand areas are excluded.

a) Southern Vancouver Island (Victoria to Campbell River)

Most old-growth forests have been liquidated in the Douglas-fir and Dry Western Hemlock Biogeoclimatic Zones, with the remaining logging activity concentrated in the Wet Western Hemlock and Mountain Hemlock Zones. Few old-growth winter ranges remain. Options for maintaining static level deer populations in the higher snowfall portions of this area are limited. Presently most potential deer wintering areas in these higher snowfall areas consist of very young second growth (5-30 years) that will not likely have much wintering capacity for many years. Short-term options for enhancing second growth for winter range exist only at elevations below 400 m near the coast. Older, second-growth stands (50+ year) are more prevalent in these lower elevations.

b) Central Vancouver Island (area bounded by Campbell River, Gold River, Port Alice, and Beaver Cove)

The Wet Douglas-fir and Dry Western Hemlock Subzones have been logged extensively, particularly in the Sayward Forest, the Salmon River valley, and the Nimpkish River Valley. Most old growth on the low coastal plain area has been cut, and logging is now at higher elevations into the Wet Western Hemlock Subzone. Most areas have a considerable number of years of logging left, but low-elevation winter logging is in short supply. A portion of the deer winter ranges has been maintained;
thus some deer populations may be retained in high snowfall areas. Options for immediate enhancement of second growth for deer winter range are again limited to low elevations, that is, low snowfall areas. Many winter ranges in higher snowfall areas have been logged recently so that regeneration is only 5-10 years old or in the case of the Sayward forest, 20-40 years old. Some cutovers adjacent to winter ranges are being considered for silvicultural manipulation to produce spring forage.

c) North Vancouver Island (Port Hardy Area)

Logging has been extensive in the Port Hardy, Holberg, Port Alice, and Port McNeil quadrangle. Most of the higher quality stands have been logged, and forest companies are now exploiting lower quality stands. Winter ranges have been protected where necessary. Enhancement of second-growth stands for deer will likely be limited to a few spring forage areas at higher elevations and possibly some lower elevation areas in the Wet Hemlock Subzone.

d) Opportunities to enhance second growth for winter range

An examination of recent Tree Farm Licence (TFL) management and working plans (#7, #39, #37) and some rather dated forest stand data for all MacMillan Bloedel Divisions on Vancouver Island (B.C. Wildlife Section files, Nanaimo) indicated that less than 20% of the second-growth stands exceeded 50 years of age and less than 2% exceeded 100 years. Additionally, most of the 50+ year-old stands were located at very low elevation (i.e., low snowfall areas). Work by numerous investigators (Jones 1974; Kale 1976; Harestad 1979) has suggested that second-growth stands, if left to develop undisturbed will not attain the necessary deer winter range characteristics (i.e., lichen abundance, uneven age canopy, snow accumulation and ablation patterns, litterfall, forage abundance and diversity) for 200 years or more. It may be possible to hasten the attainment of these characteristics via silviculture. (e.g. Nyberg et al. 1985b). The viability of this option in moderate snowfall areas is high if it can be demonstrated that 50- to 80-year-old stands can be made to provide adequate winter range. One of the focuses of the IWIFR project will be to see if winter range can be developed in young stands (Nyberg et al. 1985b).
The original 1:50 000 Canada Land Inventory (CLI) maps have not been upgraded or corrected, but Figure 7 illustrates the current thinking within the B.C. Wildlife Section about Island-wide deer production capabilities. Capability was determined by considering the estimated densities of deer in old-growth watersheds versus logged watersheds. Intra-specific competition and the influence of predation were not considered.

5.2.1.3 Deer predators

The major predators of deer on Vancouver Island are wolf, cougar, and black bear. Wolves are by far the most important predator and, in light of recent investigations, appear to be limiting deer numbers (Hatter 1982; Jones and Mason 1983). Most influence from predators to date has occurred in the northern Vancouver Island region. Based on sightings, distributions, and the hunter sighting index, wolf numbers have increased during the 1970's and early 1980's while deer numbers have decreased (Atkinson and Janz 1983).

Although wolves are suspected to be limiting deer populations, the nature of the predator-prey system remains unclear (Section 5.1.2). Presently there is no direct information that predators, such as wolves influence seasonal movements and habitat selection by deer (Hatter 1982; Jones and Mason 1983). Jones and Mason (1983) suggested that increased wolf activity did not appear to change the nocturnal use of cutovers by deer in the Nimpkish Valley. The actual need for escape or hiding cover and the spatial aspects of escape cover and feeding require more investigation (McNamee et al. 1981). A more specific discussion on problems concerning the Vancouver Island wolf-deer interaction is given by Hatter (1982).

5.2.1.4 Competition

Competition between deer and their conspecifics on Vancouver Island is probably infrequent, but it is possible that local problems exist. These conflicts occur when "islands" of prime habitat remain following some ecologically catastrophic event (e.g., fire or logging).

Inter-specific competition may arise between elk and deer on deer winter ranges, as well as on spring forage production areas. The White and Adam watersheds and the Nimpkish Valley all experience elk and deer range overlap, particularly on prime deer winter ranges, which suggests competition. Deer and elk in the Power River watershed on the west coast of Vancouver Island
FIGURE 7. Apparent capability of Vancouver Island to support deer (from Nyberg 1985).
also experience competition. The significance of the competition with respect to depletion of the resource base is unclear. No quantitative data exist to enable evaluation of the competition that occurs in the Nimpkish and Power river watersheds.

5.2.1.5 Behaviour

The following discussion concerning behaviour of Vancouver Island black-tailed deer comes from four sources: Gates (1968); Jones (1975); Harestad (1979); and Rochelle (1980). Quantitative data exist only for food habits and seasonal home range selection. Knowledge about courtship, response to physical environment, and anti-predator strategies is anecdotal at best.

Habitat selection and home range

Selection for old-growth timber as cover is well documented in the situation where only open clearcut habitat or old-growth habitat types were available during winters with high snowfall (Jones 1975; Harestad 1979). Ongoing studies indicate this same selection exists when young second-growth habitat is available as well (Doyle et al. 1985). No information is available from locations where deer have the potential to select from open, young second-growth, older second-growth, or old-growth habitat types. Some of the older second-growth stands provide adequate snow shelter but provide little forage. Although selection is thought to be based on factors relating to reduced snow depth, the importance of other parameters such as thermal cover, security cover, and forage availability is still unclear. No study to our knowledge has provided quantitative data regarding security cover or thermal cover. It is also important to note that seasonal movements such as migration may be related to such variables as seasonal differences in food supply, although there appears to be a large learned or inherent basis for the behaviour (Harestad 1979). Preliminary evidence suggests that site fidelity may override specific habitat selection regardless of winter condition.

Home range use and habitat selection were described by Harestad (1979) for five deer on northern Vancouver Island. Home range size varied considerably among individuals, but a consistent decrease in size from summer to winter ranges occurred. Similar patterns have been
observed in the study under progress in the Nanaimo River region of Vancouver Island (Doyle et al. 1985).

Harestad (1979) found deer to use home ranges rather than territories and commented further that this confirms predictions by Geist (1974) concerning the spatial organizations of ungulates in environments with seasonal fluctuations in availability of resources.

**Predator avoidance**

Little or nothing is known regarding Vancouver Island black-tailed deer predator avoidance strategies, or even if they have any.

**Food habits**

Food habits of black-tailed deer are best summarized by Rochelle (1980) (Figure 8). Jones (1975) found that conifers, shrubs, and lichens occurred in 50% of the rumen samples taken during a severe winter. During a mild winter, ferns and forbs occurred in 50% of the rumen samples in addition to conifers, shrubs, and lichens. Rochelle (1980) described black-tailed deer as opportunistic feeders since a relatively high consumption of forage items (such as shrub berries and fungi) were available for only short periods of time.

5.2.1.6 Growth and regulation

The two theoretical bases for explaining population growth and population regulation outlined in Section 5.1.5 (i.e., carrying capacity and net energy gain/loss) have rarely been applied to Vancouver Island deer. Jones and Mason (1983) used reproductive parameters, night counts and pellet group counts to evaluate growth and reproduction of northern Vancouver Island deer populations. The following aspects of carrying capacity were assessed: 1) predation by wolves and human hunters; 2) cover changes caused by forestry activities, and 3) climatic dynamics of the physical environment. Population trends indicate that annual recruitment was initially high, but later reduced by the severe winters of 1968-69 and 1971-72. Despite subsequent mild winters which allowed populations to rebound, pressure by wolves and hunters is believed to have kept numbers relatively low. Wolf activity was negatively correlated with a 75% reduction (occurring over 6 years) in deer numbers (Jones and Mason 1983). Currently deer number indices remain low, indicating approximately 2-9 deer per square kilometre in most northern Vancouver Island watersheds (Table 4).
FIGURE 8. Seasonal importance values (%) for forage types consumed by black-tailed deer in forested and cutover habitats. Importance value is the product frequency of occurrence and percent volume. Percent importance value is the importance value of individual types divided by the sum of importance values for all types (from Rochelle 1980).
The "net energy" approach to date has been primarily in the form of conceptual models, and thus its discussion is reserved for Section 5.4.2. It should be pointed out, however, that the energy approach is best suited for predator-free environments unless predation rates are well defined.

In recent times, old-growth logging (causing extreme temporal and spatial changes in cover and available nutrients), a few irregularly spaced, severe winters, and increases in wolf populations have produced extremely complex and poorly understood changes in Vancouver Island deer numbers.

On Vancouver Island it is clear that the recent increases in wolf populations are now seriously limiting deer populations (Jones and Mason 1983). Shelter from snow, as well as winter forage availability and quality -- either alone or as modified by snow, are other major factors limiting deer populations. The abundance, distribution, and quality of forage resources fluctuates seasonally, being most abundant in summer and least available in winter. The deer's body reserves accumulated prior to winter, and the rate of depletion of these reserves over winter, determine the welfare of the deer. If wolves and hunters were absent from the snow-free coastal areas of Vancouver Island, then forage quantity and quality would probably limit deer. There is no direct evidence at this time to suggest that summer or fall food resources are limiting to Vancouver Island deer.

5.2.2 The nature and extent of public demand: past, present, and projected

Public demand for deer is primarily for recreational and guided hunting, with the latter representing only about 5% of the current estimated harvest of deer. Other demands include non-participatory, non-consumptive, and genetic conservation.

Demand and use of deer is assessed by four measures: harvest, number of hunters, number of hunter days, and hunter success (deer per hunter or deer per hunter day). These data are derived from the hunter sample (a voluntary mail questionnaire), regional game or road checks, and access or gate records kept by logging companies. In combination, these sources of information indicate changes in harvest and hunter effort.

From a provincial perspective, Vancouver Island has, over the period of 1960 to 1980, contributed an average of > 40% of the provincial deer harvest. Island deer hunting has accounted for 35-50% of the provincial recreational hunting days spent on deer.
Since 1950 the Vancouver Island deer harvest has varied between 5000 and 28 000 deer, averaging 16 400 ± 1060 (X ± S.E.) (Figure 9). The distribution of the harvest has also varied over the past 20 to 30 years (Figure 9). In the mid 1960's, 80% of the harvest was from the south half of the Island, and 20% from the north half. By the early 1970's, the north half's proportion of the harvest was 60%. During the mid and late 1970's, deer herds and harvest declined dramatically on the north Island coincident with a large increase in wolves (see Section 5.2.1.6), so that by 1984, the north Island contributed only 20% of the harvest.

The number of hunters on Vancouver Island fluctuated around 20 000 between 1960-1980 but has declined to 14 000 since 1980 (Figure 9). Approximately 78% of these hunters reside on the South Island (hunter questionnaire data). For 1976 to 1984, the years for which we have data specific to management units, the proportion of Vancouver Island hunters who hunt the north Island declined from 60 to 30%. The proportion of south Island hunters who travelled north to hunt dropped from 37% in 1976 to 20% in 1984.

The data on hunter days spent on Vancouver Island for all seasons are limited to 1976-1984. During this period hunter days increased from approximately 140 000 to 190 000 in 1982 but has returned to 140 000 in 1984. The proportion occurring on the north Island dropped from 40 to 25%, as might be expected from the changes in distribution of hunters.

Hunter rates of success have declined all over Vancouver Island from 6 to 8 days to bag a deer in the 1960's, to 15-20 days required in the early 1980's. On the north Island the decline has been more recent and pronounced (Figure 9).

In summary, the number of hunters remained essentially constant on an Island-wide basis for 20 years, but has dropped in recent years; deer harvest has declined mostly on the north Island; hunter effort (measured in days) has fluctuated considerably, and has shifted to the south Island; and hunter success rates have declined in all areas of Vancouver Island over the last 10-15 years.

Projected demand for deer in the next 10-20 years and beyond are now being prepared. Present projections, though only in general, suggest that in the next 5-10 years harvests are likely to continue declining. One reason is that south Vancouver Island areas did not have sufficient amounts of winter range to support the deer population in the moderately severe winter of
FIGURE 9. Hunter/harvest/success trends on Vancouver Island from the early 1950's to 1984: (A) Hunter effort (days/deer) for south island (---); north island (-----); and total island (-----); (B) Season success (deer/hunter) (-----) and total hunters (-----); and (C) Total deer harvested for the island (-----); proportioned by north and south Islands. Estimated trends are depicted by (-----).
1981/82, and approximately 30% of this population died (B.C. Fish and Wildlife surveys - spring 1982). Another reason is that wolves are presently increasing on southern Vancouver Island and deer numbers may decline as they did on the north Island during the mid 1970's (Hebert et al. 1981; Jones and Mason 1983). On the north Island, harvests and deer populations will likely remain low or even decrease further unless wolves become less plentiful and unless present winter ranges are preserved.

Despite these forecasts it is expected that potential demand for deer will increase gradually. This expectation is based on a constant participation rate for recreational hunting and a projected increase in the human population of Vancouver Island and the Lower Mainland.

Non-consumptive use will likely be greatest within easy travelling distance of population centres, and in or adjacent to parks or other major public recreation areas.

Consumptive users will no longer be able to exploit either large deer herds, such as those of the 1950's and 1960's, or a continual supply of newly accessed or logged areas. Future demand will depend less on this exploitative type of hunting and more on factors such as traditional hunting habits, travel costs, aesthetics, reasonable access, and the capability of an area to produce deer for harvest.

Approximately one-third of Vancouver Island will contribute little towards meeting anticipated demand for deer (Figure 10). This one-third consists of:

1. areas of Vancouver Island where hunting is severely restricted or is not allowed, as in parks and in high-growth urban areas on the east coast and Gulf Islands,

2. areas where access is extremely restricted (usually to boats only) such as off-shore islands and a large portion of the rugged west coast between Barkley Sound and Quatsino Sound, and

3. areas of demonstrated low capability for supporting substantial numbers of deer. This includes the southwest coast of Vancouver Island from Muchalet Inlet south, to just north of Port Renfrew. As well, half of this area is restricted access.

The remaining two-thirds of Vancouver Island can be rated as low, moderate, or high-demand hunting areas on the basis of capability, location relative to population centres, and attractiveness for hunting. Figure 10
Anticipated demand for deer hunting on Vancouver Island.

FIGURE 10.
illustrates the current thinking about future hunting demand for deer on Vancouver Island.

5.2.3 Goals and objectives

Province wide, the first objective is to increase the deer population from 425,000 to 475,000 animals distributed in their present range; the second is to provide 900,000 hunter days of recreation with an annual kill of 60,000 (15 days per deer harvested); and the third is to provide opportunities for people to view deer in natural habitats. All three objectives seek to meet societal needs, especially consumptive demands. The projected increase in deer populations assumes a like increase in demand.

The management objectives for Vancouver Island black-tailed deer are derived from provincial objectives. The Regional objectives (B.C. Ministry of Environment 1980) are:

1. To maintain deer numbers at present day or historical levels, depending upon carrying capacity:
   i) In partially logged watersheds where mature and old-growth timber have been deferred for winter range, the objective will be to maintain deer production at levels comparable to the 1970-1980 levels; and
   ii) In the second-growth forests of productive watersheds, the objective will be to increase production from the present level of 2-5 deer per square kilometre to historic levels of 10 - 20 deer per square kilometre.

2. To maintain a minimum annual harvest of 15,000 ± 5000 deer. These objectives are based on an underlying approach of optimizing consumptive and non-consumptive use of deer.

Meeting these two objectives requires two types of action: first, to optimize deer production in second-growth; and second, to maintain the habitat necessary to sustain deer in severe winters at numbers sufficient to meet production targets.

5.2.4 Deer management activities: current, problems projected

Managing to meet stated objectives means that biologists must be able to adequately inventory the characteristics of deer habitat (food and cover aspects), monitor changes in the structure and size of deer populations over time and space, estimate the effect of predators, estimate and control
recreational use of deer, and finally, assess the effectiveness of management strategies.

At present, deer management on Vancouver Island is subjective, extensive, and largely unchanged over the last 30 years. Harvests are monitored via game checks (discontinued in 1981 due to insufficient funds) and hunter questionnaires. Control is attempted by setting season length and bag limits. Harvest data are used to supplement indices of population trend and structure because reliable, cost-effective inventory methods are unavailable.

The current goals of habitat management for deer on Vancouver Island are to preserve critical habitat and to maintain future habitat management options. Although it is not a current practice, future habitat management will be aimed at improving some existing habitat. Ideally, these goals should be met with the maintenance of sufficient habitat, of sufficient quality, to sustain the number of deer required to meet specific deer management objectives. These goals should be accompanied by a legislated mandate to manage habitat by specific population objectives, specific production goals, specific data on deer numbers and condition, specific data on range quality, and a sound and sufficient understanding of deer habitat relationships.

None of these accompaniments is present on Vancouver Island, making present habitat management basically habitat protection. This is done mostly on the basis of general principles of ungulate ecology, and some limited site knowledge and extrapolation of knowledge gained through research in a few areas such as the Nimpkish Valley and Northwest Bay.

On Crown forest lands, BCFS solicits recommendations for protection of wildlife habitat from the Wildlife Branch, though these are not necessarily implemented. Forest lands on the remaining third of the Island are controlled primarily by private forest companies and within this area wildlife managers have little or no affect.

Most of the present habitat protection for deer on Vancouver Island is directed at old-growth forests. The Habitat Management Section of the Vancouver Island Region of the B.C. Ministry of Environment regularly evaluates logging plans on Crown land for their potential impacts on deer habitat. Based on this evaluation, recommendations are made to minimize negative impacts. The major prescriptions are:
1. Protecting winter range habitat by deferring such areas from cutting, and attempting to have such areas removed from the annual allowable cut (AAC).
2. Providing planned release of areas for spring forage by issuing cutting deferrals.
3. Stipulating green-up periods for cutovers in an attempt to provide forage and cover.

In the mid 1970's, habitat protection activities for Vancouver Island deer were formalized with the preparation of "Habitat protection guidelines for ungulates" (Davies 1976). Originally, these guidelines were prepared to bring some order to what was, at that time, a rather chaotic "fire-fighting" system of habitat protection. The guidelines were based on an overall subjective assessment of what biologists knew about deer and their habitat requirements, and what they felt was necessary to sustain deer populations on all areas of Vancouver Island.

The Island was divided into habitat protection zones for which zone-specific prescriptions were developed based on the amounts of winter range, the cut rates, the green-ups, and the cutblock sizes and locations. The primary step in defining zonal boundaries was to delineate land units wherein standard prescriptions could be applied. The zonation was not, as has often been mistakenly believed, based solely on land capability to support deer. Capability was a major consideration, but the zonation also considered logging development, remaining options for maintaining deer, land tenure, recreational demand, and access. Thus the zonation was essentially subjective, and based on the idea that habitat protection measures should be applied most strongly in areas where the Ministry of Environment had the best potential to maintain deer populations, and where such populations would be used most readily. On the basis of these guidelines and some subsequent field assessments, Winter Range Plans were developed for major Tree Farm Licences on Vancouver Island. Plans for providing the necessary spring forage areas adjacent to these winter ranges are presently being prepared.

If habitat protection guidelines for old-growth forests are to become less subjective, a much improved quantitative data and knowledge base and a much more specific set of objectives regarding deer population management are required. In low elevation, second-growth systems, future habitat protection activities will likely be directed towards providing adequate cover and