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Integrated Management of Timber and Deer: Coastal Forests of British Columbia and Alaska

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Foreword

Resource managers in the United States and Canada must face increasing demands for both timber and wildlife. Demands for these resources are not necessarily incompatible with each other. Management objectives can be brought together for both resources to provide a balanced supply of timber and wildlife. Until recently, managers have been hampered by lack of technique for integrating management of these two resources. The goal of the Habitat Futures Series is to contribute toward a body of technical methods for integrated forestry in British Columbia in Canada and Oregon and Washington in the United States. The series also applies to parts of Alberta in Canada and Alaska, California, Idaho, and Montana in the United States.

Some publications in the Habitat Futures Series provide tools and methods that have been developed sufficiently for trial-use in integrated management. Other publications describe techniques not yet well developed. All series publications, however, provide sufficient detail for discussion and refinement. Because, like most integrated management techniques, these models and methods have usually yet to be well tested, before application they should be evaluated, calibrated (based on local conditions), and validated. The degree of testing needed before application depends on local conditions and the innovation being used. You are encouraged to review, discuss, debate, and—above all—use the information presented in this publication and other publications in the Habitat Futures Series.

The Habitat Futures Series has its foundations in the Habitat Futures workshop that was conducted to further the practical use and development of new management techniques for integrating timber and wildlife management and to develop a United States and British Columbia management and research communication network. The workshop—jointly sponsored by the USDA Forest Service and the British Columbia Ministry of Forests and Lands, Canada—was held on October 20-24, 1986, at the Cowichan Lake Research Station on Vancouver Island in British Columbia, Canada.

One key to successful forest management is providing the right information for decisionmaking. Management must know what questions need to be asked, and researchers must pursue their work with the focus required to generate the best solutions for management. Research, development, and application of integrated forestry will be more effective and productive if forums, such as the Habitat Futures Workshop, are used to bring researchers and managers together for discussing the experiences, successes, and failures of new management tools to integrate timber and wildlife.

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Abstract

Nyberg, J. Brian; McNay, R. Scott; Kirchhoff, Matthew D. [and others]. 1989. Integrated management of timber and deer: coastal forests of British Columbia and Alaska. Gen. Tech. Rep. PNW-GTR-226. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 65 p.

Current techniques for integrating timber and deer management in coastal British Columbia and Alaska are reviewed and evaluated. Integration can be improved by setting objectives for deer habitat and timber, improving managers' knowledge of interactions, and providing planning tools to analyze alternative programs of forest management. A handbook designed to summarize relevant knowledge and assist planning in coastal British Columbia is described and examples of its contents are included.

Keywords: Deer (black-tailed), forest planning, integrated resource management, old growth, habitat ecology, timber management, British Columbia, Southeast Alaska.

Contents

Problem Analysis

Throughout Western North America, deer are the big-game animals most sought after by hunters and other recreationists. On the Pacific coast from Alaska to northern California, two subspecies of black-tailed deer attract about 3.5 million hunter-days of effort each year (table 1). Columbian black-tailed deer (*Odocoileus hemionus columbianus* (Richardson)) occupy the coastal area from Estero Bay, California, to Rivers Inlet on the central British Columbia coast, and Sitka black-tailed deer (*O. h. sitkensis* Merriam) range from Rivers Inlet north to Prince William Sound, Alaska (Wallmo 1981).

Table 1—Hunting recreation generated by black-tailed deer

State or Province	Years of survey	Hunter-days per year
Alaska	1983	69,820
British Columbia	1980-84	217,653
California	1980-84	1,229,125
Oregon	1980-82, 1984	1,471,648
Washington	1984	500,000
Total		3,488,246

Sources: Alaska Department of Fish and Game, British Columbia Wildlife Branch, California Department of Fish and Game, Oregon Department of Fish and Wildlife, Washington Department of Game.

In British Columbia and Alaska, black-tailed deer inhabit coniferous forests most of the year. As timber harvesting and stand management activities affect more than 100 000 hectares (240,000 acres) annually, the area of forest land unaffected by humans is declining steadily. In many areas of south-coastal British Columbia, deer habitats have changed since the 19th century from predominantly mature and old-growth forests to mosaics of even-aged stands of young conifers, among which are interspersed remnant patches of original old growth. Habitats are free from the impacts of humans only in parks, reserved forest lands, and areas of Alaska and northern British Columbia where logging has not been economically attractive.

Most forest land in British Columbia and Alaska is owned by Federal, Provincial, or State governments that seek multiple or integrated use of the land. Forest managers must strive to supply both timber and deer, among many other resources. This presents difficult challenges: deer depend on forested habitats that are sometimes degraded and sometimes improved by logging and silviculture, but deer can also interfere with establishment of new tree crops.[1] Managers must attempt to balance needs for winter habitat with timber harvesting, browsing damage with huntable populations, and forage availability with rapid growth in tree volume. Further, the actual number of deer in a managed area may not reflect the habitat's capability because

[1] This discussion emphasizes the effects of forestry activities on deer habitats. Although the impact of deer on forests (especially browsing damage to seedlings) is also significant, that topic is not central to the theme of the paper and is not discussed further.

numbers often change from factors beyond the land manager's control, such as predation and hunting. Periodic severe winters in British Columbia and Alaska add to the management challenges. Young clearcuts, for example, may produce high deer numbers over a series of years with little snow, but be relatively unproductive of deer during years with severe winters.

Nevertheless, because of its effect on habitat quality, forest management can be a powerful tool for manipulating land capability to produce deer (Hall and Thomas 1979, Nyberg 1987, Witmer and others 1985). For good or ill, every tree felled, planted, or fertilized has an impact on habitat value. To choose their methods and, ultimately, to satisfy their clients, public forest managers need guidance on how to allocate land to timber and deer production and how to integrate management of the two resources. The following discusses past and present approaches to providing this guidance in British Columbia and Alaska and outlines a handbook designed to improve integrated management of timber and deer in coastal British Columbia.

Historical Approaches to Resolving the Issue

The historical, social, and economic contexts of forest management differ markedly between British Columbia and Alaska, leading to differences in management strategies and flexibility. British Columbia's old-growth timber and forest land are the best in Canada, generating revenues that dwarf the economic value of deer. For example, forestry revenues (stumpage, royalties, rent, and incidental income) to the Province from the Vancouver Forest Region were $50.97 million (Canadian) in 1981 (British Columbia Ministry of Forests 1982). This figure does not include multiplier effects or taxes levied on timber companies and forest workers. The value of deer hunting, including total expenditures and a willingness-to-pay estimate, was approximately $15.38 million for the same area (estimated from figures in Reid 1985a, 1985b). Coastal forests, however, are the habitats in the Province that produce the most deer, and deer are highly valued by the public for esthetic and quality-of-life reasons (Reid and others 1986). Land-use legislation provides little guidance to tradeoffs between timber and deer: the British Columbia Forest Service is instructed only to "plan...so that the production of timber and forage, the harvesting of timber,...and the realization of...wildlife...and other natural resources values are co-ordinated and integrated..." (Ministry of Forests Act, Revised Statutes of British Columbia Chapter 72, Section 4(c), 1979). Managers have received little guidance on how to "co-ordinate and integrate" resources on a forest-land base that long ago was allocated almost entirely to timber production and has been heavily harvested since.

Alaskan forests, on the other hand, are less valuable and productive than those of British Columbia. Of the nearly 6.8 million hectares (16.7 million acres) of Federal land on the Tongass National Forest in southeast Alaska, only 257 000 hectares (635,000 acres) were considered "commercially important" (that is, more than 30,000 board feet per acre) by Smith and others (1983), although 708 000 hectares (1.75 million acres) are scheduled for eventual harvest (USDA Forest Service 1986). Deer populations are more lightly used in Alaska than in British Columbia, although still highly valued. Land-use law for the National Forests of the United States requires a more formal planning program than for the Provincial Forests of British Columbia, including land-use zoning, explicit evaluation of management options for all forest resources, and public consultation. Forest managers are assisted by more wildlife specialists in the United States than in British Columbia.

Deer habitat on forest land in both British Columbia and Alaska has, in the past, been provided in two ways: by allocating land to remain as unmanaged old growth and by managing young forests to produce habitat requirements that are in short supply. Both methods have often been applied on large land units such as Tree Farms and National Forests. The land-allocation approach has been used where mature and old-growth stands provide unique winter ranges that cannot be replaced by managed stands. These winter-range stands are reserved temporarily or permanently from harvesting or other management. This is conservative management: timber production is sacrificed to ensure that adequate winter habitat is available. The land-management approach has employed many systems for incorporating deer-habitat concerns in harvesting or silvicultural operations, but the goal has usually been to ensure that cover and forage areas are provided in appropriate spatial patterns and temporal sequences.

Land allocation has been an important management tool for deer in Alaska and mountainous areas of British Columbia because snowy winters in these areas impose more severe stresses than further south. When snow at high elevations or in openings buries vegetation and limits mobility, deer must forage either at lower elevations or in habitats where snow is intercepted by overhead conifers. Mature and old-growth stands with patchy canopies provide snow interception and forage (including ground vegetation and arboreal lichen litterfall) (Bunnell and Jones 1984). When logging removes critical winter habitat, many deer die during long, snowy winters (Jones and Bunnell 1984), and populations sometimes remain depressed for many years thereafter (Hebert 1979, Olson 1979).

In British Columbia, old growth on public land is allocated as deer habitat at the request of the Ministry of Environment and Parks, which is responsible for managing deer populations. The British Columbia Forest Service, the land management agency, then defers logging of the requested blocks. These "winter-range" blocks, on southerly slopes at low elevations, typically are 20-75 hectares (50-185 acres) and make up less than 15 percent of a management unit, such as a medium-sized watershed. No legislated allocation usually exists; forest managers simply refuse to approve logging plans that propose harvesting these designated winter ranges. In a few cases, legal protection has been granted by establishing winter-range areas as Ecological Reserves (Tsitika Planning Committee 1978). Approved or requested winter-range deferrals total over 100 000 hectares (240,000 acres) in south-coastal British Columbia.

Old-growth retention for deer habitat has caused considerable turmoil since 1970. Most of the stands now deferred in British Columbia were, at one time, included in the land base used to calculate annual allowable cuts, and many deferred stands still are. Continued deferral will eventually require less cutting, meaning fewer jobs and lower timber revenues than exist today. Also, many winter ranges are easily accessible by road, making them prime candidates for low-cost logging. No decision has been made on their long-term future, although a study designed to lead to such a decision was completed in 1983 (British Columbia Ministry of Environment and Ministry of Forests 1983).

Old-growth forests are allocated for wildlife production in southeast Alaska's Tongass National Forest through the National Forest planning process. The relatively small percentage of forest land scheduled for harvest in southeast Alaska makes land allocation more feasible there than in British Columbia. All old growth, however, is not equally valuable as winter deer habitat. The highest volume stands of old-growth western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) and Sitka spruce (*Picea sitchensis* (Bong.) Carr.) (usually located on valley bottoms and lowest slopes) provide superior winter habitat, particularly during periods of deep snow (Schoen and others 1984, 1985; Kirchhoff and Schoen 1987). In other seasons, and in low-snowfall periods during winter, deer move higher up the slopes and expand their ranges into lower volume old-growth stands (Schoen and others 1984, Schoen and Kirchhoff 1985). Areas with diverse old-growth stands, therefore, produce maximum numbers of deer.

Alaskan land managers would like to predict the quantity and juxtaposition of habitat types needed to carry desired levels of deer through given winter conditions, but little scientific basis yet exists for making such predictions. Deer managers have advocated preserving entire watersheds to assure that deer can meet their needs for habitat during all seasons (Matthews and McKnight 1982, Schoen and others 1984). The practicality of this approach is limited, however, because of the large amount of land that would be excluded from the timber base.

Deer managers in southeast Alaska, therefore, increasingly advocate protection of stands or patches of habitat that are of highest value to deer during severe winters. These same stands are also in shortest supply. Deer managers assume that sufficient quantities of other habitats will remain after logging to meet deer needs because the vast majority of old growth is noncommercial or marginally commercial. Thus, as in British Columbia, the question of land allocation is increasingly directed at a relatively small but important fraction of the land base.

The land-management approach has been used to enhance nonwinter and mild-winter habitats in conjunction with harvesting and silvicultural operations. This approach incorporates adjustments in pattern and timing of forest treatments to provide desired cover and forage values for deer. In British Columbia, four concerns are common: (1) adjustment of clearcut size to reduce distance to cover, (2) short-term delays in logging (3-10 years) to allow security (hiding) cover to develop in adjacent regenerating stands, (3) sequential logging of timber blocks near winter ranges to ensure spring forage is available in young cut-over areas throughout the rotation period, and (4) early and heavy thinning to maintain high levels of forage production in young stands. In Alaska the most important issues are the extent of cut-overs, the effects of thinning on forage and cover, and the effects of the trees cut during thinning on deer mobility.

Differences in administration of forest management in British Columbia and Alaska are reflected in how deer habitat concerns are incorporated into management plans. In British Columbia, responsibility for planning and conduct of logging and silviculture is delegated, in most areas, to private firms holding area-based cutting rights. Government agencies, led by the British Columbia Forest Service, approve and monitor company programs. Companies have no responsibility for wildlife, so logging plans are initially developed without reference to deer needs. Company plans, first submitted to the Forest Service, are sent ("referred") to the Ministry of Environment and Parks for their comment on wildlife and fishery impacts. After discussion, where necessary, some or all Ministry of Environment and Parks comments are reflected in the plan eventually approved by the Forest Service. This referral system is simple and requires few wildlife staff; however, it discourages incorporation of deer habitat concerns early in the planning process and often leads to use of undesirable negotiating tactics by advocates of wildlife and timber (Thomas 1985).

Planning of National Forest management in Alaska uses the interdisciplinary team approach. This approach is used occasionally for high-value watersheds in British Columbia. Under this system, the lead agency brings together a group of its own experts and others to formulate a set of joint resource objectives and develop an integrated resource plan. This process has several advantages, among them the encouragement of effective deer habitat management through recognition of habitat objectives from the start of the planning process and the establishment of a common understanding of problems and potentials. The interdisciplinary team approach consumes much staff time, however, and requires many specialists for each team. As with other approaches, success depends on good information about timber and deer resources and an adequate understanding of the ecological relations linking the two. Lack of staff (especially Ministry of Environment and Parks and Forest Service wildlife biologists) is the primary reason for infrequent use of interdisciplinary planning in coastal British Columbia.

Management Context and Alternatives

Allocation of old growth as deer habitat is controversial in British Columbia and Alaska. Some old growth is undoubtedly required; the important question is the extent of reserves required to satisfy public demands for timber, deer, and other forest resources and values. All alternatives to old-growth retention as winter habitat are impractical or unproven (table 2).

To date, both the referral system and the interdisciplinary approach have been less than satisfactory. Timber objectives and programs typically dominate the planning process, in part because measurable objectives for other forest resources have not been established. Even on National Forest land in Alaska, where timber management activities should or are required to be consistent with other goals of the forest plan, lack of a systematic means of integrating wildlife and timber objectives has discouraged joint management of the two resources. Also, information exchange between forest and deer managers about interactions among deer, habitat, and forest practices has been sporadic. This is particularly true in British Columbia where specific resource responsibilities are segregated in different agencies. Biologists and foresters, lacking both clear objectives for deer habitat and tools to assess habitat responses, are thus poorly equipped to plan innovative integrated programs.

Table 2—Alternative strategies for managing winter deer habitat (Nyberg and others 1986)

Approach	Advantages	Disadvantages
Retain old-growth ranges.	• Best ranges maintained; therefore, deer capability maximized. • Other environmental, social, esthetic, and cultural values retained. • Possible to harvest old growth later if desired.	• Loss of revenue and employment from timber industry because of low rate of logging.
Cut old growth and accept heavy deer losses during snowy winters.	• Increased revenue and employment from logging.	• Reduced hunting and viewing opportunities. • Other environmental, social, esthetic, and cultural values of old growth lost. • Options for future harvest of old growth foregone.
Cut old growth and feed deer artificially.	• Increased logging revenue and employment. • Deer populations maintained in some areas. • Deer more visible at feed depots.	• Expensive. • Impractical in many areas because of lack of road access. • Increased risk of disease, predation, and habitat deterioration when deer are concentrated at feed depots. • Reduced "wildness" of deer. • Other old-growth values lost.
Cut old growth and manage younger stands to act as winter ranges.	• Increased logging revenue and employment. • Deer populations at least partially maintained.	• Expensive silvicultural investments required. • Volume and product quality reduced in managed winter ranges. • Probably more feasible in Douglas-fir than hemlock/spruce forests. • Other old-growth values lost. • Promising but not proven to be feasible.
Wildlife agencies or private groups purchase old-growth stands and dedicate to preservation.	• Forest owners compensated for losses. • Deer populations and other old-growth values maintained.	• Extremely expensive. • Logging revenue and employment foregone.

Before management of timber and deer in coastal British Columbia and Alaska can improve, two needs must be met. First, clear and achievable objectives for deer habitat or deer populations must be stated and communicated to all planners. Regional wildlife and habitat plans, currently in preparation by the Ministry of Environment and Parks, USDA Forest Service, and Alaska Department of Fish and Game, promise to address this need. Second, those who develop forestry plans must be able to evaluate the impacts of proposed activities on deer while management options are being considered. This could be accomplished by providing foresters either with assistance from wildlife biologists or with a basic understanding of deer ecology and habitat needs plus analytical and planning tools for evaluating impacts of proposed management activities.

No prospects exist for major change in resource administration in British Columbia nor for significant increase in government resource staff. More one-to-one interaction between foresters and biologists, therefore, appears impractical. The alternative, an improved understanding of deer habitat and forestry plus simple planning tools, is possible. Several examples in the United States already exist. These examples arose from the need for National Forest managers to provide documented, objective assessments of the impacts of forestry programs to comply with requirements of the National Forest Management Act of 1976 (U.S. Laws, Statutes, etc. 1976) and other legislation (Thomas 1979). Beginning with guidelines for deer and elk habitat in Oregon and Washington (Black and others 1976), this approach that encourages improved understanding and use of simple planning tools has developed along several pathways, including tabular and graphical analysis systems (Thomas and others 1979, Witmer and others 1985) and computerized simulation models (McNamee and others 1986). The USDA Forest Service is applying the approach nationwide under their Wildlife and Fish Habitat Relationships program (Nelson and Salwasser 1982).

The habitat assessment procedures, whether pencil-and-paper or computer models, share several important characteristics. Deer habitat values are expressed in quantitative units so that assessment of forestry impacts is objective. Because habitat objectives are stated in numerical terms for specific areas, deer are on equal footing with timber in the determination of forest goals. Further, because impact assessments must be open to public scrutiny, interactions between forestry, habitats, and deer are described in simple relations reflecting the most important ecological factors. Thus a written explanation of assessments is provided, the assumptions and hypotheses of the assessment procedures are exposed to critical review, and communication of key knowledge about deer between biologists and foresters is encouraged. Other advantages of the assessment procedures are that biologists need not be on call as experts to forest managers and that forest managers need not let inadequate knowledge prevent them from considering deer needs if biologists are not available.

The characteristics of these assessment procedures make an approach leading to improved understanding suitable for coastal British Columbia, as well. Quantified habitat objectives, simple relations expressed as assessment tools, and improved communication would foster better integration of timber and deer management. But risks are involved. Oversimplification of complex ecological relations between deer and forests may, in some situations, produce misleading results. Written procedures based on generalized knowledge can never completely replace the judgment of an expert biologist. As with any structured approach, the assessment procedures are best applied by seasoned biologists and foresters working together. Whenever possible, other methods for assessing habitat impacts should also be evaluated. Given the current level of integration of timber and deer planning in coastal British Columbia, however, the risk of taking this new approach seems acceptable. Where land management is the preferred strategy for resolving deer habitat issues, this planning approach (called "habitat relations analysis" here) offers a convenient, systematic vehicle for consideration of deer habitat needs. The application of this approach to deer habitat management in coastal British Columbia is illustrated below.

Case Example: Handbook on Deer Habitats in Coastal Forests of Southern British Columbia

In the management handbook described in the appendix, deer-forestry interactions are simplified to present only the basics of ecological relations. A more complete description of these relations is provided here.

Relations Between Black-Tailed Deer and Their Habitat

Change comes to coastal deer habitats in three ways: through the natural succession of vegetation communities; through human impacts, including forest management; and through natural catastrophes such as wildfires. Deer respond to these changes behaviorally, physiologically, or in both ways.

Biologists usually plan deer management programs for populations rather than individuals. For black-tailed deer, the concept of the population is vague, largely because deer tend to be solitary or to occur in small, loosely knit groups (Geist 1981) and because few barriers to population dispersal exist other than large expanses of ocean. Thus, populations cannot be defined by herds that migrate between traditional seasonal ranges or by stable resident groups in particular areas. The common definition of a black-tailed deer population, which is used here, is the deer occurring in a given geographical area such as a watershed.

Several parameters can be used to monitor deer responses to environmental changes: behavioral responses can be detected as changes in home-range size, migration patterns, seasonal range locations, and timing and pattern of daily movements; physiological responses, such as changes in body condition, number of offspring, and survival of adults and their offspring. These measures are usually taken from a sample assumed to represent the population, and the most frequently observed response is used to characterize the population. Deer have varied perceptions and behaviors, however; means and modes do not express the full range of behavioral strategies. Several behavioral categories (for example, migrators and residents) need to be recognized. Means or modes can then be more appropriately applied to such parameters as physiological responses when the sample is stratified by behavioral categories.

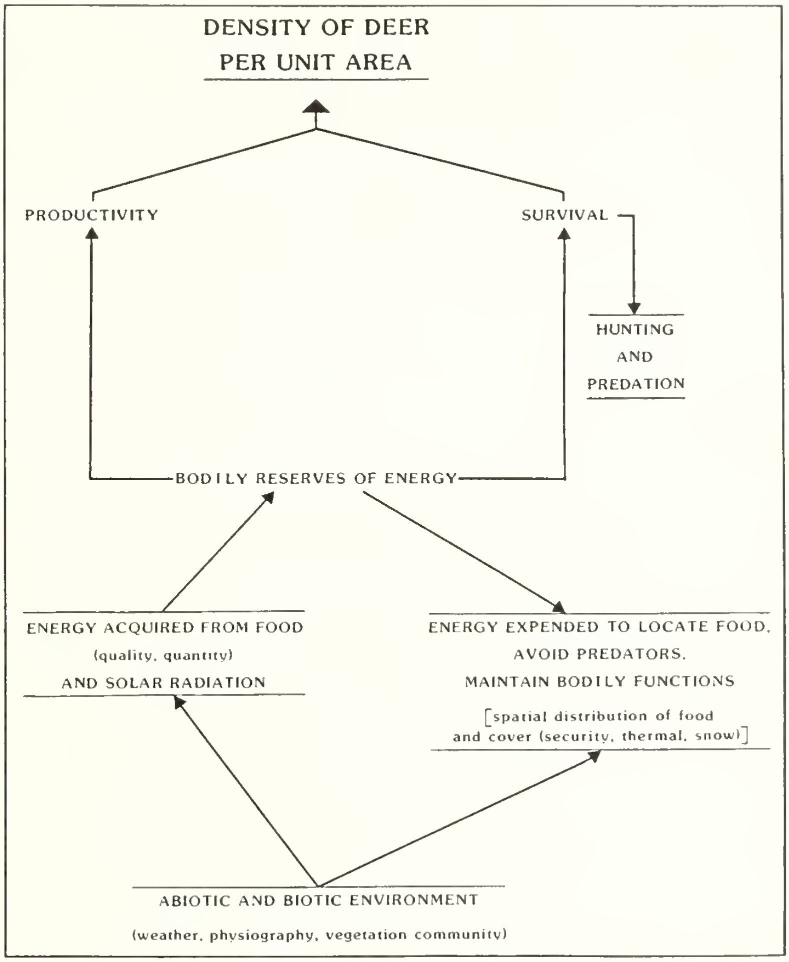

Figure 1—Factors that influence the density of deer. Arrows indicate the flow of energy.

Figure 1 depicts relations among factors that determine physiological responses. Density of deer is a function of productivity (largely determined by body condition) and survival (most influenced by weather, predation, and hunting). Parasites, disease, and accidental deaths are seldom important limitations on black-tailed deer populations. Habitat management must recognize the relative importance of the mortality factors. For example, increased forage abundance may provide no benefit to deer if predators or hunters limit populations, although increased security cover may be greatly beneficial.

A number of habitat variables interact to determine the quality of deer habitat. The least manageable, but nevertheless important, are the physical characteristics of the landscape. Slope, aspect, and elevation are especially important because they affect temperature, solar irradiation, and precipitation. During winter and spring, moderate to steep slopes on southerly aspects at low elevations are often extremely important, particularly in areas subject to snowy winters such as the mountains of Vancouver Island and the coastal mainland. These sites are the warmest and have the shallowest snowpacks, quickest snow melt, and earliest flush of new growth. In the summer, northern aspects and high elevations offer cool temperatures and delayed maturation of vegetation. In all seasons, steep, rugged slopes provide security (escape) for deer.

Whereas physical features determine the underlying capability of any area but are essentially unaffected by forestry, vegetation communities provide two essential habitat factors that can be easily managed: food and cover. Although these generic terms imply a host of different concepts and environmental factors, they describe useful categories and are widely accepted.

Food—The annual cycle of plant growth and availability has important consequences to deer. At the onset of the growing season when forage quality is at its peak, most preferred forages such as fireweed (*Epilobium angustifolium* L.), red huckleberry (*Vaccinium parvifolium* Smith), and trailing blackberry (*Rubus ursinus* Cham. and Schlecht.) exceed deer requirements for digestible energy (greater than 50 percent dry-matter digestibility) and protein (greater than 16 percent protein content for growth and lactation) (Robbins 1983). Forage biomass peaks in summer after quality has begun to decline. During late autumn and winter, both quantity and quality of forage decrease, reaching levels seldom sufficient for maintaining the physical condition of deer (Rochelle 1980). The composition of diets shifts away from herbaceous species that dominate during spring and summer toward increasing browse and conifer foliage in winter (Cowan 1945, Gates 1968, Rochelle 1980). Huckleberry, salal (*Gaultheria shallon* Pursh), western redcedar (*Thuja plicata* Donn ex D. Don), and arboreal lichens (*Alectoria, Bryoria,* and *Usnea* spp.) are among the most important winter foods. Certain evergreen herbs such as bunchberry (*Cornus canadensis* L.), five-leaved bramble (*Rubus pedatus* J.E. Smith), and fern-leaved goldthread (*Coptis asplenifolia* Salisb.) remain highly digestible and are highly preferred when available.

The quality of habitat is determined by a number of factors, including overstory characteristics and seasonal changes in food composition and availability. The overstory competes with understory plants for light, moisture, and nutrients and, in turn, affects the composition, quantity, quality, and structure of forage from the understory. The overstory also affects abundance of arboreal lichens in mature and old-growth stands. Because of the nature of the digestive system of deer and differences in the availability and quality of forage, diets are diverse and vary among seasons and areas.

Figure 2 illustrates factors that influence nutrient intake. The composition, size, growth stage, and productivity of the plant community determine the forage types available and their nutritional quality; deer behavior and limitations of the digestive system determine what food is used. Weather conditions, especially drought and snowfall, further restrict the availability of forage.

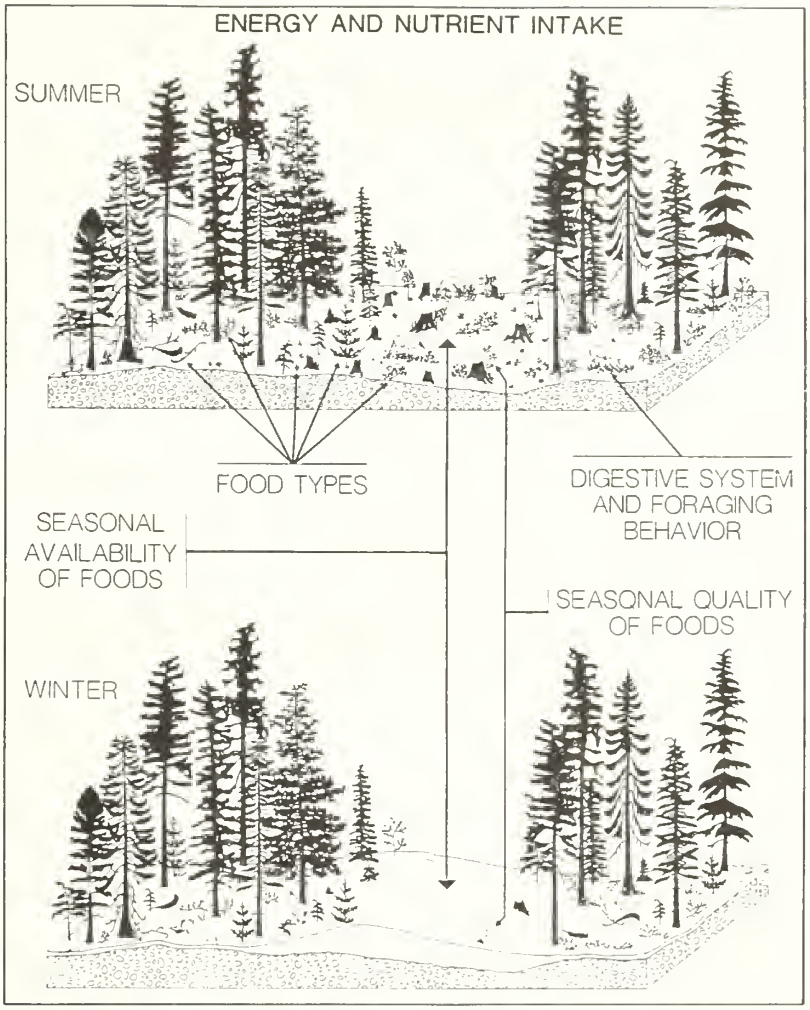

Figure 2—Factors that influence energy and nutrient intake.

Cover—In coastal British Columbia, cover is important for three reasons: (1) to reduce energy expenditures for thermoregulation and for locomotion during periods of snowpack accumulation, (2) to limit food burial by snow, and (3) to allow deer to escape or hide from hunters and predators (fig. 3). Cover can be vegetative or topographic. Trees and shrubs reduce energy expenditures for thermoregulation by moderating the effects of heat, cold, wind, and rain (Beall 1974, Leckenby 1977). Topographic features providing shade or windbreaks also reduce thermoregulatory costs. Coniferous cover allows deer to expend less energy when moving because trees intercept snow, reducing depth of the snowpack below (Harestad and Bunnell 1981, McNay 1985). The energy cost of moving through 25 centimeters (10 inches) of snow is about 2.5 times that of moving through 10 centimeters (4 inches), and the cost rises even faster as snowpacks become deeper (Parker and others 1984). When snowpacks are deep, food is also more available under moderately dense coniferous canopies than in the open.

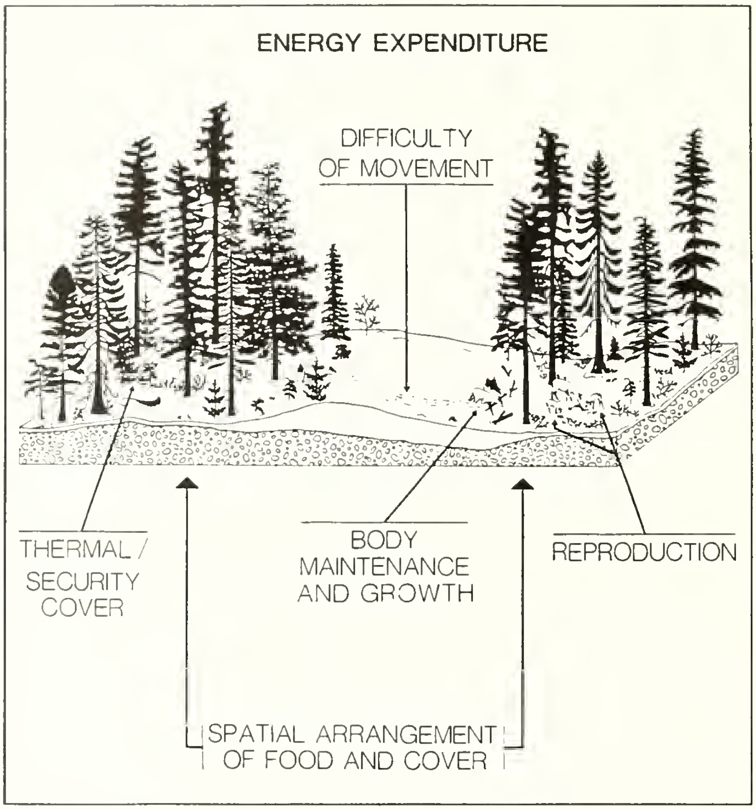

Figure 3—Factors that influence energy expenditure.

Both vegetation and topography provide security cover. The value of dense vegetation as cover from hunters is well documented; its value for use in escaping predators is often speculated but unproven. Topographic variability provides other opportunities for deer to select good vantage points, hide from view, and escape into rugged terrain (Geist 1981). Deer experience other energy expenditures not significantly affected by cover, such as the costs of basic metabolism, reproduction, growth, and rumination (fig. 3).

Habitat Suitability—Suitability of habitat for deer is determined by the interaction of land capability, the potential for nutrient intake, and the modification of energy expenditure (fig. 4). Many variables could be used in assessing forestry impacts on energy intake and output, including diet composition, seasonal availability and quality of foods, deer behavior, the spatial arrangement of food and cover, microclimate, snowpack accumulation, and security cover. Surrogates will have to be used for some of these factors, and relations must be expressed simply to be applied to forestry programs that cover large areas. The appendix illustrates the application of this approach to deer habitats in coastal British Columbia.

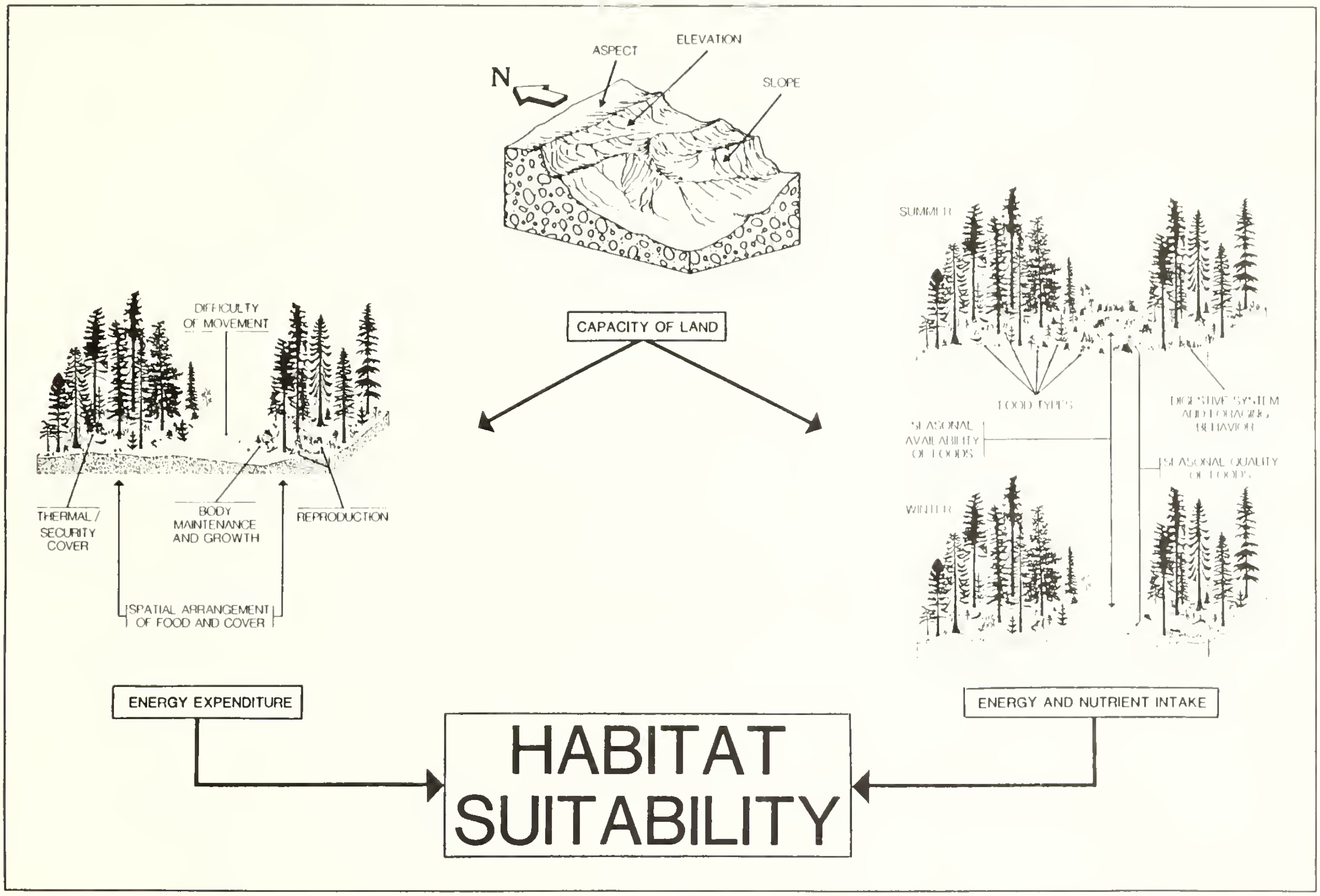

Figure 4—Factors that influence habitat suitability for black-tailed deer.

Handbook Implementation

The handbook "Deer Habitats in Coastal Forests of Southern British Columbia" (described in the appendix) represents a new approach to integrated management in coastal British Columbia. Because no clear policies or objectives have been set by the British Columbia Forest Service for deer production on Crown forest lands, and because some forest managers are not confident of the knowledge base and reasoning that supports habitat management requests from the Ministry of Environment and Parks, a vigorous program will be required to introduce the handbook to managers and promote its use. The integration of timber and habitat management must be shown to have a logical basis that can be easily understood and applied. The handbook must be viewed not as another large paperweight but as a reference source and planning tool that can help managers do their jobs better.

Key handbook users will be those who prepare, review, and approve management plans for logging and silviculture:

1. Among the private forest companies and forest consultants: foresters, engineers, and technicians on logging and forestry staffs of field divisions, and consultants to divisions.

2. In the British Columbia Ministry of Environment and Parks: biologists and technicians on the habitat management and wildlife staffs of regional offices.

3. In the British Columbia Forest Service: foresters and technicians on the timber and silviculture staffs of district offices.

Although others will likely use the handbook, including planners and educators, the technology-transfer program will target key users. Goals will be to familiarize these users with the handbook's purpose and content and to demonstrate its application in day-to-day tasks to encourage implementation in routine management.

Several principles will guide the technology-transfer program:

- Managers must understand why they should use the handbook. Integrated-use policies and the high values of both black-tailed deer and coastal forests will be emphasized. Problems with the current system for integration will be discussed.

- A major objective will be to summarize ecological principles and management techniques that forest and deer managers employ. The aim is not to make expert deer biologists of foresters or vice versa but rather to explain in a simple fashion the most useful relations linking forestry and habitat quality.

- A balanced but complete overview of the ecological aspects of forestry-deer interactions will be provided, emphasizing beneficial as well as negative effects of forestry practices on deer habitats.

- The handbook will not provide guidelines or specify prescriptions; that is, it will not tell managers how to manage. Instead, it will address questions such as: "If I carry out a given action, what will be the resulting effect on deer habitat?"

- Whenever possible, written material will be supplemented with on-the-ground demonstrations and trials. Managers will be encouraged to participate in testing and implementing ideas and strategies so that improvements can be made quickly.

With the initial distribution, upper management will encourage field staff to read and use the handbook. Next, a training program will be developed for field personnel. Acceptance and use of the handbook by field practitioners should lead to its eventual implementation in routine procedures.

Initially, no new policy will likely be established to require forest or deer habitat managers to use the handbook. The most needed information and tools, therefore, must be provided in as simple and useful a package as possible. If initial use by a few enthusiastic cooperators—particularly in areas with persistent deer-forestry problems—provides a "foot in the door" and improves integrated management, wider application should follow.

Training program—Trainees will include staff from the Ministry of Environment and Parks, the British Columbia Forest Service, and forest companies in mixed groups to encourage cooperation and interchange of ideas. Emphasis will be placed on showing how the handbook can be used to evaluate the effects of a proposed forestry plan on deer, to enhance a particular seasonal range, and to develop alternative approaches for maintaining or improving deer habitat when planning a logging or silvicultural program.

Two-day training sessions will cover theory and practical applications with example plans and field tours. Further training will be scheduled to reach new users or to follow up the first session. Concurrently, several field demonstration sites will be prepared to illustrate key concepts, particularly winter-range creation in young forests, enhancement of forage with thinning, and herbicide impacts on forage species. Already, two demonstration sites have been established on Vancouver Island that show how winter range can be created, and others will be added soon. Operational trials will be needed to test the practicality and effectiveness of winter-range creation and spring-forage management in young stands.

The handbook will later be supplemented with a pocket-sized field manual addressing issues such as stand suitability for thermal and security cover, distance-to-cover relations, and spring forage management. Habitat assessment procedures also likely will be computerized in conjunction with implementation of the British Columbia Forest Service geographic information system.

Handbook Evaluation

Evaluation of handbook effectiveness is needed to gauge success and guide further development. In the absence of measures of public welfare or satisfaction that would reflect the "real" success of the handbook, four indices could be used:

1. Measures of changes in deer **habitat use** that result from implementation of specific ideas or techniques from the handbook, such as winter-range creation in young stands.

2. Measures of changes in deer **abundance or health**, such as density, animal condition, or reproductive success.

3. Measures of changes in **management or planning systems**, such as widespread acceptance of the handbook, decreases in number of controversies over forestry plans, or reduced delays in plan preparation and approval.

4. Measures of changes in **resource use**, such as the profitability of forestry operations conducted under integrated plans, hunter success rates, or number of hunter-days spent afield.

Of the four, the most easily quantified measures of management success are the commodities produced from forest land: wood products and deer harvested or viewed. These are subject to many other influences besides forest management, however, including international and local demand, weather conditions, and prices of competing products. Thus, although harvest levels for timber and deer are already routinely monitored by government, more information is needed for evaluation of land management programs. Salwasser and others (1983) stressed this in arguing for wildlife monitoring programs on United States public lands that track populations and habitat quality.

To supplement harvest information usually gathered for timber and deer, monitoring should focus on points 1 and 3 above. These indices must also be interpreted cautiously. Evaluation of habitat use requires assumptions about how deer select habitats, and actual population responses may not be reflected by evaluation categories, such as "best" habitat (Schamberger and O'Neil 1986).

Evaluation of the handbook's effect on management systems requires cooperation from users. Without procedures for enumerating problems encountered by managers, as they try to incorporate deer habitat concerns in forestry planning, evaluation is difficult. Because the occurrence of problems has not been measured in the past, measurement of improvement is also difficult. As public attitudes change and the amount of old growth decreases, habitat concerns will become increasingly prominent. The number of management problems may remain constant or increase regardless of the handbook's success. The results of monitoring management systems, therefore, must be interpreted cautiously and with these influences in mind.

Questions

A number of questions about design and use of the handbook remain unanswered. These include:

1. Will the handbook assist management significantly if management agencies do not develop more detailed policies and procedures for integrated management for timber and deer?

2. Has the desired balance between background information and practical management procedures been achieved?

3. Has the simplification of ecological relations for management interpretation been overdone; that is, are there "dangerous oversimplifications"?

4. How can the value and effectiveness of the handbook be determined? Can managers monitor results and adapt where required?

Summary

As two of the most valuable products of forest land, timber products and black-tailed deer are important concerns of resource managers in British Columbia and Alaska. With changing economic conditions and public attitudes, the preeminence of timber harvesting will likely be challenged by other resource concerns on public land. Thus, although forest management will continue to affect most of the land base in British Columbia and a smaller but still significant proportion of land in southeast Alaska, timber harvesting will drive the planning system to a smaller degree in the future.

The increasing emphasis on nontimber values in the United States is clearly demonstrated by the evolution of statutory and administrative standards for planning the uses of National Forest lands over the past 30 years (Thomas 1979). In British Columbia, lower public pressures and lack of legislation like that in the United States, among other reasons, have slowed progress toward better planning systems. The Province, however, likely will see a similar trend in land management priorities. For instance, of the residents of coastal British Columbia who were contacted during a recent public opinion poll, one-third regarded preservation of heritage values, wildlife, and natural beauty as more important than forest products or forest industry jobs, and four-fifths felt their government should be more active in setting and enforcing environmental standards on forest land (Decima Research Limited 1986).

Timber management is by far the dominant force shaping habitat conditions; thus, although informally, foresters manage wildlife. Forestry plans should, therefore, incorporate objectives for both deer and timber. When developing alternative programs to achieve these objectives, managers should consider the use of forestry activities to improve habitat where possible and to mitigate detrimental effects of timber management.

Only by managers and researchers from both the forestry and wildlife communities sharing knowlege will integrated management improve. Managers must identify problems and questions arising from land management, and researchers must provide solutions and answers. For example, a crucial topic for research is the development of procedures for assessing long-term influences of forestry on habitat. Planning horizons that now span 5 years need to be extended to at least 20 years and preferably to the length of the rotation period. Tools for planning need to be based on existing data (inventories) and current levels of management sophistication. Complicated models requiring extensive data collection are not helpful to managers with little time and less money.

Foresters and deer managers, as applied biologists, share much in their backgrounds and motivations. With objectives clearly stated and knowledge effectively communicated, they would be free to cooperate in developing and testing new solutions to problems for which neither group currently has answers. Even with a common understanding of ecological relations and resource goals, disagreement will still exist over some issues. Effective communication, however, can help resolve many disputes and is the surest way to build mutual respect.

A new handbook for deer habitat management in coastal British Columbia is presented as an example of a stepping stone to improved integrated management. The handbook also should be useful as an educational and a planning tool.

Acknowledgments

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Appendix

DEER AND ELK HABITATS IN COASTAL FORESTS OF SOUTHERN BRITISH COLUMBIA: A HANDBOOK FOR FOREST AND WILDLIFE MANAGERS

A Summary of Proposed Content

Integrated Wildlife - Intensive
Forestry Research Program

September 1986

Province of British Columbia

Ministry of Forests and Lands
Ministry of Environment and Parks

TABLE OF CONTENTS

FIGURES

INTRODUCTION

One of the key products of the Integrated Wildlife-Intensive Forestry Research (IWIFR) Program will be a handbook entitled "Deer and Elk Habitats in the Coastal Forests of Southern British Columbia". It will incorporate new knowledge gained from IWIFR, background information on deer, elk, and forestry, and descriptions of existing policies and procedures for management of deer and elk habitats in the area. The handbook is being designed to serve a number of users in different ways, the most important being as a problem-solving tool and as an educational document for managers of forests and wildlife. A large group of authors, including staff from the British Columbia Ministry of Forests and Lands, the British Columbia Ministry of Environment and Parks, and the University of British Columbia, are currently preparing a draft version. Final printing and distribution to users is expected in mid-1987.

Here, we provide a summary of the design principles, the planned content, and the expected uses for the handbook, and selected examples of pages from several handbook sections as they are expected to appear in the final publication. The examples illustrate only the sections dealing with coastal black-tailed deer; separate sections describing elk ecology and habitat management techniques will be included in the final handbook. Because of space limitations, some parts of the handbook are not discussed here. A detailed table of contents for the handbook, beginning on page 39, indicates the full projected content.

This summary is intended both to inform readers about the handbook and to stimulate criticism of the design, organization of information, level of detail provided, and potential usefulness of the finished document. **Your comments on the concept and proposed content of the handbook will be carefully considered by the handbook team as they complete its preparation.** A form for written comments to the editors is provided on page 43.

DESIGN PRINCIPLES

Rationale

The handbook is designed with three key principles in mind:

1. It must be easy for several different organizations (forest companies, B.C. Forest Service, Ministry of Environment and Parks) and people with different backgrounds (biologists, foresters, technicians) to use.

2. It must be a useful tool both in assessing the impacts of forestry plans on deer and elk habitat ("reactive" situations like the referral system) and in preparing habitat management plans for key areas ("proactive" situations).

3. It must not tell managers how to manage, by specifying constraints or rules to be followed everywhere. Instead, it must describe relationships between forestry and habitat quality in ways that allow the impacts of proposed forestry activities to be evaluated. Decisions, based on impact evaluations, will be left to forest and wildlife managers.

Features

To direct the various users to appropriate portions of the handbook, a **Reader's Guide** will be included in the front material (see pages 6 and 7 for the Reader's Guide example).

The contents of the handbook will be organized in three parts. **Part I** (described on page 8) will provide the knowledge managers need to incorporate deer and elk habitat concerns in forestry programs: e.g., management priorities, ecological principles, forestry impacts on habitat, animal impacts on forestry, and techniques for managing important habitats. **Part II** (described on page 22) will provide a systematic procedure for applying the information from Part I in planning. **Part III** (described on page 28) will provide detailed supporting information for Parts I and II in several appendices.

Several themes or "building blocks" will be used throughout to simplify the complicated ecological interactions between the animals and the forests into practical management issues: 1) snowpack zones (Figure 1) will be used to stratify the handbook area into two zones with different management concerns and strategies; 2) forage and cover requirements will be used to provide a means of assessing the impacts of changes in forest conditions; and 3) seasonal ranges (winter, spring, summer) (Figure 2) will be used to describe the changing importance of habitat components through the year.

The handbook is intended to provide a practical reference book for use mainly in the office. It will be accompanied or followed by a companion pocket manual, shortened and repackaged for field use.

READER'S GUIDE

This handbook is intended to give answers to deer and elk habitat management questions for a wide range of users. The Reader's Guide is provided to help users find these answers as quickly as possible, with a minimum of page turning.

PURPOSE	EXAMPLE SITUATION
ECOLOGICAL BACKGROUND	1. Learn ecological principles relating deer to habitat and forestry.
	2. Develop a training program on approaches to habitat management.
PLANNING	1. Prepare a Silviculture Plan meeting deer habitat objectives.
	2. Prepare a 5 yr Development Plan meeting deer habitat objectives.
ASSESSING PLANS	1. Determine if potential conflicts exist between forestry and deer habitats.
	2. Recommend measures to minimize impact on forest/deer resources.
	3. Determine the deer habitat value of specific stands.

To use the Reader's Guide, first select your general purpose in consulting the handbook (e.g., planning) from the three categories in the left column on the opposite page. Then read across to select an example situation similar to yours. The example questions listed below will lead you to the section(s) of the handbook that should provide the information you need.

Finally, at the beginning of the appropriate section of the handbook, you will find a detailed table of contents that should list the topics that interest you.

EXAMPLE QUESTIONS

- What makes good winter ranges?
- What are the common habitat management approaches used by the Ministry of Environment?
- What problems will deer cause in managed stands?
- What is the potential impact of proposed forestry activities?
- What are the techniques to reduce impacts on deer?
- How can potential conflicts be identified?
- How should prescriptions be formulated?
- Which understory communities supply the best spring forage?

PART I - DEER AND ELK ECOLOGY, FORESTRY IMPACTS, AND HABITAT MANAGEMENT

Content

This section, the longest of the handbook, will contain three major components (Figure 3):

1. The **Introduction** (Chapter 1) and **ecology** chapters (Chapters 2, **Deer Ecology**, and 3, **Elk Ecology**), will provide background on the values of coastal forests, deer, and elk, the habitat management system currently being used, and the ecological principles relating the animals and their key habitats. These chapters will also introduce the themes of snowpack zones, food and cover requirements, and seasonal ranges, which recur throughout the handbook.

2. Chapter 4, **Interactions Between Deer, Elk, and Forestry**, will describe the impacts of forestry practices on deer and elk and the ways in which deer and elk affect forest management.

3. Chapter 5, **Habitat Management Techniques**, will describe techniques that forest and wildlife managers can use to manipulate specific habitat features or seasonal ranges to achieve an objective or reduce a conflict. Detailed information to supplement this section will be contained in the appendices.

The following pages contain details and examples of Chapters 2, 4, and 5.

Rationale

Part I is designed to provide managers with the information they need to understand the interactions between the animals, their habitats, and forestry activities; and with the tools (management techniques) they can use when assessing or managing habitats as described in Part II.

PART I

DEER AND ELK ECOLOGY, FORESTRY IMPACTS, AND HABITAT MANAGEMENT

CHAPTER 5 -HABITAT MANAGEMENT TECHNIQUES

-Food
-Cover
-Management in the Shallow Snowpack Zone
-Management in the Deep Snowpack Zone

CHAPTER 4 -FORESTRY/ANIMAL INTERACTIONS

-Habitat Management Policies and Procedures
-Key Habitat Problems
-Forestry Impacts on Deer and Elk
-Deer and Elk Impacts on Forestry

CHAPTER 3 -ELK ECOLOGY

CHAPTER 2 -DEER ECOLOGY

-Life Cycle
-Requirements from Habitat
-Meeting the Requirements
  -Home Ranges
  -Seasonal Ranges
  -Critical Habitat Features

CHAPTER 1 -INTRODUCTION

-Deer, Elk and Forests: The Resources and Their Management
-Snowpack Zones

Figure 3. Overview of Part I.

PART I, CHAPTER 2: BLACK-TAILED DEER ECOLOGY

Questions Answered

This chapter will address questions such as: "As a resource manager, what should I know to understand the habits of deer in my area and what they need to survive?"

Content

Chapter 2 will provide an overview of deer **habitat ecology** in coastal British Columbia, with a discussion of important behavioural and physiological influences on habitat use. It will include a brief discussion of the characteristics and distribution of all deer taxa in British Columbia, and provide details on the distribution and life of black-tails on the coast. The **habitat requirements** of deer -- food, cover, and water -- will be explained, and the annual variations in these needs related to the seasons and life cycle (see example on pages 12 and 13). The ways in which deer attain these requirements will be covered in a section on **annual and seasonal ranges** (Figure 4). The typical topographic and vegetative features of winter range, spring range, and summer range in the two snowpack zones will be described in detail, with emphasis on changes in food and cover requirements as deer move between seasonal ranges. The importance of a mixture of seasonal ranges and habitat requirements will be covered in a section on juxtaposition and interspersion, and the critical features of the seasonal ranges will be listed to summarize the chapter.

Use

This chapter should be useful to anyone needing information on the basics of black-tailed deer ecology and the important features of deer habitat in coastal British Columbia. We anticipate it will be of most interest to forestry staff who were not educated in wildlife, but who regularly deal with deer habitat concerns. It should also be useful as a training tool for new recruits to the wildlife and habitat protection staffs of the Ministry of Environment.

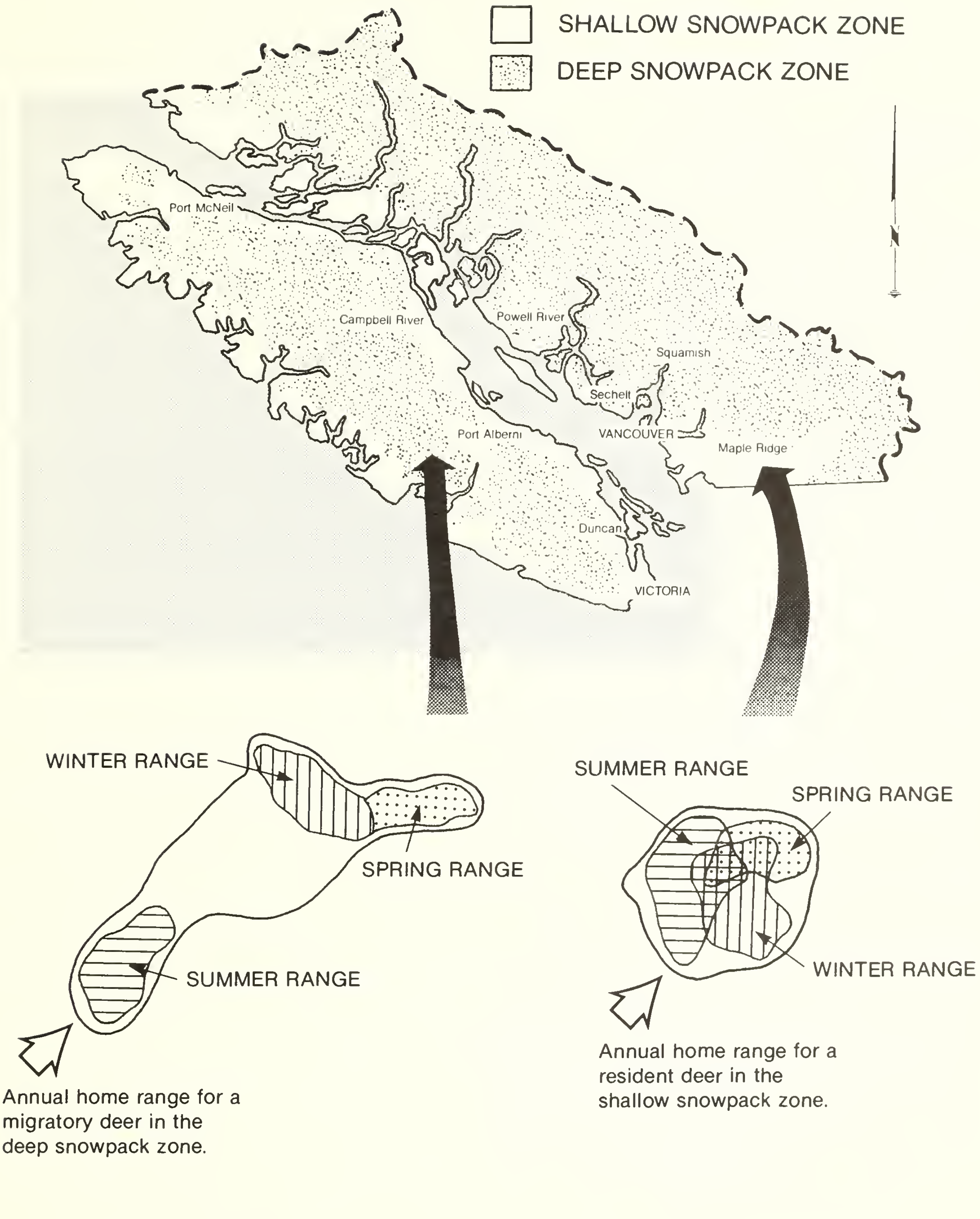


Figure 4. Typical home range patterns in the two snowpack zones.

DEER REQUIREMENTS

Deer have three basic requirements: food, water, and cover. Cover can be classified into three categories based on its ability to reduce stress imposed by an animal's immediate microclimate (thermal cover), provide security, and intercept snow.

Food — Potential limitations

Deer obtain a portion of their water and all of their energy, protein, vitamins, and minerals from their food. In southwestern British Columbia both digestible energy and protein are scarce enough to limit deer abundance or health in specific seasons on many ranges. Phosphorous also may be limiting. Phosphorous requirements are about 0.25 to 0.30% dietary dry matter which are higher than concentrations found in red huckleberry, an important deer food. There is no evidence that vegetation in the region is deficient in other nutritional requirements.

Nutritional deficiencies result from the ways in which the digestive system of deer interacts with seasonal changes in the chemical composition of their foods. In the rumen, the first chamber of the four-chambered stomach found in deer and all other ruminants, microbes ferment the food before it passes to the fourth chamber (the abomasum) where enzymatic digestion typical of mammalian stomachs begins. One beneficial result of ruminal fermentation is that deer can partially digest complex carbohydrates, such as cellulose, that mammals without rumens cannot utilize.

In most plants the chemical composition of stem and leaf tissue and the places where nutrients are stored change markedly with the seasons. In newly grown material during spring most of the important nutrients are simple compounds located in cell sap, where they are readily digestible (Figure 14). As the tissue ages potential nutrients become more complex and are stored in the walls of cells where they are less digestible. As the season progresses further these walls toughen by adding lignin and become increasingly indigestible. The total amount of energy in plant leaves and stems actually differs little between species or even seasons, but in some plants more of the energy is present in compounds deer cannot digest. Forbs such as fireweed contain less fibre and more of the energy in them is digestible. The higher quality of these plants results from the manner in which changes in plant composition interact with the rumen fermentation process or digestive physiology of deer. This interaction has important implications to habitat management.

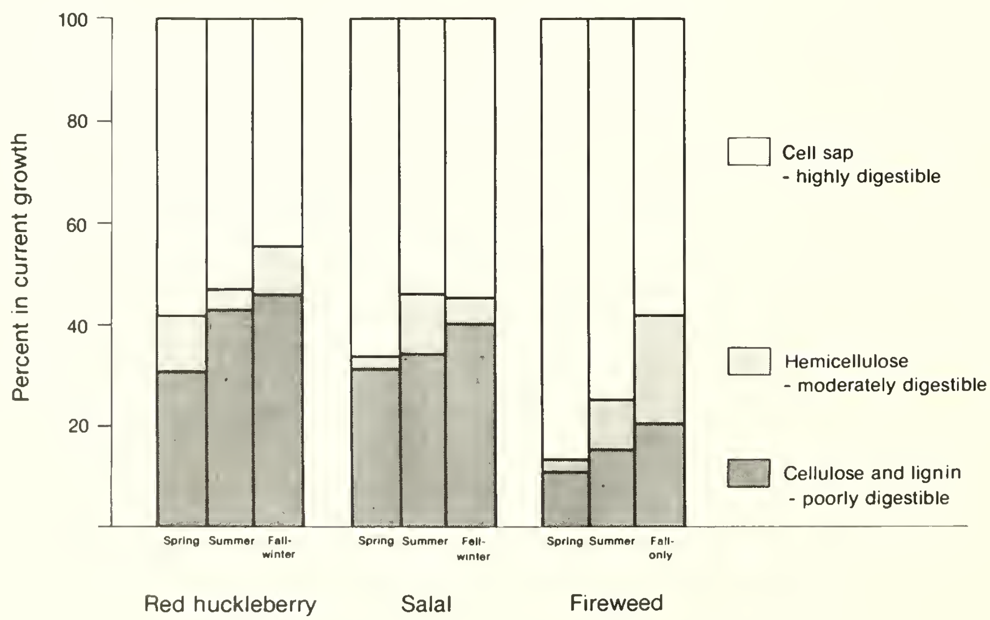


Figure 14. Seasonal differences in the cell composition of the current year's growth of three important deer forage species.

Digestive physiology — quantity and quality

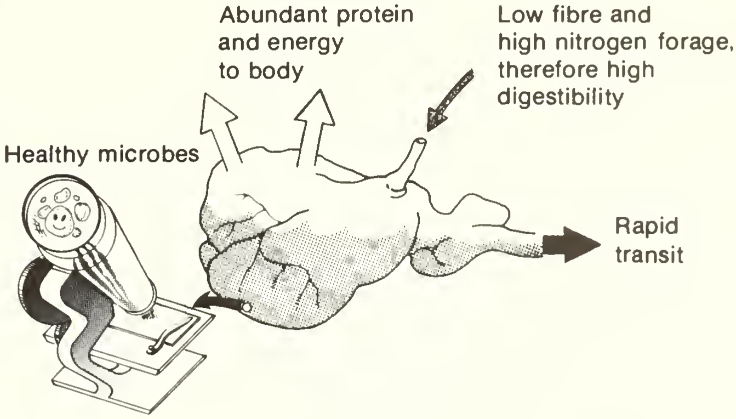
Only energy and protein are commonly limiting to deer in south coastal B.C. Energy is necessary to run the processes or 'deer machinery'; proteins are necessary to build and service the machinery. Proteins are critical structural components, important in reproduction and growth, but are also active as enzymes, hormones, and transport mechanisms in the body. To provide sufficient energy and protein both quantity and quality of forage are important.

As the complexity of carbohydrates increases through the year (e.g., from starch to cellulose), both the amount of calories deer can extract and the rate at which these are extracted decline. Fermentation then slows, less energy is available, food stays longer in the rumen, and the deer's intake of all nutrients is restricted. If rumen microbes can obtain only small amounts of energy from incoming food, the rate at which they synthesize protein also is reduced (Figure 15). Most of the protein used by deer comes from microbes in the rumen. Amounts of nitrogen in the forage can become sufficiently low that microbes can no longer synthesize protein or ferment cellulose at a rate sufficient to maintain deer. There may be abundant food but its quality is poor. On ranges with very low quality food deer can starve with their stomachs full.

This seasonal pattern of changing forage quality happens to some degree on all ranges. As new growth ages the proportion of available nitrogen decreases, the amount of less digestible fibre or cell wall increases, and the proportion of undigestible fibre (lignin) increases. As a result, most vascular plants are far less valuable to deer in winter than in the spring or summer. As they age some plants also develop secondary compounds, such as tannins or other phenolics, which further reduce their digestibility.

The volume of a ruminant's 'fermentation tank' (rumen-reticulum) increases with its weight and is about 3.5 times larger in elk than in deer (Bunnell and Gillingham 1985). Elk can consume greater amounts of less digestible forage than deer without filling their 'tanks' and seriously reducing the amount of energy obtained per unit time. The narrower mouth of deer permits them to be more selective, but to be productive they still must eat more highly digestible forage than elk require.

SPRING AND EARLY SUMMER DIET



DIET DURING SEVERE WINTERS

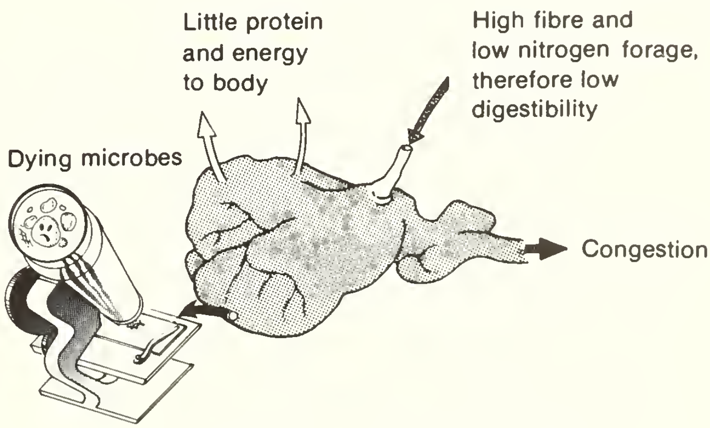


Figure 15. Effects of good and poor forage quality on rumen function.

PART I, CHAPTER 4: FORESTRY/ANIMAL INTERACTIONS

Questions Answered

This chapter will follow up on the ecological relationships discussed in Chapters 2 and 3 by answering questions such as:

"What are the current policies and planning systems used to protect and manage deer and elk habitat?"

"What are the effects of individual forestry activities on habitat values?"

"What effects do deer, elk, and habitat management have on forests and forestry programs?"

Content

Chapter 4 will cover several topics that are of daily concern to forestry and habitat management staff. It will first describe the **policies** and **procedures** used by the Ministry of Forests and Lands, the Ministry of Environment and Parks, and forest companies to address habitat concerns that arise during the planning of logging and silvicultural operations. The major **habitat problems** (winter range, spring range, etc.) will be covered next, followed by a discussion of the nature, extent, and **impacts of each common forestry activity** (e.g., logging, site preparation, thinning). An example of the forestry impacts section is provided on pages 16 and 17. Finally, the ways in which **deer and elk affect forestry** will be described, including both direct effects such as browsing of tree seedlings and indirect effects such as logging deferrals to protect key habitats.

This chapter and the following one (Chapter 5) will be closely linked (Figure 5). Chapter 4 will provide answers to questions that are often site specific, arising from plans generated by forest companies or the Forest Service. A typical question would be: "If I weed this plantation with a herbicide, what will be the effects on deer?" Chapter 5, **Habitat Management Techniques For Deer,** will address a different question: "How can I manage forested habitats to achieve a desired deer or elk objective?". Both chapters, however, will focus on how forest management alters deer and elk habitat, and what actions may be appropriate to maintain or improve this habitat.

Use

Chapter 4 will be most useful as an educational or training document for those people needing a better knowledge of forestry/animal interactions; and as a guide to habitat problems and opportunities arising from specific forest treatments. Foresters, biologists, and technical staff should all find it applicable to their interests.

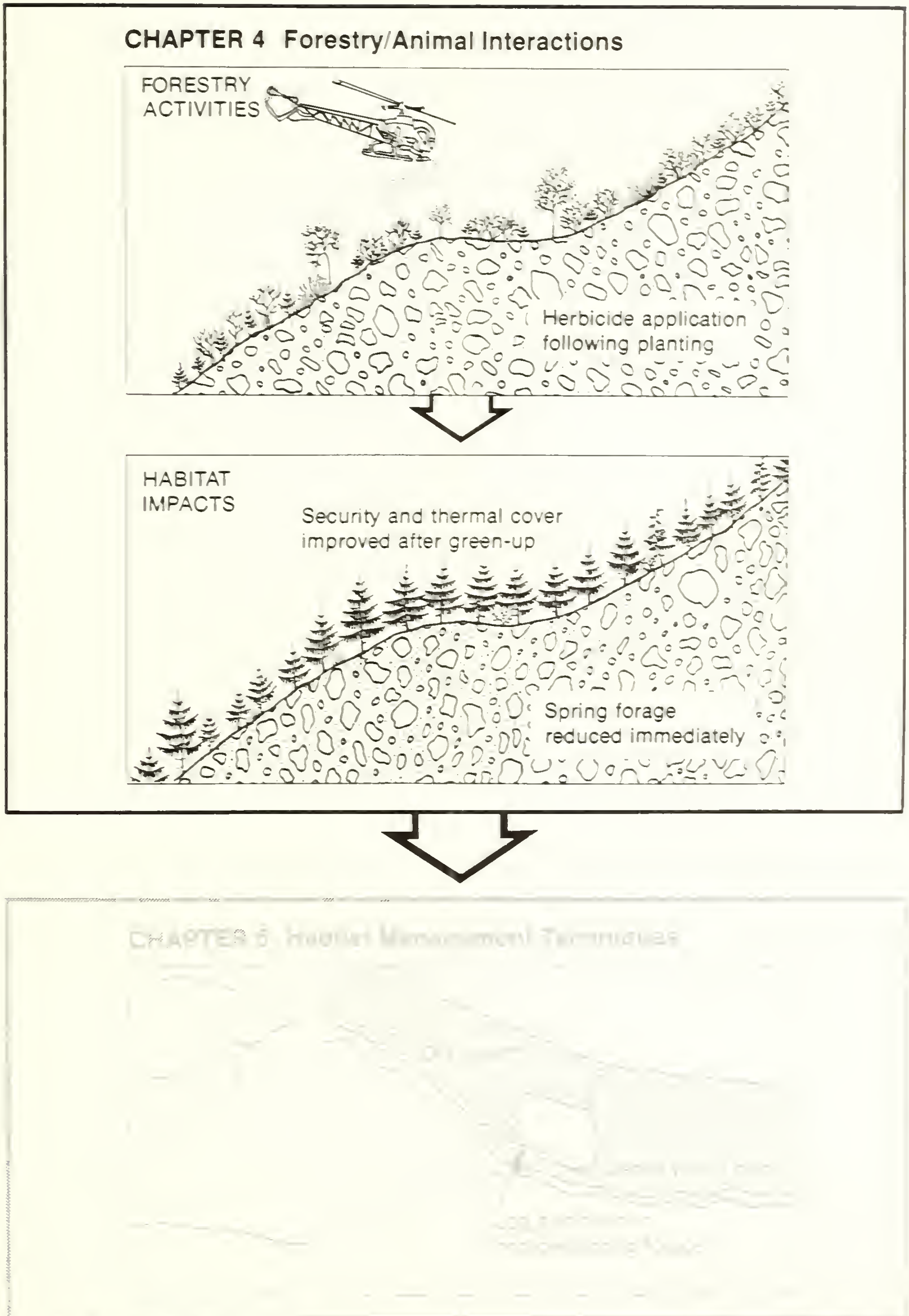


Figure 5. Major components of Chapter 4 (Interactions Between Deer, Elk and Forestry) and its linkage to Chapter 5 (Habitat Management Techniques for Deer and Elk).

LOGGING

More than 95% of coastal logging employs clearcutting. There are several advantages of clearcutting over selective harvesting systems on most sites. Most important are its suitability for regenerating preferred tree species such as Douglas-fir and western hemlock which grow best in full sun, the efficiency it allows in yarding logs on steep terrain, and the elimination of damage to standing residual trees when large old-growth trees are felled and yarded. The vast majority of trees are felled with chainsaws, but there is a trend toward increased use of mechanical feller-bunchers in small timber. Mechanized cutting is expected to further increase in importance as forests are converted from old-growth to younger stands.

Among the many types of yarding systems in use, high-lead yarders and ground skidders are most common. Skidders cause far more soil disturbance and are usually limited to slopes less than 30%. In recent years high-lead yarding has begun to decline in importance as many companies switch to grapple-yarding, a form of skyline logging (Figure 44).

Logging affects deer in three ways. First, cutting of overstory trees immediately reduces the amount of cover provided by the stand. After logging, the site will have no value as thermal, security, or snow interception cover (Figure 45) until a new stand has grown to at least 3 m high, unless patches of small residual conifers remain uncut. On the other hand, the removal of the shading overstory and of the below-ground competition by tree roots leads, by the third growing season following logging, to an increase in the quantity of forage available (Kellman 1969). This major flush of vegetation often provides 15-20 years of valuable forage in clearcuts (Figure 46).

Second, the composition of the understory changes due to soil disturbance during yarding, as pioneer plant species invade freshly exposed soil in full sunlight. Subsequent site preparation activities such as slash-burning often enhance the species shift. This change of understory produces more spring and summer forage, especially herbs such as fireweed, at the expense of shrubs which form the bulk of the winter forage supply.

Third, logging leaves woody debris on the site. This debris may, depending on the nature of the logged stand and the value of the wood, pose a serious barrier to deer use by preventing or discouraging them from moving through it. The debris problem is most severe in old-growth stands of hemlock and redcedar due to the high porportion of non-merchantable wood in many of these stands and because many trees break or shatter when felled. Debris is usually a minor concern when mature and old-growth Douglas-fir is being logged. Debris less than 30 cm high has little effect on deer unless it

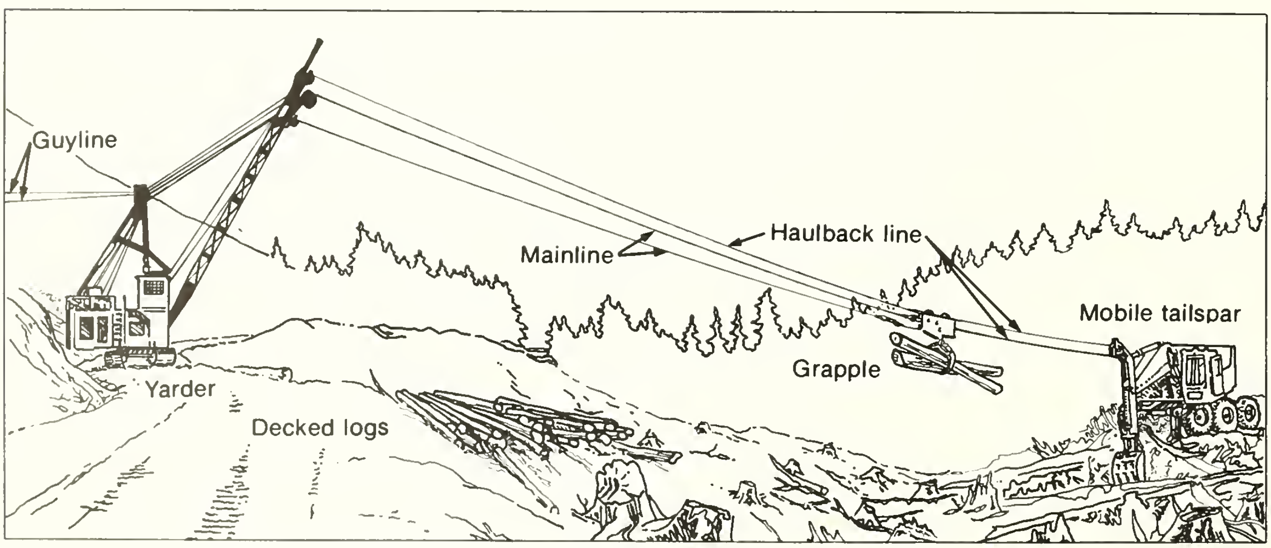


Figure 44. A typical grapple-yarding system in coastal British Columbia.

covers more than 50% of the ground, but at slash depths greater than 30 cm, deer expend large amounts of extra energy in moving about because they must jump over obstacles. These energy costs increase most dramatically when there are more than 25 obstacles greater than 30 cm high in every 100 m of travel (Figure 47). Extremely heavy debris loads can also limit the long-term vegetation response of a site by occupying most of the potential growing sites.

Figure 45. Recently logged areas provide poor habitat for deer when snow is deep.

Figure 46. Abundant and diverse communities of herbs and shrubs provide excellent spring and summer forage in many clearcuts.

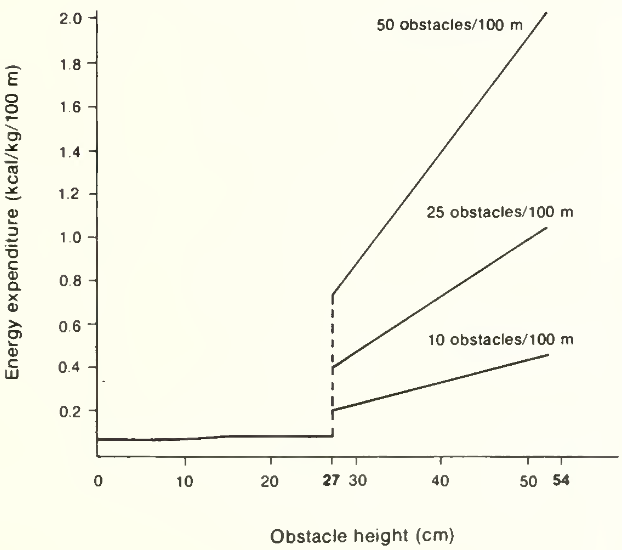


Figure 47. Effects of density and height of woody debris on energy expended by deer walking on level terrain. Adapted from Figure 9 of Parker *et al.* (1984).

SUMMARY: EFFECTS OF LOGGING

Effect on Access	– Detrimental when slash is deep (>30 cm) and abundant (>25 obstacles/100 m).
Effect on Cover	– A major detriment until a new crop is established. Loss of thermal and security cover may be ameliorated somewhat if patches of small residual trees remain. Loss of snow interception cover may be critical for deer in some areas.
Effect on Forage	– A minor detriment in the first year after logging due to destruction of understory plants and soil disturbance. A major benefit in the long-run for herb production initially and shrub production later. Benefits may persist for 20 years.

PART I, CHAPTER 5 - HABITAT MANAGEMENT TECHNIQUES FOR DEER AND ELK

Questions Answered

The types of questions addressed in Chapter 5 will include:

"What approaches or techniques are available to improve the quality or amount of deer habitat requirements, including rooted forage, lichen forage, thermal cover, security cover, and cover from snow?"

"What are the characteristics of good seasonal ranges in each snowpack zone, and which techniques are best used to improve the quality of these ranges?"

"How do variations in the size and interspersion of forage and cover areas affect habitat quality in each season?"

Content

This chapter will begin with a discussion of the various forestry techniques (silvicultural and logging activities) that can be used to improve each of the two types of forage and three types of cover identified as key habitat requirements (Chapters 2 and 3). Usually these techniques will require one or more of the routine forestry treatments covered in Chapter 4 (Figure 6), but other unusual techniques that would only be used on limited areas of very high value will also be included (e.g., artificial dispersal of arboreal lichens). The application of these techniques to management of the three seasonal range types in each snowpack zone will then be described. An example for winter range in the deep snowpack zone is shown on pages 20 and 21. The chapter will conclude with a summary of similarities and differences in techniques between the two zones, and a discussion of alternative means for resolving the key habitat concerns outlined at the beginning of Chapter 4.

Use

The emphasis in this chapter will be on the planned management of forested areas as deer and elk habitat. This approach will sometimes be used by Ministry of Environment staff in managing areas such as the Skagit Recreation Area, where recreation -- rather than forestry -- is the top priority. More often though, it will be employed by small teams of foresters and biologists from government and industry to evaluate short-term options for enhancing habitat during forest management, or for mitigating negative effects of a particular forest practice.

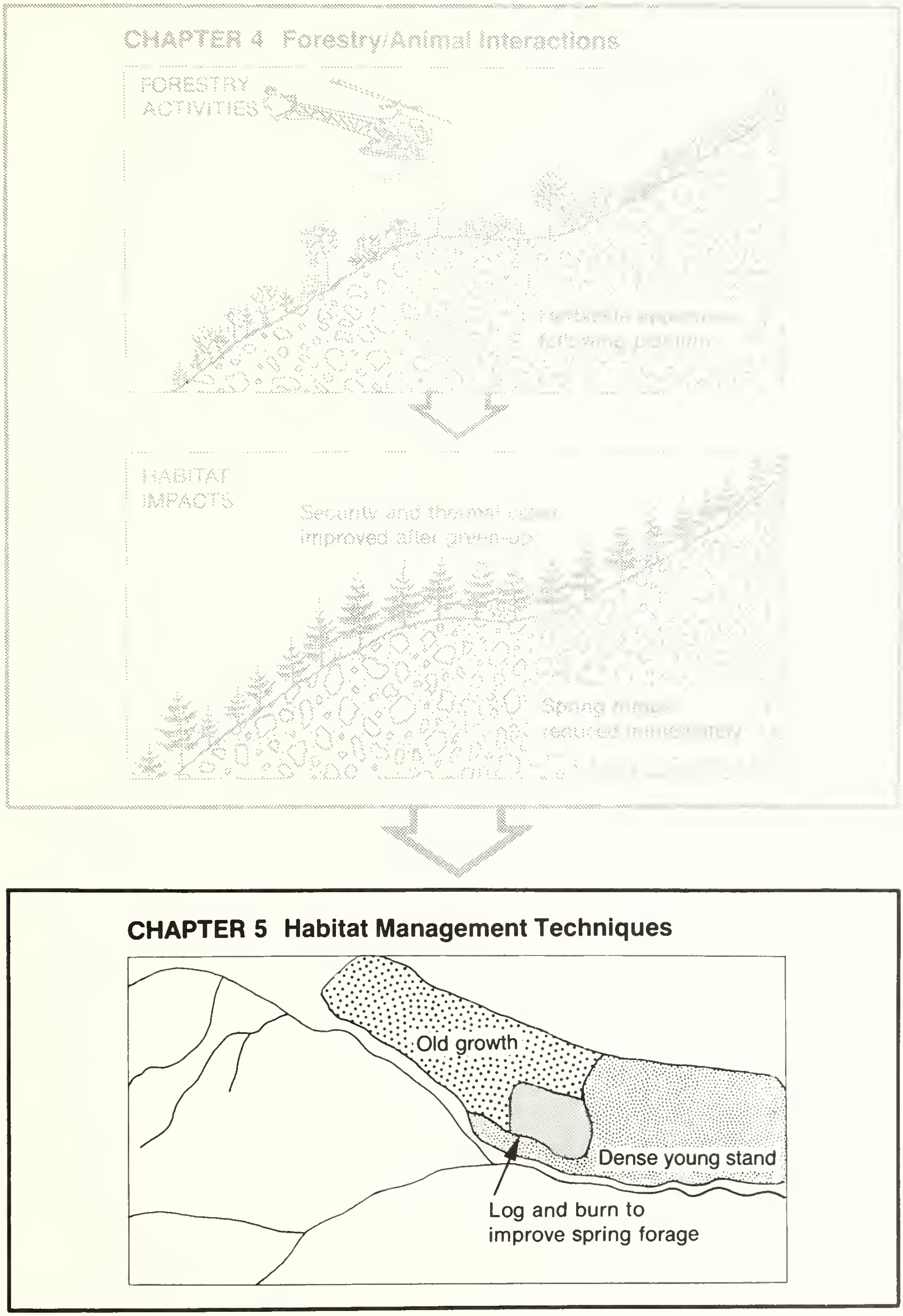


Figure 6. Example of a technique to improve deer habitat, from Chapter 5.

DEEP SNOWPACK ZONE: WINTER RANGE

Retention Of Old Growth

In the deep snowpack zone, old-growth forests on favourable topography provide the best winter range. Their value as winter range results primarily from the large size of the trees present and the heterogeneous nature of the canopy, and less from the age of the trees. Because trees are large their crowns intercept snow effectively, which reduces snow depth on the ground and, therefore, the costs of deer movement and the rate at which rooted forage is buried. They also provide a deep canopy which entraps radiation and produces good winter thermal cover. The heterogeneous nature of the canopy, resulting from natural mortality and irregular regeneration of conifers, provides gaps which permit patches of shrubby forage species to thrive. These gaps also encourage a more open-grown form among adjacent trees which provides a favourable environment for arboreal lichens, an important winter forage.

Although large trees and variable canopies are most significant, age of the trees also appears to be important, for two reasons. First, older trees grow more slowly and shed bark less rapidly, allowing arboreal lichens to accumulate on a relatively stable substrate and drop to the ground as branches break or lichen clumps separate. Second, older stands often have an understory of young cedar and hemlock which can provide thermal cover, security cover, and forage during winter.

When snow is deep and the costs of moving about are great, deer do best when all their needs can be met within small areas. Some, but not all old-growth forests provide these needs; heterogeneous canopies allow them all to occur in close proximity (Figure 73). For these reasons, the most effective way to provide winter range in the deep snowpack zone is to retain old-growth on favourable topography (Table 5).

The factors that need to be considered in selecting old-growth blocks for retention as winter ranges are numerous (p. 107). Many stands will have all the desired features but those that are lacking in some respect, such as having no rock outcrops, may still provide valuable habitat. In some cases several stands with apparently equivalent habitat characteristics may be available for designation as winter ranges to be deferred or preserved from logging. The levels of past deer use in the stands, as indicated by pellet-group surveys, can be used to identify the highest value stands.

The Ministry of Environment recommends that winter ranges occupy about 10% of the land area below 800 m

ASPECT	0 - 45° and 315-360°	45 - 90° and 270 - 315°			90 - 270°			Snowpack Zone
Slope / Slope position	All	< 40%	40-60%	> 60%	< 40%	40-60%	> 60%	
Valley bottom	Unsuitable	Unsuitable	Moderate	N/A	Low	Optimum	N/A	Shallow
			Low		Unsuitable	Moderate		Deep
Mid-slope	Unsuitable	Unsuitable	Low	Moderate	Low	Optimum	Optimum	Shallow
			Low	Moderate	Unsuitable	**Optimum**	**Optimum**	Deep
Upper slope	Unsuitable	Unsuitable	Low	Moderate	Low	Optimum	Optimum	Shallow
			Low	Low	Unsuitable	Low	Moderate	Deep
Slopes > 1000 m	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Shallow
								Deep

Table 5. Topographic influences on the capability of the landscape to provide winter and spring ranges for deer.

elevation in each watershed where deer capability is high and high levels of deer production are desired. On Vancouver Island, winter range blocks should be at least 20 ha in size and be spaced at intervals of no more than 5 km in each high-priority watershed (D.C. Morrison, personal communication). These recommendations for block size and spacing were derived from early radio-telemetry studies of deer movement (Harestad 1979) and may be revised considerably as spatial patterns of habitat are investigated further during the second phase of the Integrated Wildlife-Intensive Forestry Research Program.

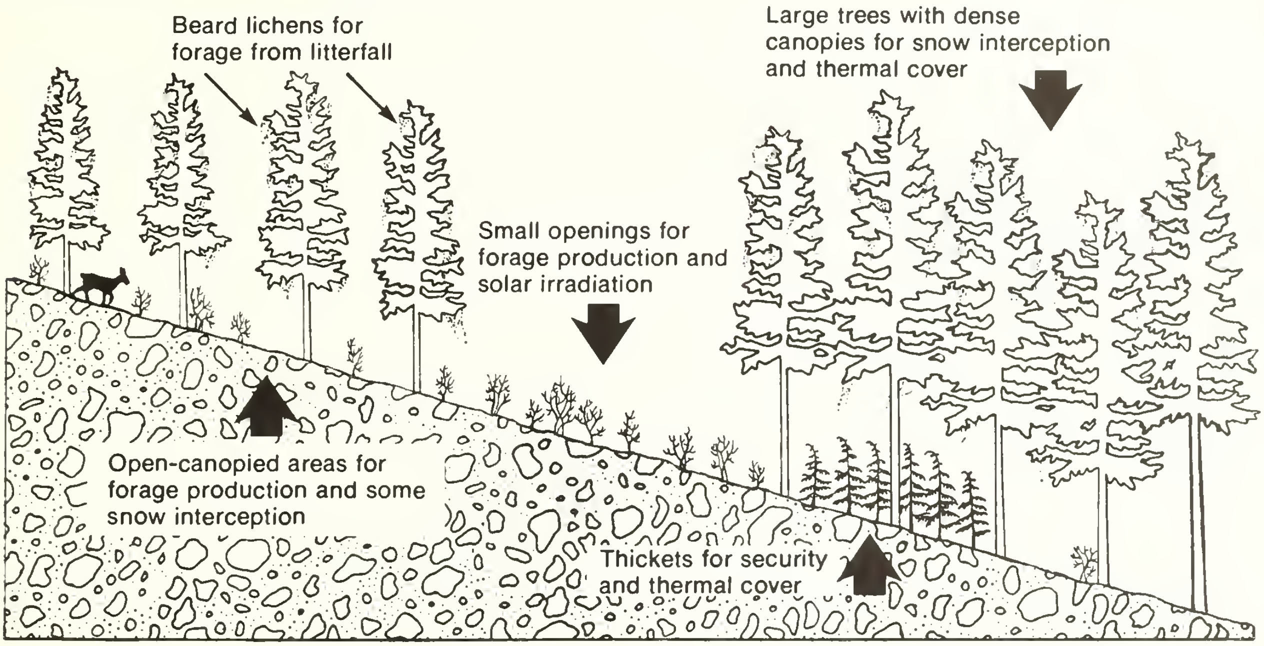


Figure 73. Good winter ranges provide many important habitat features in close proximity to each other.

DESIRED FEATURES OF OLD-GROWTH RANGES

TOPOGRAPHY

Southerly aspects
Moderate to steep slopes (40-80%)
Lower elevation (<1000 m)
Minimal shading by adjacent mountains during winter
Scattered rock outcrops or small bluffs

FOREST STRUCTURE AND COMPOSITION

Heterogeneous canopy averaging 65-75% crown closure, with
- Large trees
- Small patches with high crown closure (>75%) for snow interception
- Small patches with open canopies (<65%) for forage production and some snow interception
- Small openings for forage production and high solar irradiation
- Abundant beard lichens (*Alectoria, Bryoria, Usnea*)
- Abundant winter browse in the understory
- Patches of conifers in the understory for security cover, thermal cover, and, if western redcedar or hemlock, food

PART II - PLANNING, MANAGING, AND MONITORING HABITATS

Content

The second major portion of the handbook will contain its "working tools" in a six-step procedure. This procedure will be designed to help managers apply the information from Part I in day-to-day management. It will cover all the major aspects of planning for habitat management, from setting habitat objectives and evaluating habitat capabilities to developing management prescriptions and monitoring results. Extensive cross-references to information sources elsewhere in the handbook will be provided.

The following pages describe the structure of Part II (Figure 7), discuss the steps in the procedure, and give an example of the content of one step (Step 3).

Rationale

Most managers faced with heavy workloads and resource problems of many types will not be able to become familiar with all the detailed information contained in Part I. They need to extract only the pieces of information relevant to a specific problem, be it maintaining adequate security cover in a heavily logged valley or enhancing spring forage during a large-scale silviculture program. The procedure for assessing and managing habitat will be designed to fit with and complement other planning systems such as the logging plan referral system.

PART II

PLANNING, MANAGING, AND MONITORING HABITATS

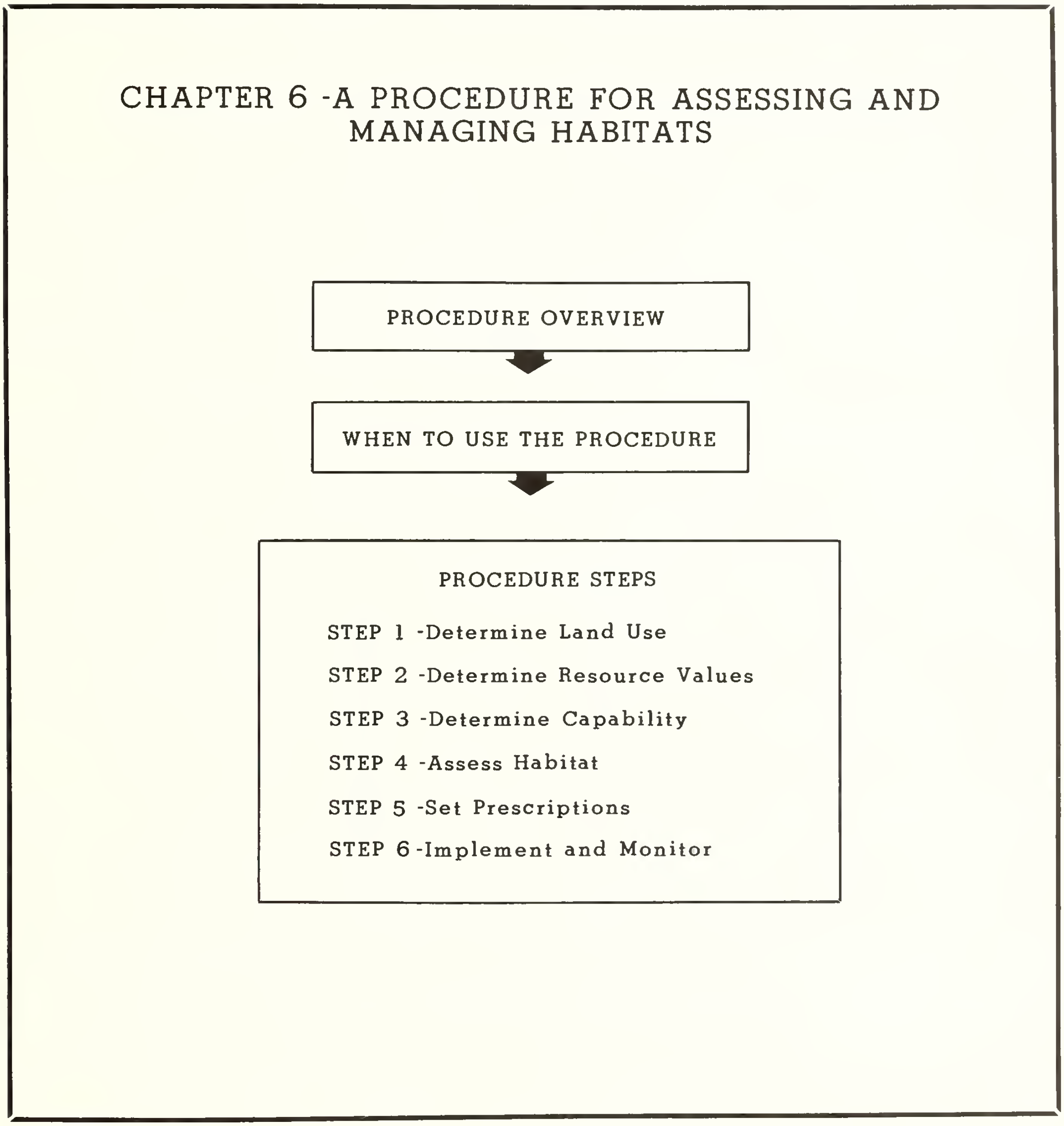


Figure 7. Structure of Part II of the handbook.

PART II, CHAPTER 6 - A PROCEDURE FOR ASSESSING AND MANAGING DEER AND ELK HABITATS

Questions Answered

The key question to be addressed by the procedure is: "How can I use the information in the handbook to prepare a forestry plan that will have acceptable impacts on deer and elk, or to identify opportunities for habitat improvement?"

Content

The procedure for assessing and managing habitats will be designed to provide users with a framework for evaluating habitat conditions and resolving habitat management problems, such as those that may arise during preparation of a 5-Year Development Plan for an area with high-quality deer habitat. The procedure will be composed of six steps (Figure 8), each of which will direct users to the sources of information they will need, either in the handbook or elsewhere.

Step 1 will help the user determine the influences that historical, current, and proposed use in the area could have on options for habitat management (e.g., the proximity of wilderness park land). At the second step, the user will determine the area's priority for habitat management by evaluating potentials and constraints for deer production and use (e.g., the severity of winters in the area and the road access available), and then consulting wildlife managers to confirm their goals for the area. The value of the timber resource and limitations on its use -- such as economic and seasonal accessibility -- will also be determined at Step 2. Next, in Step 3, the topography and vegetation of the area will be evaluated (see example on pages 26 and 27) to provide the basis for estimating food production and the value of the cover available (Step 4). The objective of these steps will be to compare the land's current suitability as deer habitat with its potential capability and its projected suitability in future under forest management. Habitat problems such as deficiencies of certain components or imbalances in the proportions of various habitats will be apparent when Step 4 is completed. These problems will then be addressed at Step 5, where alternative prescriptions for habitat management will be proposed. The sixth and last step will guide managers in implementing the selected prescriptions and establishing a monitoring program to measure the effects on habitat quality.

Use

This procedure will be applicable to a wide range of training and planning tasks, but each user and application will have a different focus. Thus the parts of the procedure that will be used and the ways in which they will be applied may be quite different. A forester who is new to the coast and dealing with a high-priority watershed for deer may want to use the whole procedure, while a Ministry of Environment biologist concerned about spring habitat suitability near a specific winter range may only consult Steps 3 through 5.

STEP 1
Determine Land Use

STEP 2
Determine Values

STEP 3
Determine Capability

STEP 4
Assess Habitat

STEP 5
Set Prescriptions

STEP 6
Implement and Monitor

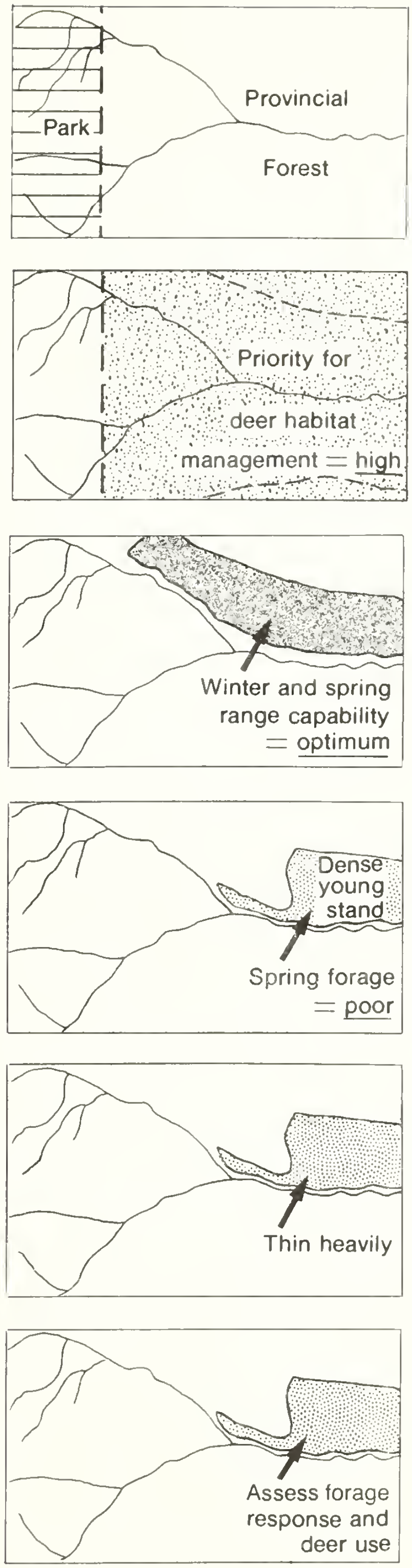
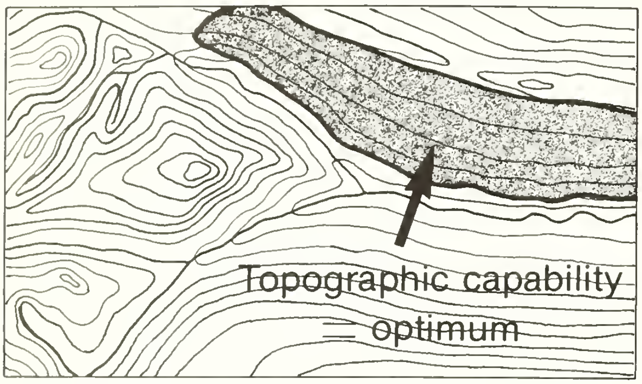


Figure 8. Steps in the habitat assessment and management procedure.

STEP 3: DETERMINE TOPOGRAPHIC CAPABILITY AND POTENTIAL VEGETATION

PURPOSE: To determine the potential capability of a site or area as deer habitat and the vegetation that will or could occur there. Topography is the main factor determining capability; climate and soil are the main influences on potential vegetation. Together they form the basis for analyses of deer habitat suitability (Step 4, p. 154). Maps and air photographs are the primary sources of information needed for this step.



CAPABILITY: The topographic factors of elevation, aspect, and slope interact with other abiotic factors to influence local climates (snowfall, snow accumulation, temperature, wind, and irradiation). During the summer and fall seasons topography has little effect on habitat selection by deer. For those seasons we assume that all topography has OPTIMUM capability to support deer. Selection of specific topography is most noticeable during winter and spring due to differential snow accumulations and forage "green-up" patterns. Generally, deer tend to select winter and spring ranges that are characterized by moderate and steep slopes with southerly aspects at elevations below 1000 m. Any location higher than 1000 m in elevation is considered UNSUITABLE as deer winter range and any location above 800 m is UNSUITABLE as spring range. Northerly aspects (0-45°, 315-360°) are considered UNSUITABLE for winter or spring range, as are slopes less than 40%. OPTIMAL winter and spring ranges have southerly exposures (90-270°) and moderate or steep slopes greater than 40% (Table 5).

POTENTIAL VEGETATION: Vegetation is the foundation of potential or current habitat suitability because it determines the cover and food that a site will provide. Potential habitat suitability is determined by the climatic climax vegetation; current suitability is determined by the existing vegetation, which may be successional or climax. The objective of this part of Step 3 is to stratify the stand or area of interest into understory communities (Appendix 1, p. 167) which will be used later (Step 4) as a basis for suitability analyses. Our understory community categories are derived from Biogeoclimatic Zones and soil moisture and nutrient regimes. To identify or map understory communities, the following information sources can be consulted: ecosystem maps, terrain maps and/or air photos, soils maps, topographic maps and a Biogeoclimatic Units map.

ASPECT	0 - 45° and 315-360°	45 - 90° and 270 - 315°			90 - 270°			Snowpack Zone
Slope / Slope position	All	< 40%	40-60%	> 60%	< 40%	40-60%	> 60%	
Valley bottom	Unsuitable	Unsuitable	Moderate	N/A	Low	Optimum	N/A	Shallow
			Low		Unsuitable	Moderate		Deep
Mid-slope	Unsuitable	Unsuitable	Low	Moderate	Low	Optimum	Optimum	Shallow
			Low	Moderate	Unsuitable	Optimum	Optimum	Deep
Upper slope	Unsuitable	Unsuitable	Low	Moderate	Low	Optimum	Optimum	Shallow
			Low	Low	Unsuitable	Low	Moderate	Deep
Slopes > 1000 m	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Shallow
								Deep

Table 5. Optimal winter and spring ranges have southerly exposures and moderate or steep slopes.

ACTIONS

ACTION 1: Determine Topographic Parameters

The parameters required are slope, aspect, and elevation for the particular stand or area being analysed. Obtain them from a topographic map of the area.

ACTION 2: Determine Winter/Spring Range Capability

The information gained from action 1 is now input to Table 5 to determine the capability of the particular area as winter or spring range. The result is recorded for comparison with the suitability results from Step 4.

ACTION 3: Determine Soil Moisture and Nutrient Regimes

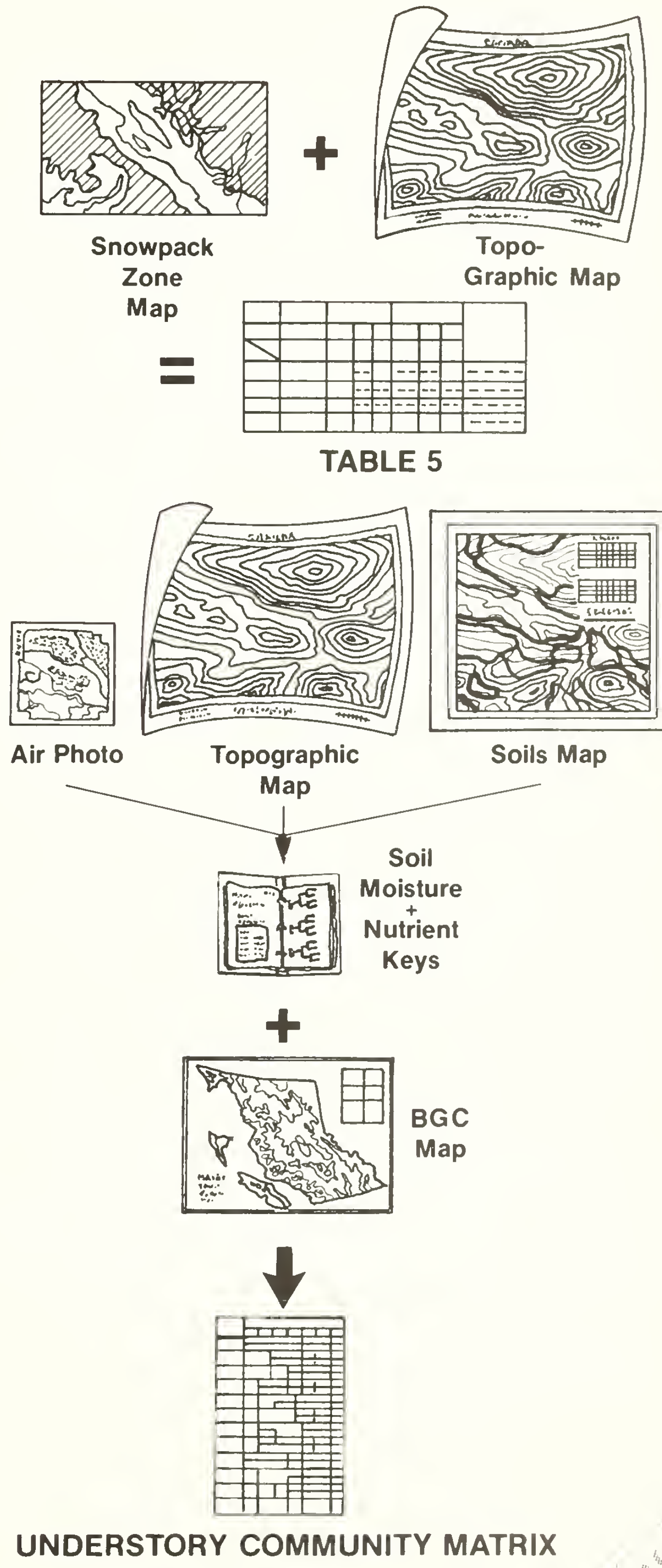
This is one of the most difficult actions to perform as it involves the utilization of many information sources (e.g., soils maps, air photos, topographic maps, and terrain maps) to provide inputs to the Vancouver Forest Region's keys for soil moisture and soil nutrients (Klinka *et al.* 1984) unless a map of ecosystem units is available. For best results the keys should be assessed on the basis of soil examinations to a depth of at least 30 cm.

ACTION 4: Determine Biogeoclimatic Zones

Using the 1:500 000 scale Biogeoclimatic Units map for the Vancouver Region (Nuszdorfer *et al.* 1985), determine the Unit that applies to the area under analysis.

ACTION 5: Determine the Potential Vegetation

With information gained from actions 3 and 4 as inputs to Table 38 (Understory Community Matrix - p. 170), the understory community that is likely to occur on the site is determined. The identification of the understory community sets the stage for the habitat suitability (cover and food) analysis that follows in Step 4.



PART III - APPENDICES

Content

The appendices will contain several types of information to supplement Parts I and II (Figure 9). **Appendix 1 (Understory Communities)** will describe the ecological characteristics of the major plant communities found on the coast, explain how to identify and map them, and summarize the value of each one as deer and elk habitat. When available, information on the effects of forestry activities on the communities will also be presented. The **Habitat Suitability Models (Appendix 2)** will provide simple quantitative relationships that relate habitat value (suitability) to measurable features of land and vegetation. A **glossary** of technical terms **(Appendix 3)**, a list of **Latin names (Appendix 4)**, and a large-scale map of the **snowpack zones (Appendix 5)** will also be provided.

The balance of this booklet includes brief descriptions and example pages of Appendix 1 (Understory Communities) and Appendix 2 (Habitat Suitability Models).

Rationale

The information in the appendices will be too detailed to be integrated within Parts I and II, yet it will form some of the most useful material in the handbook. To make the earlier parts as readable as possible, therefore, we will present much of the most technical information in Part III, with many "signposts" to it in the earlier text. The appendices will be consulted most often by people using the handbook in planning and conducting field activities.

PART III

APPENDICES

APPENDIX 5: 1:500 000 MAP OF SNOWPACK ZONES

APPENDIX 4: LATIN NAMES

APPENDIX 3: GLOSSARY

APPENDIX 2: HABITAT SUITABILITY MODELS

CONTENTS:

-Quantitative Relationships Between Forest Variables and Deer/Elk Habitat Suitability

USE WITH STEPS:

-2 (Topographic Capability)

-3 (Assess Habitat)

APPENDIX 1: UNDERSTORY COMMUNITIES

CONTENTS:

-Ecological Features

-Value to Deer/Elk

-Responses to Forestry Activities

USE WITH STEPS:

-2 (Potential Vegetation)

-3 (Assess Habitat)

Figure 9. Contents and suggested uses of Part III.

PART III, APPENDIX 1 - UNDERSTORY COMMUNITIES AND SPECIAL HABITATS

Questions Answered

Typical questions that could be answered using the Understory Communities appendix are:

"Which combinations of climate and site features provide similar habitat for deer?"

"What is the potential forage value of a Salal-Huckleberry site compared to a Moss site?"

"Which understory communities in my area could provide the best summer forage, if properly managed?"

Contents

This appendix will contain information on **ecological characteristics** and **deer and elk values** for 29 understory communities and five special habitats. These categories cover all the forested and non-forested habitats of the south coast. The understory communities will be derived by grouping similar ecosystem or site associations recognized by the Biogeoclimatic Ecosystem Classification system of the B.C. Ministry of Forests and Lands. The communities will be classified on the basis of similar understory vegetation at climatic climax, regardless of successional vegetation or tree species. Each community will thus represent all the ecosystem associations that provide similar deer and elk habitats, despite minor differences in vegetation, soils, or climate. The special habitats will be five more general categories, such as rock outcrops and non-forested wetlands, that provide particularly valuable habitats for deer or elk.

For each understory community, the following information will be provided: its **geographic range** of occurrence, its typical **site and forest stand characteristics**, its **climax understory vegetation**, its position on the **matrix of biogeoclimatic units and edatopes** (soil moisture and nutrient regimes), and its **value as habitat** for deer and elk (Figure 10). If enough information is available, the typical response of its understory vegetation to **forestry practices**, such as site preparation and thinning, will also be described. Pages 32 and 33 illustrate the layout for one widespread understory community.

Use

The understory community information should be useful to anyone involved with managing specific sites for deer and elk, especially where forage production is an objective. Perhaps its most common application will be in selecting sites for intensive management of winter and spring forage.

UNDERSTORY COMMUNITIES

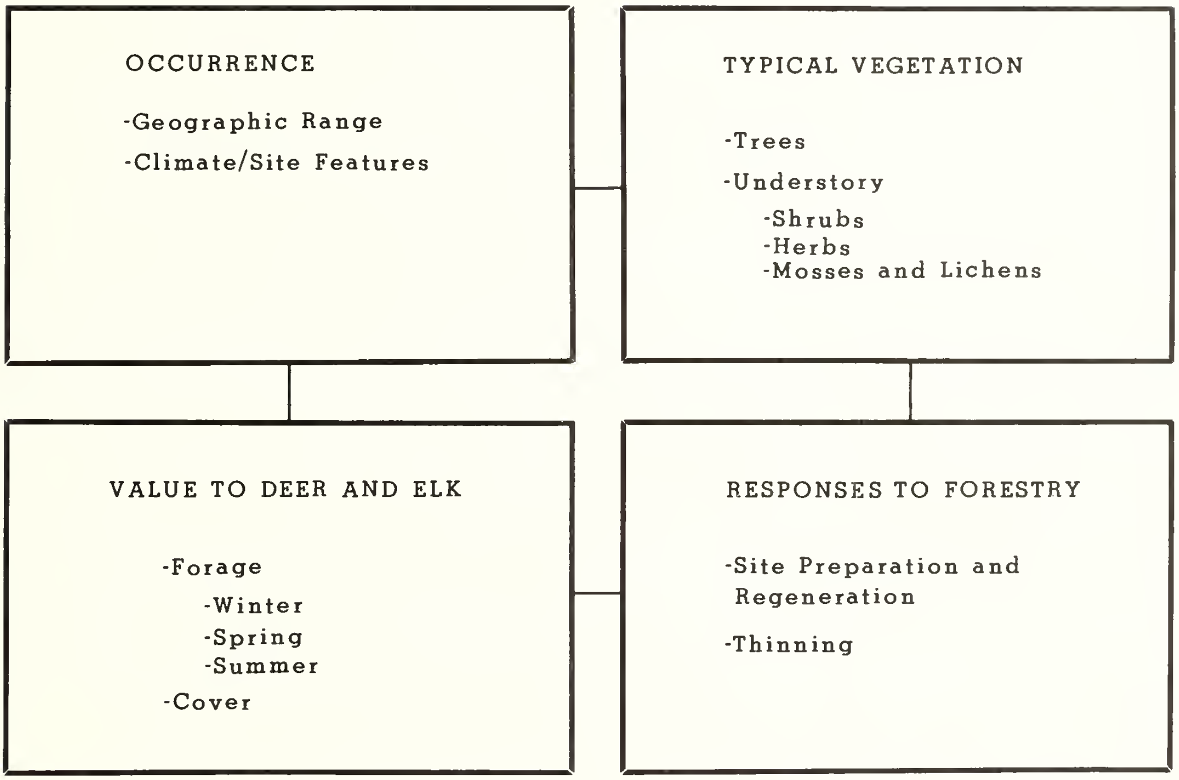


Figure 10. Information provided for each understory community.

SALAL – HUCKLEBERRY UNDERSTORY COMMUNITY

Biogeoclimatic Unit[1]	SNR[2]	Soil Moisture Regime (Potential Hygrotope)[3]: 0	1	2	3	4	5	6	7
CDF	A B C	Lichen - Salal[4]		Salal - Huckleberry			Moss		Sphagnum - Hardhack
	D E	Lichen - Tall Oregon grape		Salal - Dull Oregon grape			Sword fern	Salmonberry	Skunk cabbage
CWHa1	A B C	Lichen - Salal	Salal - Huckleberry		Huckleberry - Moss		Deer fern		Sphagnum Hardhack
	D E		Moss - Dull Oregon grape				Sword fern	Salmonberry	Skunk cabbage
CWHb1	A B C	Lichen - Salal	Salal - Huckleberry		Huckleberry - Moss		Deer fern		Sphagnum - Deer fern
	D E				Moss		Sword fern	Salmonberry	Skunk cabbage
CWHb3	A B C	Lichen Salal	Salal - Huckleberry		Huckleberry - Moss		Deer fern		Sphagnum - Deer fern
	D E		Salal - Dull Oregon grape		Moss		Sword fern	Salmonberry	Skunk cabbage
CWHd	A B C	Lichen-Salal	Salal - Huckleberry			Deer fern			Sphagnum
	D E			Moss		Sword fern			Skunk cabbage
CWHb2	A B C	Lichen Salal	Huckleberry - Moss			Deer fern			Sphagnum - Deer fern
	D E					Rosy twistedstalk - Five-leaved bramble			Skunk cabbage
CWHb4	A B C	Lichen - Moss			Huckleberry - Moss		Deer fern		Sphagnum - Deer fern
	D E		Huckleberry - Dull Oregon grape				Rosy twistedstalk - Five-leaved bramble		Skunk cabbage
CWHa2	A B C	Lichen - Prince's pine	Salal - Huckleberry		Huckleberry - Moss		Deer fern		Sphagnum - Hardhack
	D E		Moss - Dull Oregon grape				Sword fern	Salmonberry	Skunk cabbage
CWHc1	A B C	Lichen - Prince's pine		Moss - Falsebox			Moss		Sphagnum
	D E	Lichen - Tall Oregon grape		Moss - Dull Oregon grape			Oak fern		Skunk cabbage
CWHb5	A B C	Lichen - Falsebox	Moss - Kinnikinnick		Huckleberry - Moss		Deer fern		Sphagnum - Deer fern
	D E				Huckleberry - Rosy twistedstalk		Oak fern		Skunk cabbage
MHa	A B C	Lichen Pink mountain heather	Huckleberry Moss				Deer fern		Sphagnum - Deer fern
	D E				Huckleberry Rosy twistedstalk		Rosy twistedstalk - Five-leaved bramble		Skunk cabbage
MHb	A B C	Lichen - Pink mountain heather	Black huckleberry - White rhododendron		Huckleberry - Moss		Deer fern		Sphagnum - Deer fern
	D E				Huckleberry - Rosy twistedstalk		Rosy twistedstalk - Five-leaved bramble		Indian hellebore
MHp	A B C D E	Lichen - Pink mountain heather	Mountain heathers		Black huckleberry - White rhododendron		Sitka valerian - Arnica		Indian hellebore

Table 41. The position of the Salal-Huckleberry understory community on the biogeoclimatic unit/edatope matrix.

Species	Season: Winter	Spring	Summer
Deer	1.0	0.7	0.7
Elk	0.4	0.2	0.2

Table 42. Potential forage values, by season, for deer and elk.

LOCATION: Throughout Vancouver Island and southwestern B.C. in maritime climates at lower elevations (CDF, CWHa1, CWHa2, CWHb1, CWHb3, CWHd); primarily on dry to medium (0-4), nutrient very poor to medium (A-C) sites, except in the CWHd and CWHb1 which are also from medium to very rich (C-E) (Table 41).

SITE CHARACTERISTICS: Mainly gentle to steep upper slopes, except in the CDF where it also occurs on middle slopes, on coarse textured, shallow to deep soils on the slopes (morainal blankets, or colluvial or morainal veneers over bedrock), and on very coarse textured soils on flatter areas (fluvial or glaciofluvial).

STAND CHARACTERISTICS: Primarily Douglas-fir at lower elevations with increasing amounts of western hemlock as the elevation and rainfall increases; may also have minor amounts of western redcedar and amabilis fir.

UNDERSTORY COMPOSITION:

Shrubs: Salal, red huckleberry, Alaskan and oval-leaf blueberry, baldhip rose, dull Oregon grape, trailing blackberry

Herbs: Prince's pine, wall-lettuce, bunchberry, twinflower

Mosses & Lichens: *Stokesiella oreganum, Hylocomium splendens, Rhytidiopsis robusta, Rhytidiadelphus loreus*

VALUE TO DEER

The Salal-Huckleberry understory community has the highest winter forage potential for deer of any understory community, especially on south-facing slopes. In mature and old-growth stands abundant arboreal lichens complement an understory dominated by salal and red huckleberry. Cedar browse is also available, as are Douglas-fir and hemlock branches and litter. During winters of deep snow, these forages provide the bulk of the deer diet. The ability of the overstory to intercept appreciable amounts of snow, thus providing easier mobility and greater forage availability, has made mature and old-growth stands on Salal-Huckleberry sites valued as deer winter ranges. It is possible that younger seral stages can be modified to fulfill this same function. Forage potentials at other times of the year are lower (Table 42) due to deer preferences for more succulent forage. In early seral stages (clearcuts) invasion of pioneer herbs such as hairy cat's ear, pearly everlasting, bracken fern and fireweed can boost both forage abundance and diversity. Most Salal-Huckleberry sites are burned prior to planting to reduce competition by salal; this aids in establishing and maintaining the preferred herb forage. Clearcuts on such sites can function well as spring range if their slope position and aspect facilitate early snow melt. Low to moderate summer/fall use is expected, primarily from resident animals.

VALUE TO ELK

Although this understory community is fairly abundant at lower elevations, it receives only light Roosevelt elk use. Its forage potential is minimal except during the winter months when diet shifts cause use of huckleberry and conifers to increase (Table 42). Only those seral stages providing some canopy closure are useful to elk in the winter, and the amount of use then usually depends on the presence of nearby rock outcrops or other desirable winter understory communities. Use at other times of the year is also low; non-migratory elk might use all seral stages from spring through fall if richer sites were not available.

FORESTRY EFFECTS

SITE PREPARATION AND REGENERATION

Salal-Huckleberry sites are usually burned following logging in an effort to reduce competition by salal. Douglas-fir is the preferred crop species, although hemlock is often planted in the wetter subzones. Redcedar can be used to provide long-term brush control. Following burning, pioneer herbs (e.g., fireweed) often invade and increase substantially.

NON-COMMERCIAL THINNING

Non-commercial thinning of even moderate intensities provides large increases in salal abundance; huckleberries respond less dramatically (Figure 92). Certain other forage species also show favourable responses to thinning; fireweed, trailing blackberry and twinflower increased 3, 4, and 14 times respectively in one case (Nyberg *et al.* 1986).

COMMERCIAL THINNING

In stands left until commercial thinning age, understory vegetation is usually present in moderate amounts. The poor tree growth on these relatively unproductive sites allows moderate amounts of light to reach the ground. Response to thinning is not as dramatic as for non-commercial thinning (Figure 93) but overall, forage production increases. Salal, dull Oregon grape and bracken fern usually increase with thinning. Fertilization of a lightly-thinned stand tends to speed up tree crown development, reducing light to the understory; forage subsequently has less time to develop. In heavily-thinned stands, fertilization will benefit understory vigor and quality because the tree canopy remains open longer.

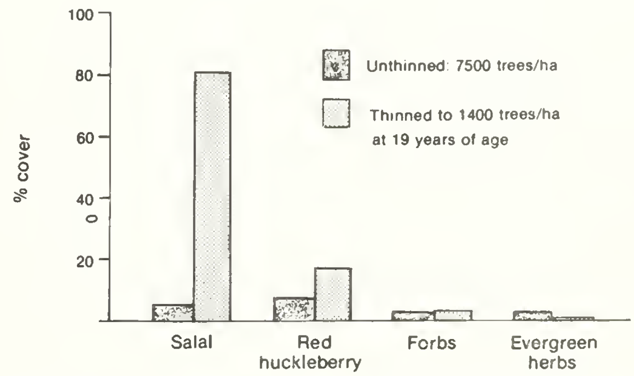


Figure 92. Abundance of selected species and species groups as affected by non-commercial thinning to 1400 stems/ha in a Salal-Huckleberry understory community.

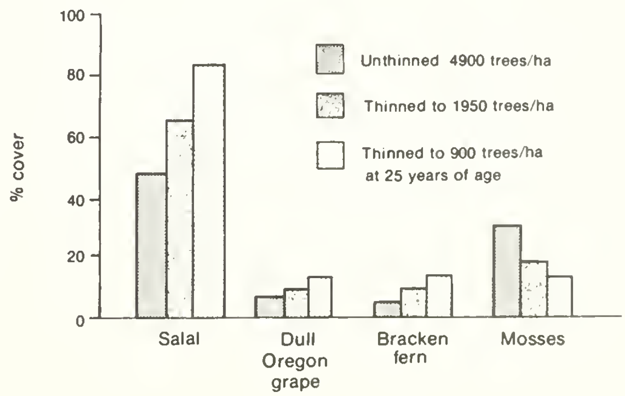


Figure 93. Abundance of selected species and species groups as affected by two levels of commercial thinning in a Salal-Huckleberry understory community.

PART III, APPENDIX 2 - HABITAT SUITABILITY MODELS

Questions Answered

The suitability models will answer questions such as:

"What is the value of the forage resource on the area being assessed?"

"How close to optimum is the arrangement of forage and cover areas?"

"Are all seasonal habitat types available in the watershed?"

Content

The models will consist of simple numerical relationships depicted in tables, graphs, or formulae that express the effects of various features of the landscape and vegetation on habitat suitability for deer and elk. These features include topographic effects, forage biomass and quality, security and thermal cover values, snow interception by the overstory, and the spatial distribution of cover.

Use

The models will provide managers with a means of evaluating, in numerical terms, the quality of existing habitat or the impact of changes in habitat such as those caused by forestry. These models will be among the most practically oriented material in the handbook, being designed to answer site-specific questions about habitat quality in a watershed or other planning area. We expect them to be used by both biologists and foresters in evaluating logging development or silvicultural plans.

Figure 11 illustrates the link between these models and the rest of the handbook, and pages 36 and 37 give an example of one of the modelled relationships.

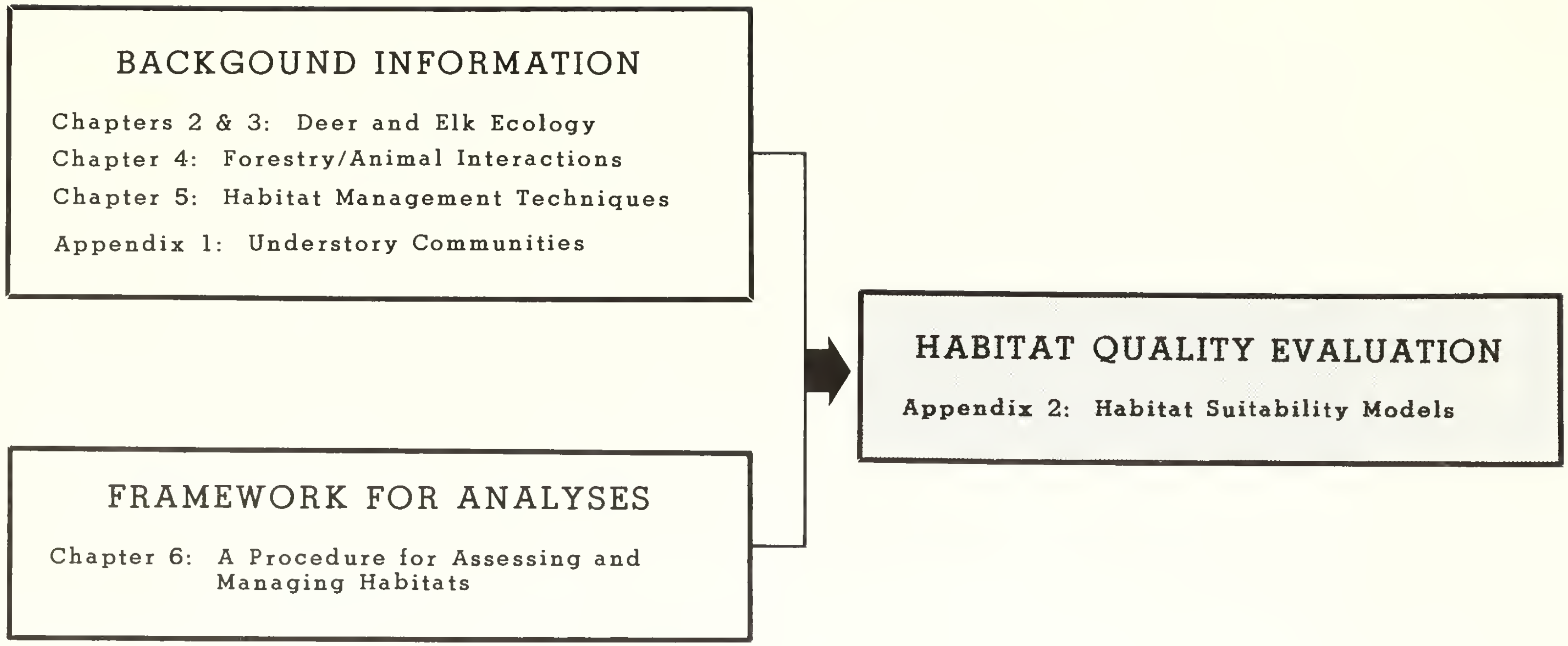


Figure 11. The relationship of the habitat suitability models to the rest of the handbook.

VALUE OF COVER

HOW MUCH SHELTER FROM SNOW CAN THE OVERSTORY PROVIDE?

The interception of snow by forest canopies is an important criterion to consider in the management of deer winter ranges. The importance of snow interception arises from the dual impact that snow has on habitat suitability: not only does snow bury forage, it also restricts movement and increases the amount of energy needed for locomotion. In severe winters, life is already hard due to lower temperatures and reduced food quality and quantity. Snow then causes a dramatically larger deficit in the energy needed to sustain deer. The objective in assessing shelter from snow is to evaluate the ability of the canopy to intercept snow to reduce the snowpack that accumulates on the forest floor.

Before we can appraise habitat suitability for snow interception, we must know the severity of local winters, the relationship between snow interception and forest characteristics, and the effect of snow on the energy costs of deer movement. When deer need to lift their legs high to walk through snow, the energetic cost of locomotion increases logarithmically with increasing snow depth on the ground. Any habitat with less than 15 cm of snow is OPTIMAL. If 15-25 cm of snow accumulates we estimate suitability to be MODERATE. If 25-30 cm of snow accumulates the habitat is of only LOW value, and it is UNSUITABLE if more than 30 cm of snow accumulates (Figure 105).

The most important factors affecting the depth of snow on the ground are the frequency and intensity of snowstorms in an area and the temperatures prevailing in the intervals between storms. These factors vary greatly among areas and among years, making it difficult to predict the snow accumulation that can be expected in any year. Generally, snowfalls in the deep snowpack zone (Figure 2, p. 13) are more intense and more frequent than in the shallow zone. In some years, snow accumulates to depths of 30 cm and more for most of the winter season at the elevations of many winter ranges in the deep snowpack zone. Similar snow depths do occur at times in the shallow snowpack zone, but usually from lighter and less frequent storms and the accumulations almost always last for short periods of time. THEREFORE, STANDS IN THE SHALLOW SNOWPACK ZONE DO NOT NEED TO BE EVALUATED FOR SHELTER FROM SNOW.

ANSWER SOURCE:

We have used data from studies on Vancouver Island and the coastal mainland to develop a method of evaluating stand suitability for cover from snow. This method is based on the assumption that a stand's ability to intercept snow is a direct reflection of its suitability as deer habitat (Figure 105). Knowing the snowstorm sizes that are typical for the area and the mean crown completeness (canopy closure) for the stand, the user needs merely to read the figure opposite and record the appropriate value for the stand being assessed.

CONFIDENCE:

Our confidence in this ranking of habitat suitability is HIGH. From previous studies, crown completeness and some measure of storm size or winter severity can explain up to 90% of the variation in snow interception.

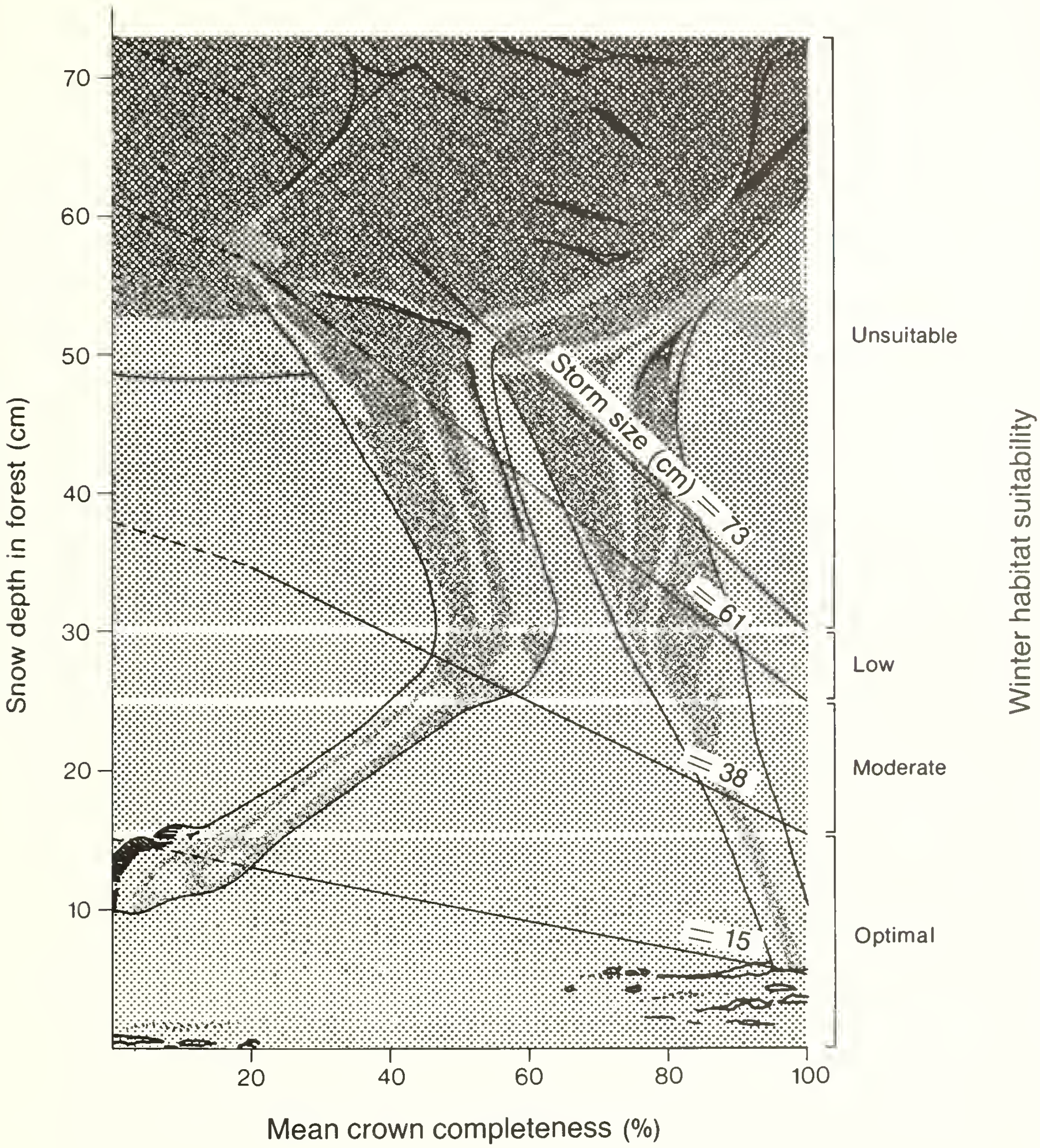


Figure 105. Effects of snowstorm size and crown completeness (closure) on suitability of forest stands as winter deer habitat.

SUMMARY

This booklet describes the projected content, design principles, users, and applications of a handbook on deer and elk habitats in the forests of south-coastal British Columbia. Fourteen example pages are also provided to illustrate the projected format of the finished handbook.

Although considerable effort by many people has already been expended in preparing drafts of various sections, the handbook's content and format are not yet finalized. We therefore invite you to comment on any aspect of the projected design or content. We would especially like to hear how we can make it more useful for forest and deer managers. A brief questionnaire is provided on page 43 on which your comments can be recorded, or you may phone the handbook editors at the numbers listed on the questionnaire.

APPENDIX A: PROPOSED TABLE OF CONTENTS FOR HANDBOOK

Deer and Elk Habitats in the Coastal Forests of Southern British Columbia

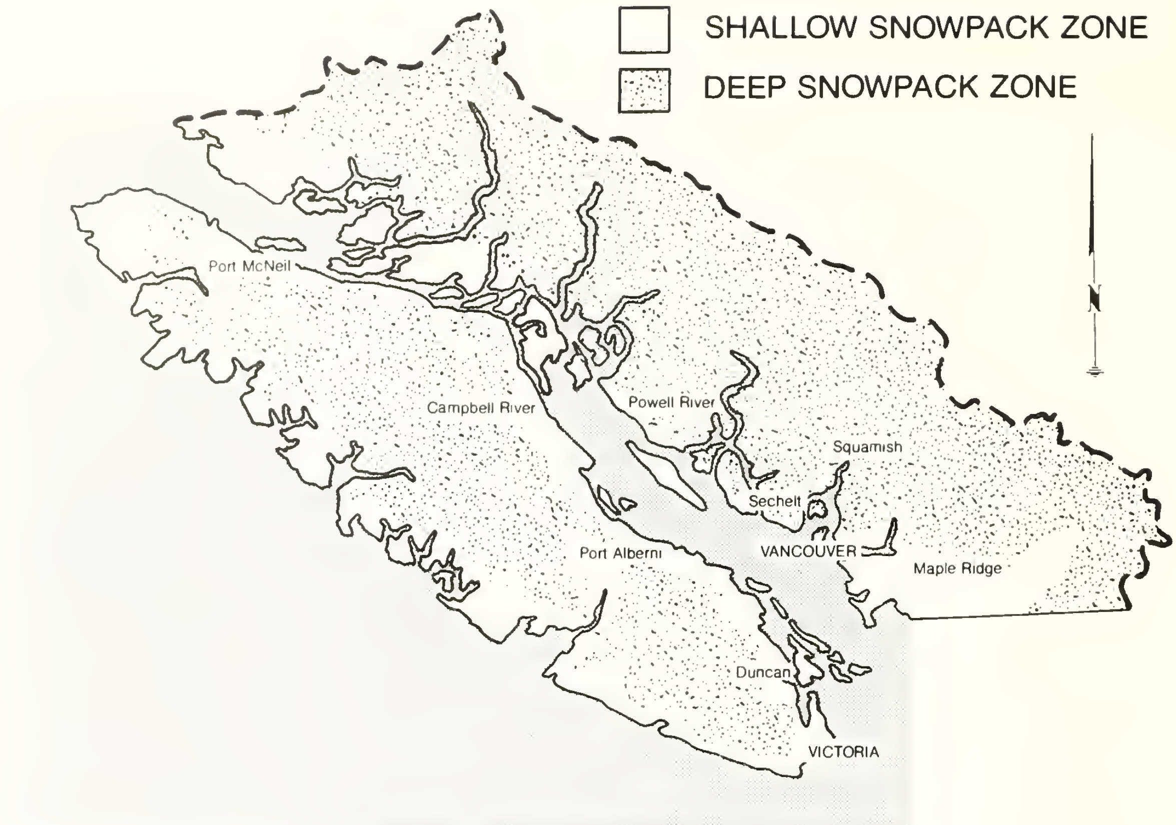


Figure 1. Snowpack zones in the handbook area.

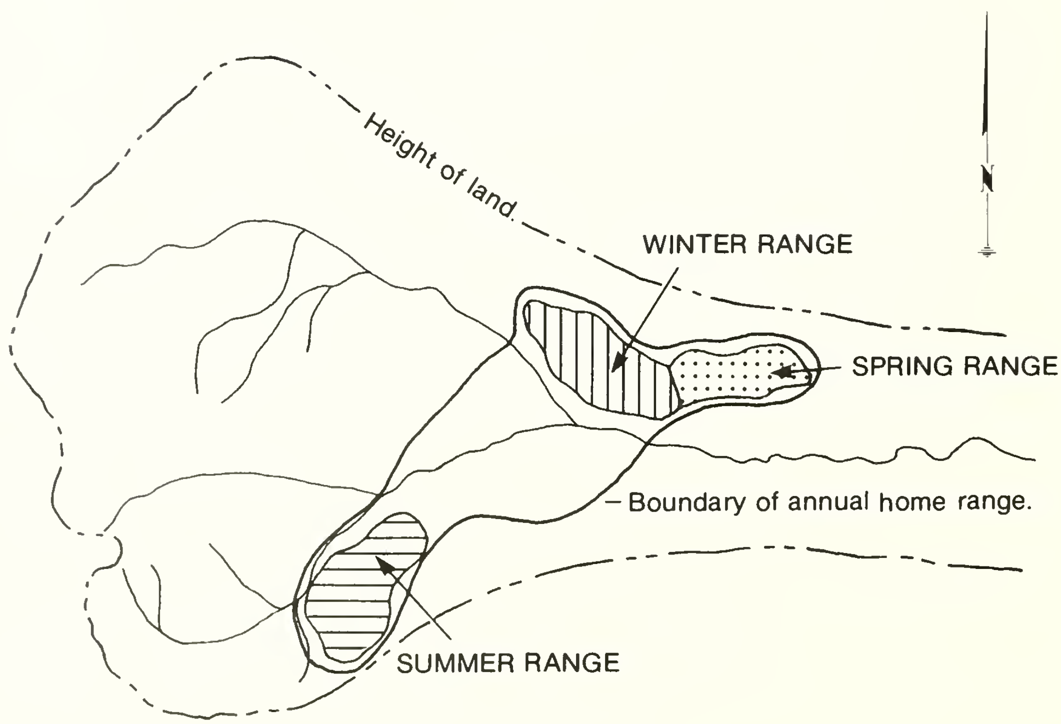


Figure 2. Seasonal ranges for a migratory deer.

PART II - PLANNING, MANAGING, AND MONITORING HABITATS

PART III - APPENDICES

NOTES:

COMMENTS ON PROJECTED DESIGN AND CONTENT OF
THE IWIFR HANDBOOK ON DEER AND ELK HABITATS

1) Will the projected contents be useful to you? What should be added or omitted (refer to page 39)?

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2) Is the level of detail too simple or too complex? Is the material easy to understand?

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3) The handbook is intended as a reference tool to be used in conjunction with a pocket field book. Is this a useful combination for you? How do you anticipate using the handbook?

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4) Please add additional comments and ideas (use an additional page if necessary).

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____
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____
____

Your name: ________________ Agency/company: ____________________

Position: ________________________________ Phone: ______________

Thank you for taking the time to give us your ideas. If you would rather phone in your comments, please call either Brian Nyberg (Technical Editor - Deer), B.C. Ministry of Forests and Lands, Burnaby, 660-7530; Doug Janz (Technical Editor - Elk), B.C. Ministry of Environment and Parks, Nanaimo, 758-3951, or Ted Richardson (Design Editor), Aprotek Design, Vancouver, 433-1887.

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Nyberg, J. Brian; McNay, R. Scott; Kirchhoff, Matthew D. [and others]. 1989. Integrated management of timber and deer: coastal forests of British Columbia and Alaska. Gen. Tech. Rep. PNW-GTR-226. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 65 p.

Current techniques for integrating timber and deer management in coastal British Columbia and Alaska are reviewed and evaluated. Integration can be improved by setting objectives for deer habitat and timber, improving managers' knowledge of interactions, and providing planning tools to analyze alternative programs of forest management. A handbook designed to summarize relevant knowledge and assist planning in coastal British Columbia is described and examples of its contents are included.

Keywords: Deer (black-tailed), forest planning, integrated resource management, old growth, habitat ecology, timber management, British Columbia, Southeast Alaska.

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