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Integrated Management of Timber and Deer: Interior Forests of Western North America

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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

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Timber and deer managers have struggled through years of increasing demands and growing conflicts in the interior of Western North America. Integrated management, supported by a sound research data base and effectively communicated to all users, is presented as the only viable approach to an increasingly complex resource future. Two examples of tools recently designed for managers in dealing with timber-deer habitat are discussed.

Keywords: Integrated management, timber management, wildlife habitat management, deer, mule deer.

Contents

Introduction

The diversity of habitats supporting deer in the interior of Western North America poses a variety of conflicts and presents an amazing array of challenges for adaptive deer management. Recent conflicts in the management of deer in Western North America have involved habitat and land-use practices rather than the traditional problems of predation and harvest.

Mule deer *(Odocoileus hemionus)* are the most common deer species in the western interior. White-tailed deer *(Odocoileus virginianus)* , however, also occur across a significant portion of the West, having both biological and economic importance in some regions (fig. 1). For example, white-tailed deer comprise 71 percent of the legal deer harvest in northwestern Montana (Mussehl and others 1986). Habitat concerns generally are similiar for the two species; consequently, both are discussed here. For more specific comparisons and contrasts between the species, refer to the works of Wallmo (1981) and Halls (1984).

We have made three basic assumptions in this paper. The first was that forest land, particularly commercial forest land used for producing wood fiber, is the primary habitat for maintaining deer populations in the area to which this publication applies; other land uses such as agriculture and wilderness playa relatively minor role. Second, the maintenance of deer and deer habitat is a desirable management goal, as is forest management. Finally, although locally a winter or summer deer range may have particularly difficult problems needing resolution, we recognize successful deer management must consider habitat structure for all seasonal ranges that receive annual use.

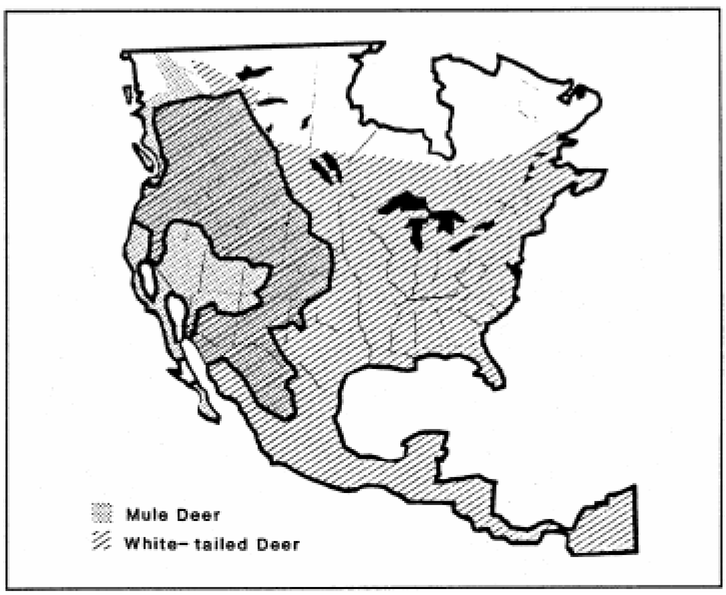


Figure 1—Approximate overlap in the distribution of white-tailed deer and mule deer (from Halls 1984).

Problem Analysis

What Is the Issue?

Summer and winter deer habitat values in interior forests are being affected by the conversion of natural old-growth stands to regulated second-growth stands. Resource managers generally have neither adequate habitat inventories nor predictive tools to assess the impacts of old-growth conversion.

Winter range is a major concern in the northern part of the western interior where mule and white-tailed deer are at distributional limits. Although some areas support relatively light snowpacks where deer can find adequate food and shelter in open or semiopen habitats, in other areas old-growth Douglas-fir *(Pseudotsuga menziesii* (Mirb.) Franco) and mixed-species forests provide deer both relief from deep snow and substantial sources of winter food. These forested winter ranges are at the center of resource conflicts.

Douglas-fir is an important component of the wood supply for the forest industry, and significant amounts of this species occur on deer winter ranges. For example, approximately 30 percent of the Douglas-fir in the Cariboo Forest Region of the British Columbia interior is located on mapped mule deer winter ranges.

This situation has led to resource allocation conflicts. To meet the demand for high-value timber, forest managers have been harvesting old-growth Douglas-fir and mixed-species stands on winter ranges. These stands are often adjacent to other land uses, such as agricultural operations and residential developments, that conflict with deer management. Wildlife managers are concerned that deer populations will continue to decline as more old growth on winter ranges is harvested. In the long term, second-growth stands managed for optimum timber production may not provide adequate winter range values for deer (Armleder 1981, Mundinger 1984). Habitats providing uneven-aged, multilayered, and dead-and-down structural components (fig. 2) have only been adequately considered (Leckenby 1984) in silvicultural designs applied to about 20 percent of the forested lands in the Northwestern United States.

Figure 2—Mule deer use uneven-aged and multilayered forested habitat throughout much of their range. These habitats are threatened by the conversion of old-growth to regulated forest stands.

Several reasons exist for these conflicts. First, allowable cuts and quotas are often high so intensive management is necessary for maintaining production levels. Intensive management techniques, which include improved genetics, fertilization, thinning, and rapid reforestation, do not result in the structure and longevity of the mature stands that are most valuable to deer. Second, mature and overmature retentions for watershed, esthetics, and other nonwildlife reasons are not alone adequate for maintaining deer populations on commercial forest lands. Long-range forest management goals often cannot accurately predict anticipated increases in the demand for recreational use of deer resources. Finally, ecological understanding of the consequences of large-scale habitat modification is lacking.

These problems are not just confined to winter range; an example is the commercial harvest of aspen stands on summer range for mule deer in Colorado. Twenty-five percent of the commercial forest in that state is made up of aspen *(Populus* spp.) (Jones 1985) that also serves as diverse habitat for a variety of wildlife, including mule deer. Aspen communities provide forage and fawn-rearing habitat throughout the summer. During fall, aspen stands provide forage that is important in preparing deer for winter survival in lower-elevation pinyon-juniper *(Pinus* spp., *Juniperus* spp.) and sagebrush *(Artemisia* spp.) winter ranges. Large-scale clearcutting has been planned for overmature aspen stands considered to be decadent and in need of rejuvenation. Implied in such plans is that clearcutting will provide new successional habitats with more edge and diversity (Thomas 1979) resulting in a beneficial, or at worst, neutral effect on deer. Unfortunately, limited data exist to predict the actual benefits or impacts of aspen clearcutting on mule deer. Cooperation between resource managers is hindered by the lack of substantiating data.

Review of Historical Approaches to Problem Resolution

Large-scale timber harvesting has occurred only since the 1960's in the interior of British Columbia and since the 1950's in the northern interior of the United States. During this period, economic interests have dominated forest-management decisions. Consequently, large areas of Douglas-fir have been harvested, winter ranges have shrunk, and the impact on deer populations is estimated to have been considerable (Leckenby 1984, Cariboo Region Fish and Wildlife 1985).

As the value of remaining old-growth stands increases, the economic tradeoffs to preserve habitats have also increased dramatically. Wildlife managers have typically used the strategy of specifying boundary changes and deferrals on a case-by-case basis. As harvest rates increase, biologists have to deal with hundreds of timber sales each year. Companies and governmental agencies have hired biologists, but the work rapidly exceeds their ability to keep up by traditional methods. Frequent transfer of personnel has disrupted communications and generated mistrust. Undesirable results have been ascribed to predecessors, and current managers have not been held accountable for the status quo. Habitat data have not been current nor available to permit objective evaluations. Remote-sensing tools for inventory and monitoring have been expensive to develop and difficult to understand and implement.

Past approaches to the deer and timber conflict in the western interior of Canada and the Western United States have generally used two silvicultural systems. The first system is even-aged management (such as, clearcutting, seed tree, and shelterwood). The objective of this system is to harvest or remove all trees not desired for regeneration and encourage rapid establishment of second-growth stands. On most sites, this approach usually maximizes both short-term economic return on timber as well as rooted forage.

This system, however, also usually eliminates deer use on the cutovers, especially on winter ranges in deep snowpack zones, until conditions recover. Under this system, optimal old-growth stand conditions are never reached or persist only for a short period before merchantable second-growth is again harvested.

The second system is uneven-aged management with the objective of periodically removing some merchantable timber through selective harvesting while retaining some forest cover at all times. This approach depends on the skillful manipulation of the stand to harvest the desired volume and to retain a useful cover-component for deer. Retention of cover is especially critical on winter range, where any reduction in thermal and canopy cover can reduce the ability of the stand to meet deer needs in winter especially in deep snowfall zones. The problems with uneven-aged management are the costs of repeated entries into the stand, the difficulties of designing and administering this type of harvest, the slash accumulations that may impede deer movement, the risk of reducing canopy cover so cover values are compromised, and the potential silvicultural problems from retaining damaged trees in the stand. Despite these problems, uneven-aged management remains one of the most common systems for integrating timber and deer management objectives.

Management Context and Alternatives

Two dilemmas for resource managers in both Canada and the United States are (1) how to deal with apparent policy conflicts within public agencies charged with managing deer, deer habitat, or both and (2) how to deal with intermingled ownerships of both public and private lands.

Legislation often requires forest managers to integrate a variety of resource values into management decisions. Controversy develops when decisions must be made on what multiple uses will prevail in specific areas. Although the degree to which this must be done is often not specified, these requirements clearly preclude complete harvesting of all winter range for mule deer and the management of second growth solely for fiber production.

Application of management solutions can be hindered by land ownership. In the interior of the Western United States, public and private land ownerships are often intermingled in a widespread alternate-section "checkerboard" pattern, which requires both appreciation of differing management philosophies and careful coordination to resolve problems common to both ownerships. Private lands support substantial deer populations in the Western United States. For example, 62 percent of the mule deer and 68 percent of the white-tailed deer distribution in Montana occurs on private land (Mussehl and others 1986).

A mutually acceptable solution is needed for allowing public and private land managers opportunities to meet their respective mandates in considering both commodity and amenity resources. Two options exist: preservation and integrated management.

The Preservation Option—Key deer habitat could be protected by adopting a preservation strategy. This approach has the advantage of assuring professionals and the public that effective habitat exists on a site now without speculation on future management actions or successional developments.

Preservation has several distinct problems for managers:

1. Unless deer resources are extremely high, the value of standing timber precludes the preservation of large blocks of old-growth habitat.

2. Severe winters present the possibility that deer populations may be crowded into preserved islands of suitable habitat. Such crowding could contribute to habitat deterioration and substantial mortality.

3. Old-growth forests are not static. For example, many of these slow growing stands are threatened by Douglas-fir beetles *(Dendroctonus pseudotsuga);* large-diameter food and shelter trees could be lost without management to provide replacement stems.

4. Commitment from the landowner to retain identified stands in their present condition over the long term is difficult and in some cases impossible to get. If the preserved blocks are lost to fire, insects, diseases, or premature harvest before second-growth stands can provide replacements, the ability of the entire range to support deer is compromised.

These problems do not rule out the use of preservation in managing deer habitat. Permanent reserves of mature timber on key portions of winter range may be desirable and acceptable. If natural forces such as fire are controlled, management to maintain old-growth characteristics may be necessary. It is unlikely, however, that enough timber could be set aside as permanent reserves to meet the goals of wildlife managers.

The Integrated Management Option—Integrated management recognizes the goals of forest and wildlife managers and seeks to reach an acceptable compromise through the application of modified forestry practices. This approach has clear advantages:

1. Large tracts of timber are not permanently reserved from contributing to the wood supply, although some reduction in the allowable cut is likely.

2. Deer-habitat values are maintained; reduced slightly; or, in some cases, potentially enhanced.

This option requires supporting data showing deer-habitat values are not substantially eroded by integrated management (Arno and others 1987). Managers cannot wait, however, until complete evidence supporting this approach is available. Because wildlife habitat issues need reconciliation now, managers are willing to accept solutions that do not yet have complete supporting data, especially if the chances for success are high and if the consequences of taking wrong actions are less serious than maintaining the status quo. Typically, managers go with the present professional experience until research dictates a modification of current understanding.

Both preservation and integrated management for deer habitat are practiced on public and private lands. Public lands administered by Provincial, State, or Federal agencies are primarily managed in a multiple-use context whereby timber management can be modified to accommodate other public resource objectives, such as maintenance of deer habitat. Under this management philosophy, preservation is most appropriate when extended rotation and old-growth retention are required. Integrated management can be applied when stand conditions permit periodic removal of some merchantable volume.

Private forest lands are managed primarily for the production of wood fiber. Management philosophy on industrial timberlands can be described as "maintaining public expectations while meeting economic objectives" (Hicks 1985). Management actions that do not significantly limit the economic flexibility of private landowners are most likely to succeed. Integrated management techniques such as selective harvesting and short-term deferral to maintain existing values can be cost effective if maintenance of deer habitat is a management objective. Concurrently, second-growth stands can be intensively managed for a mix of timber and habitat values.

An integrated-management philosophy for resolving the mule deer and timber conflict on public land in eastern Oregon has been jointly endorsed by the Oregon Department of Fish and Wildlife and the USDA Forest Service. These agencies formally agreed to apply published structural, spatial, and size definitions of wildlife habitat (Thomas 1979) in the management of all National Forest lands. This action standardized evaluation of stand inventories for potential wildlife habitat and, therefore, may have reduced overall administrative costs because wildlife habitat was no longer defined ambiguously and because habitat quality was evaluated from readily available timberstand data. This level of management sophistication was adequate for designing and evaluating timber sales in a manner reasonably sensitive to wildlife habitat needs. Wildlife biologists, however, desired a more intricate and precise approach. The effects of this standardized-evaluation approach on mule deer have not been adequately evaluated.

Case Examples of Timber-Habitat Management Tools

Two examples of recently designed tools to aid managers in dealing with timber-deer habitat issues are presented next. Each is designed to meet a specific management need as was described in the problem analysis section of this publication. Because we wish to focus on management applications, the research on which these tools are based will not be described in detail. Interested readers are referred to the original publications.

Example 1. Handbook for Timber and Mule Deer Management Coordination on Winter Ranges in the Cariboo Forest Region, British Columbia.

This section describes the process used in developing a handbook as an integrated-management tool. The process should be of interest to managers and researchers who face the challenge of integrating management of timber and wildlife. The steps in the development and implementation of the handbook are presented in figure 3. References are made to these steps as the process is described in detail.

The handbook serves as a field guide for forest and wildlife managers and logging contractors (Armleder and others 1986) and provides information for coordinating mule deer and timber management on deer winter range in the Cariboo Forest Region of British Columbia. Although the principles contained in the handbook are widely applicable, the specifics may be valid only in the Cariboo.

A low-cost version of the handbook accompanies this paper. The original is spirally bound with waterproof paper stock and some color illustrations and is intended for field use.

Ecological Understanding—Before a successful management tool can be developed, researchers must understand the ecological requirements of deer and how their habitat is affected by timber management. All possible questions need not be answered at scientific levels of acceptability, however, before the development of the tool proceeds. In this example, research continued after development began on the management handbook. In time, the scientific evidence supporting or refuting recommendations would become available to managers.

A basic qualitative model of mule deer habitat relationships is presented in the first section of the handbook and will not be repeated here. The model was included in the management tool because education and understanding are prerequisites to support new strategies and techniques.

The handbook deals specifically with the conflict of harvesting old-growth timber on mule deer winter range. To survive the winter and meet the demands of gestation, deer require suitable food and shelter. These basic requirements are supplied largely by the forest cover on winter range (fig. 4).

The conflict on winter range relates to how the sources of food and shelter shown in figure 4 are altered through typical diameter-limit timber harvesting. This harvesting system removes all stems over a minimum diameter (typically 35-40 centimeters) and consequently eliminates for deer both the canopy that intercepts snow and the major source of winter food (that is, Douglas-fir litterfall). Additionally, thermal and security cover values are reduced by the removal of stems and the damage caused to advance regeneration.

Development of an Integrated Management System—A committee comprised of forest and wildlife managers as well as researchers was established to ensure the development of a practical management system that would be acceptable to all users. This committee reviewed progress and provided the operational perspective throughout the development of the integrated management system.

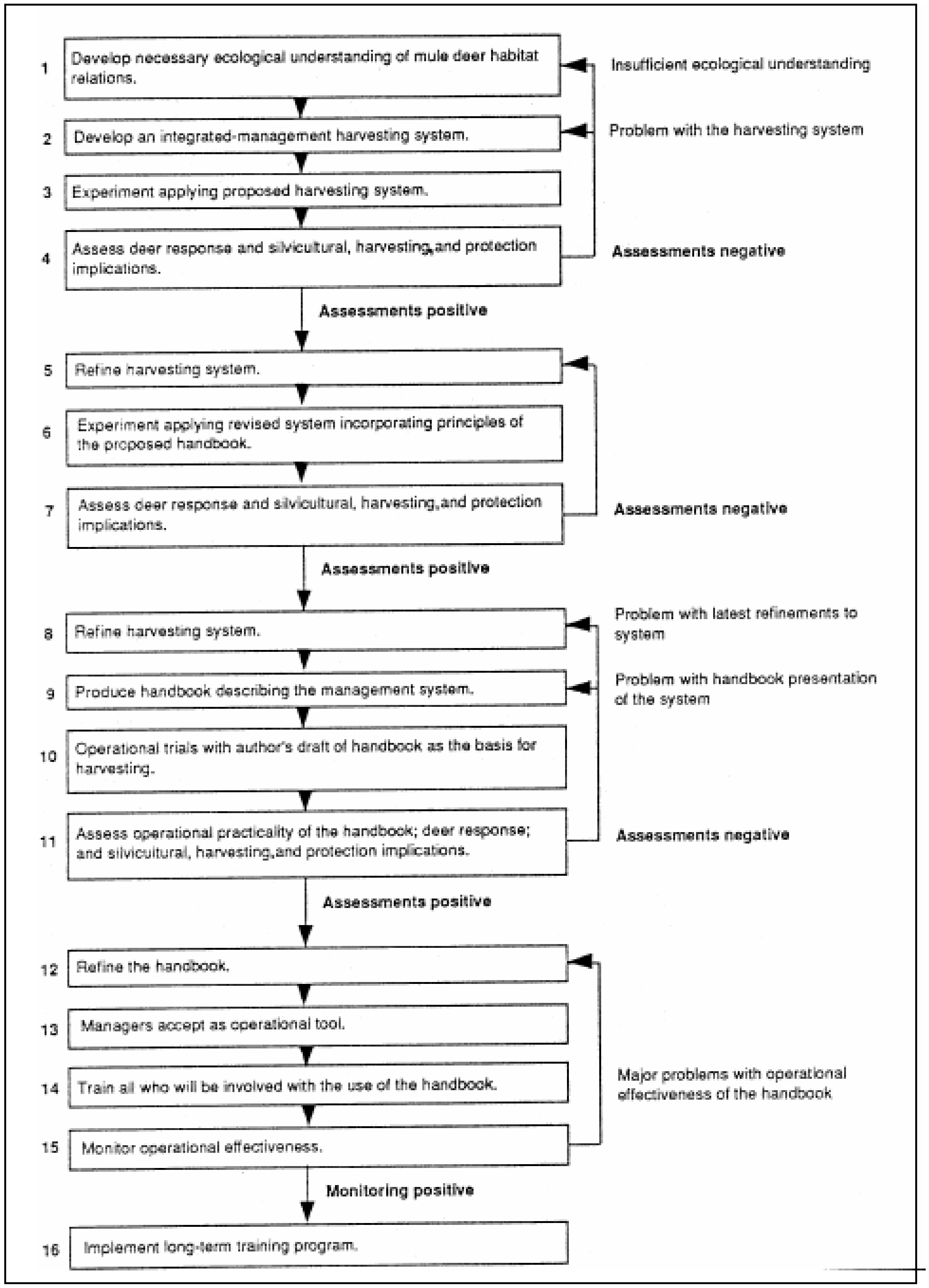


Figure 3— The steps for developing and implementing an integrated management tool: "The Handbook for Timber and Mule Deer Management Co-ordination on Winter Ranges in the Cariboo Forest Region" (Armleder and others 1986).

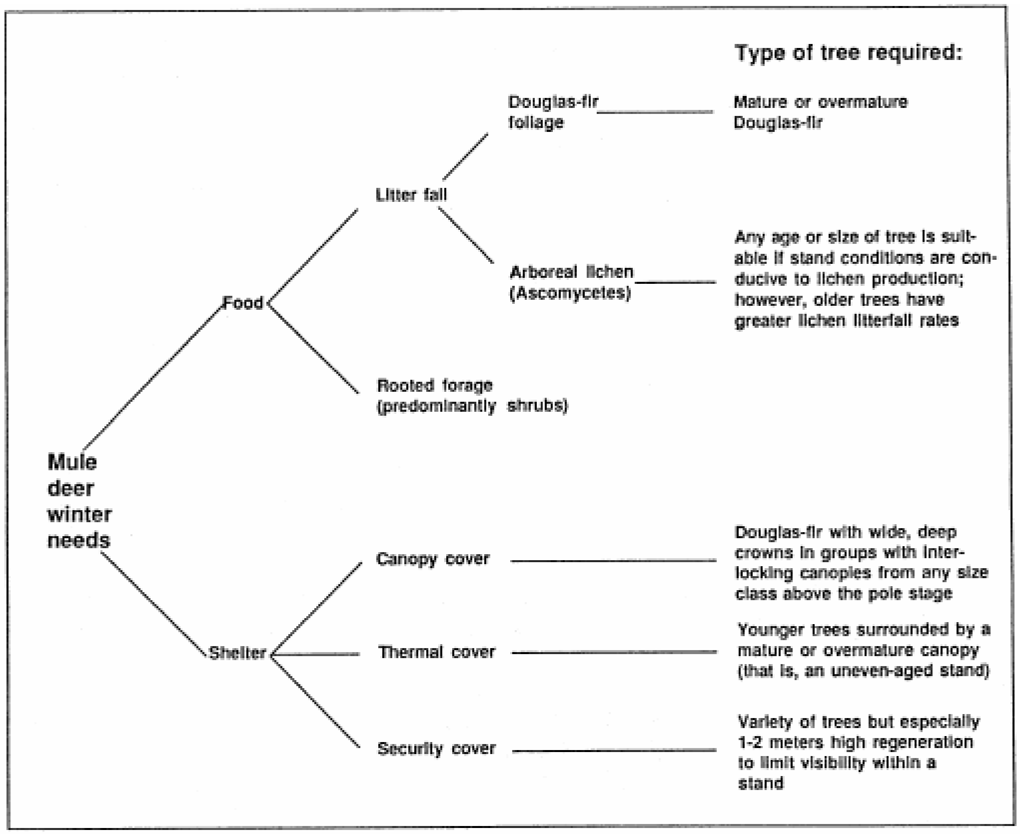


Figure 4— Type of trees required on winter range of mule deer in the Cariboo Forest Region of British Columbia (Armleder and Dawson 1987).

Given the requirements of mule deer and the problems associated with diameter-limit harvesting, researchers determined that a successful integrated management system for winter range must maintain trees that

- are able to intercept snowfall to reduce snow depths,
- are capable of supplying litterfall as a major food source over winter, and
- an provide thermal and security cover.

An uneven-aged management system was designed that would meet these requirements and reflect silvicultural considerations. This system creates and maintains a full range of age classes within a stand, producing multiple layers and sufficient stems in each class to replace those stems in the next oldest class as growth, mortality, and harvesting proceed. The ecology and the structure of most Douglas-fir stands on winter ranges in the Cariboo Forest Region are amenable to uneven-aged management. To meet the specific requirements of deer, uneven-aged management of winter range must have the following characteristics:

A. Harvesting should remove only low volumes with each pass to maintain substantial cover at all times.

B. As many mature and overmature Douglas-fir as possible should be maintained in microhabitats that are most important to deer.

C. Harvesting must be "clean" to discourage Douglas-fir beetles.

D. Steps should be taken (such as, juvenile spacing) to promote and to maintain an uneven-aged stand.

Experimentally Applying the System—This modified uneven-aged harvesting system was then tested on a mule deer winter range. The scale of the harvest was small (25 hectares), and it was carefully controlled by marking all trees to be cut. Site selection for the experiment was influenced by its suitability for future demonstration and training.

Assessment—The main objective of this first harvest was to assess the mule deer response to this type of habitat manipulation. This was done with track transects and by relocating radio-collared deer. Of secondary interest were the implications to forest management, specifically-silviculture, protection, and harvesting (including economics). These were assessed by foresters and, in the case of the logging, the contractor. The results were encouraging and are reported elsewhere (Armleder and Thomson 1984).

Refining the System—Although the assessments were basically positive, refinements to the system were necessary. Certain management realities could not be ignored if the proposed management system was to be accepted operationally:

A. Extremely low-volume harvesting may be uneconomical (the first harvest removed only 13 percent of the merchantable volume).

B. Marking trees for harvest would be costly and impractical (the first harvest was done as a mark-to-cut).

C. Single-tree selection meant inefficient harvesting and difficulties in preventing damage to residuals.

The revised management system recognized these constraints and included the following:

A. Low-volume selective harvesting was recommended (up to 20 percent of the merchantable volume can be removed in each pass).

B. The system was tailored to the snowpack zone in which a specific winter range is located.

C. The condition of the present stand (such as, age, volume, diameter distribution, and crown closure) must be recognized when recommending treatments.

D. Group selection of trees for harvest is recommended.

E. The harvesting criteria are microhabitat specific.

F. The system advocates trained fallers to select trees for harvest.

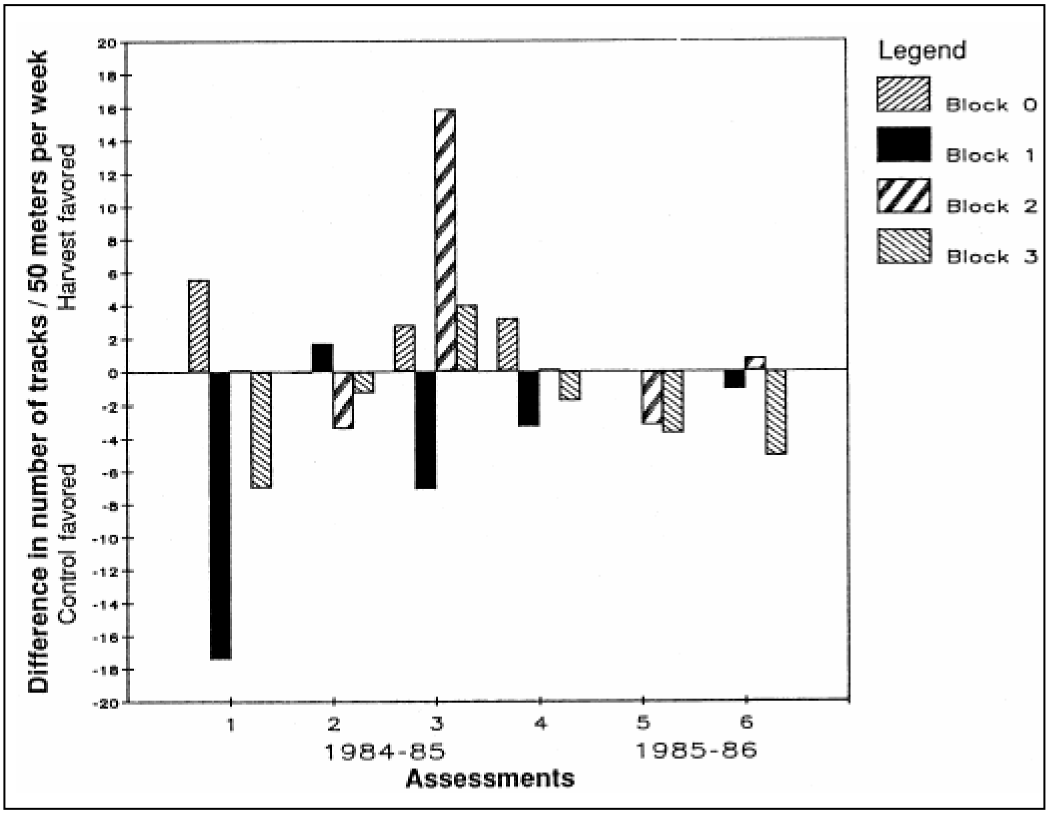


Figure 5—Mule deer response to low-volume selective harvesting measured by the difference in number of tracks/50 meters per week between a paired harvested and control block during 1 assessment. Assessments were taken several times over 2 winters on 4 paired harvested and control blocks.

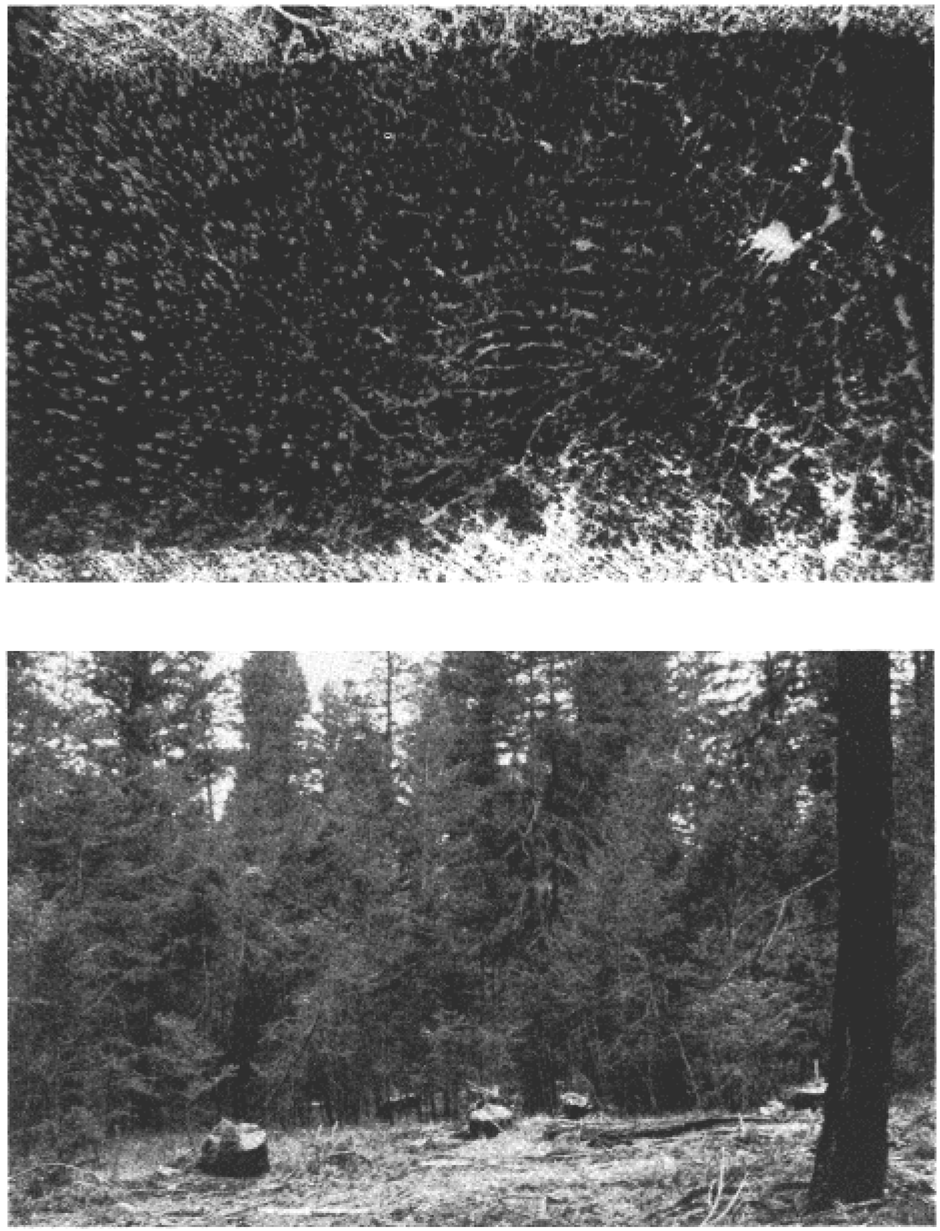
Further Experimental Testing—These steps mirror the previous three with some important differences:

A. The harvesting experiment was conducted on three times the previous area (three replicates totaling 75 hectares). The large area improved the ability to test deer response and to evaluate the harvesting on an operational scale.

B. More, attention was given to the forest management implications, although deer response was still examined closely.

C. More emphasis was placed on soliciting the reaction of potential users (foresters, wildlife biologists, and logging contractors) of the management system.

Draft Handbook—The assessments to this point were encouraging with respect to deer response and forest management implications. For example, no major changes in deer use occurred as a result of the low-volume selective harvesting (fig. 5). This contrasts with the sharp decline in deer use observed during periods of deep snow on areas of high-volume removal. The next requirement was to put the system into a package that would effectively communicate to managers and contractors. The field handbook format was chosen. After a couple of initial drafts, which were reviewed by representatives of the user groups, an author's draft was produced in the final size and format.



A

B

Figure 6—Area selectively logged according to the criteria in the handbook for management of mule deer winter range: A. Aerial view showing the harvested area on the right half and the control on the left half of the photograph. B. Ground view of area after logging showing minimal damage to regeneration and residuals.

Operational Trials—Application of the handbook during harvesting was tested next (fig. 6). Two new mule deer winter ranges were chosen, and new contractors did the logging (table 1). Neither these operational trials nor the previous experimental harvesting were subsidized. The, level of instruction to the contractors and managers was limited to the handbook and brief onsite training. These new trials, thus, tested the latest version of the harvesting system and the clarity of the handbook as a means of communicating the system to the contractors and managers.

Table 1—Experimental harvests In 1983 and 1984 and operational trials In 1985 on winter ranges In the Cariboo Forest Region In British Columbia designed to test the biological, technical, and managerial soundness of the Integrated approach to habitat management for mule deer

Year of harvest	Winter range study area	Area harvested	Replicates	Winters when mule deer response was assessed
		Hectares		*Number*
1983	Knife Creek	25	1	4
1984	Knife Creek	75	3	3
1985	Big Lake	65	4	3
1985	Tree Farm License 5	33	2	3

Assessments and Refinements—The operational productivity of the harvesting system was examined in more detail at this point. Contractors were asked to supply daily productivity reports on each piece of logging equipment. Analyses of these reports revealed that contractor familiarity with the system greatly influenced productivity. After the first few days, productivity increased significantly. Perhaps the best measure of the operational viability of the system was that all contractors were quite willing to continue harvesting in this manner.

Assessments revealed weaknesses in the handbook as a communication tool. Because the handbook applies to a multiple audience (including forest managers, wildlife managers, and logging contractors), modifications were made to clearly direct each audience to the most applicable points. Other minor changes to content and format were also made.

Biological assessments of the deer response to the harvesting system continue with these operational trials. As with the previous experiments, these tests will be conducted over several winters to examine mule deer reaction to a range of winter conditions (table 1). Only minor refinements were required to the harvesting system at this stage.

Managerial Acceptance—At this point, the forest and wildlife managers responsible for winter range for mule deer in the Cariboo Forest Region endorsed the integrated-management system, and the handbook describing it, as an operational guide to their staff. This was a relatively easy step because the key managers were involved in the process from the beginning. The tool was designed for their specific management problem and the final product was influenced, throughout its development, by their concerns.

Initial Training—The handbook was designed to "stand by itself," that is, completely communicate all pertinent aspects of the integrated-management system. However, this does not make training redundant. A training program provides an excellent platform to introduce and describe this new management tool to the users. Involvement by representatives of both forest and wildlife management agencies in the training process serves to emphasize the mutual support for the approach and sends the clear message that the handbook is to be used. Opportunity is provided to supply background information and supporting data to the recommendations presented in the handbook. The training program includes field tours of the experimental areas and the operational trials to show how the principles and concepts are applied on the ground.

Monitoring—Monitoring the operational effectiveness of the integrated-management tool is essential because it is the only method to ultimately determine if the tool contributes to the successful resolution of the management problem. As experience, understanding, and management climate change, the way opens for adaptive management to refine to the system in the future. Cooperation is needed between managers and researchers for this to work. Feedback from managers will be encouraged, and researchers will be prepared to examine their specific concerns.

Long-term Training—A long-term training program will ensure that new managers and contractors are introduced to the system. Training should continue at least until the system becomes the established and the widely accepted method of managing winter range for deer and timber. Additionally, long-term training allows the products of adaptive management to be introduced to the users.

Questions Arising From The Case Study—This handbook and the research that led to its development were designed from the start to help solve a resource management problem. To this end, the primary users, forest and wildlife managers, were involved from the start so that the handbook would have their support at the implementation stage. We are at this stage now. Will the management system and the handbook become the standard way of dealing with mule deer-timber management on winter ranges in the Cariboo Forest Region? If it does, we will have succeeded in integrating the management of two vital resources. If it does not, we will investigate whether the system, the tool, or the technology transfer failed, and we will adapt the experience to other resource conflicts.

Example 2. Implementation and Refinement of Handbooks for Coordination of Timber, Grazing, and Mule Deer Habitat In Managed Forests and Rangelands of the Pacific Northwestern United States.

Two recent handbooks for integrated management, "Wildlife Habitats in Managed Forests" (Thomas 1979) and "Wildlife Habitats in Managed Rangelands" (for introduction, see Maser and Thomas 1983) have received considerable attention by researchers and managers in the Northwestern United States. These handbooks can be used to predict the consequences of contemplated management alternatives on wildlife. Since their introduction, these tools have become practical and available to managers. This case example will focus on the implementation, refinement, and testing of these tools.

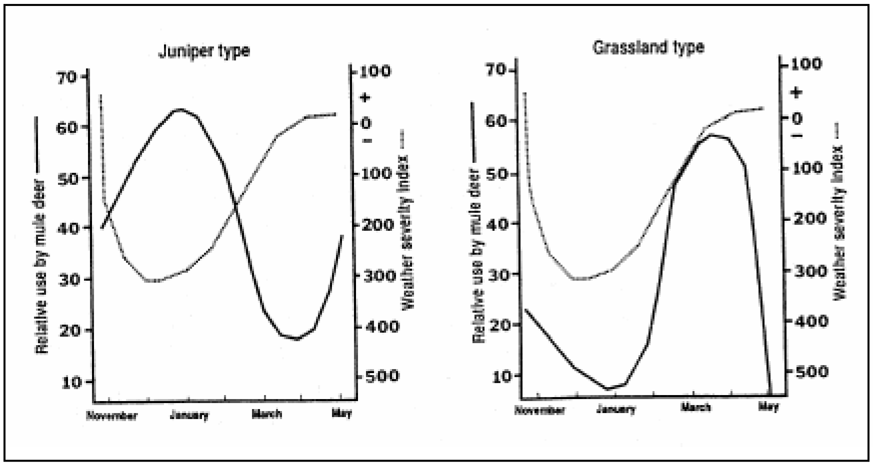


Figure 7—Deer use of cover area (for example, juniper communities) was greatest when weather severity indices were most negative (greatest stress), and use of forage areas (for example, grasslands) was greatest when weather severity indices were most positive (least stress).

Model of Mule Deer Habitat Relations—A complex physiological-nutritional-vegetational model is the foundation for the recommendations on cover and forage needs for deer in both "Wildlife Habitats in Management Forests" and "Wildlife Habitats in Managed Rangelands." Specifically, this model permits calculation of habitat effectiveness, thermal cover effectiveness, and forage quality-quantity effectiveness—all reflecting relations of deer and elk to the structure and composition of their habitats.

The model predicts energy exchanges of ruminants with cover and forage elements of their habitats and was developed from published animal physiological and vegetation structural relations (Brody 1945, Geiger 1966, Hobbs and others 1982, Holter and others 1975, Leckenby 1977, Moen 1973, Reifsnyder and Lull 1965). Predictions of this model include, for example: (1) reduction of the canopy closure of a stand from 70 to 20 percent will reduce available long-wave radiation (used to reduce thermoregulatory stress) by 70 percent, (2) loss of reradiation from the trees (as occurs after clearcut logging) is estimated to cause about a 1.3-fold increase in energy requirements on an average winter day, (3) a reduction in forest cover from 70 to 20 percent would increase the exposure of deer to incoming short-wave radiation from 13 to 40 percent of that available in the open, and (4) thermoregulatory stresses from the greater exposure to solar radiation reduces production (for example, reduces lactation and fattening rates).

This model was validated by observed thresholds of habitat use by mule deer (fig. 7) and elk with changing weather severity and forage availability and by comparing environmental temperatures with animal distribution and behavior (Leckenby 1977, 1978; Leckenby and others 1982; Leckenby and Adams 1986; Parker and Robbins 1984; Parker and others 1984).

Implementation—After cover and forage structure and size criteria were shown to be biologically supported, procedures were needed to map and tally wildlife habitat components (thermal cover, hiding cover, and forage areas) defined in guidelines adopted by the Forest Service and the Oregon Department of Fish and Wildlife (Leckenby and Schrumpf 1977, Leckenby and others 1985) (figs. 8, 9, 10). Satellite digital data and computer processing procedures were developed for inventorying, mapping, and monitoring thermal cover, forage areas, and plant communities.

These remote sensing and computer processing procedures were applied in Oregon to inventory cover and forage stands in areas from 200 hectares to 1.2 million hectares (all with a minimal spatial resolution of 0.4 hectares). The procedures have also been used to assess change (monitor availability and distribution of cover and forage) over periods of 1, 5, and 6 years. The spatial resolution mentioned is not the minimum possible; it was the limit in our applications because we chose to use the 0.4 hectares resolution of the readily obtainable multispectral scanner classifications.

Individual sessions and workshops were developed to train managers to use the tools (fig. 11). Agencies began developing computer systems and a cadre of computer-oriented biologists who could undertake the habitat evaluations. Relative costs of training personnel were low because participating biologists became expert, after 2 days of intensive training. Relative costs of hardware were low because the computer systems were already being purchased for other applications. Pertinent software was available at no cost.

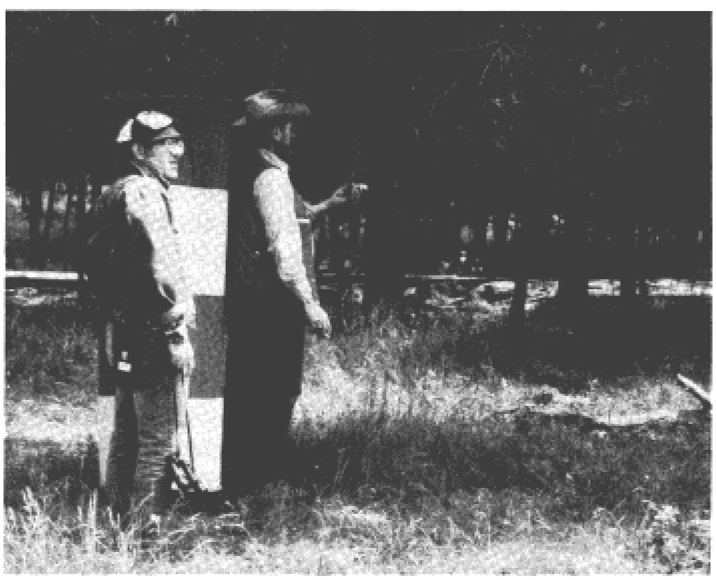


Figure 8—Stand height, crown closure, and the distance at which 90 percent of the hanging target is hidden by vegetation is being measured in field plots. These measurements helped satellite-image interpreters identify thermal cover, hiding cover, and forage areas on the Landscape images.

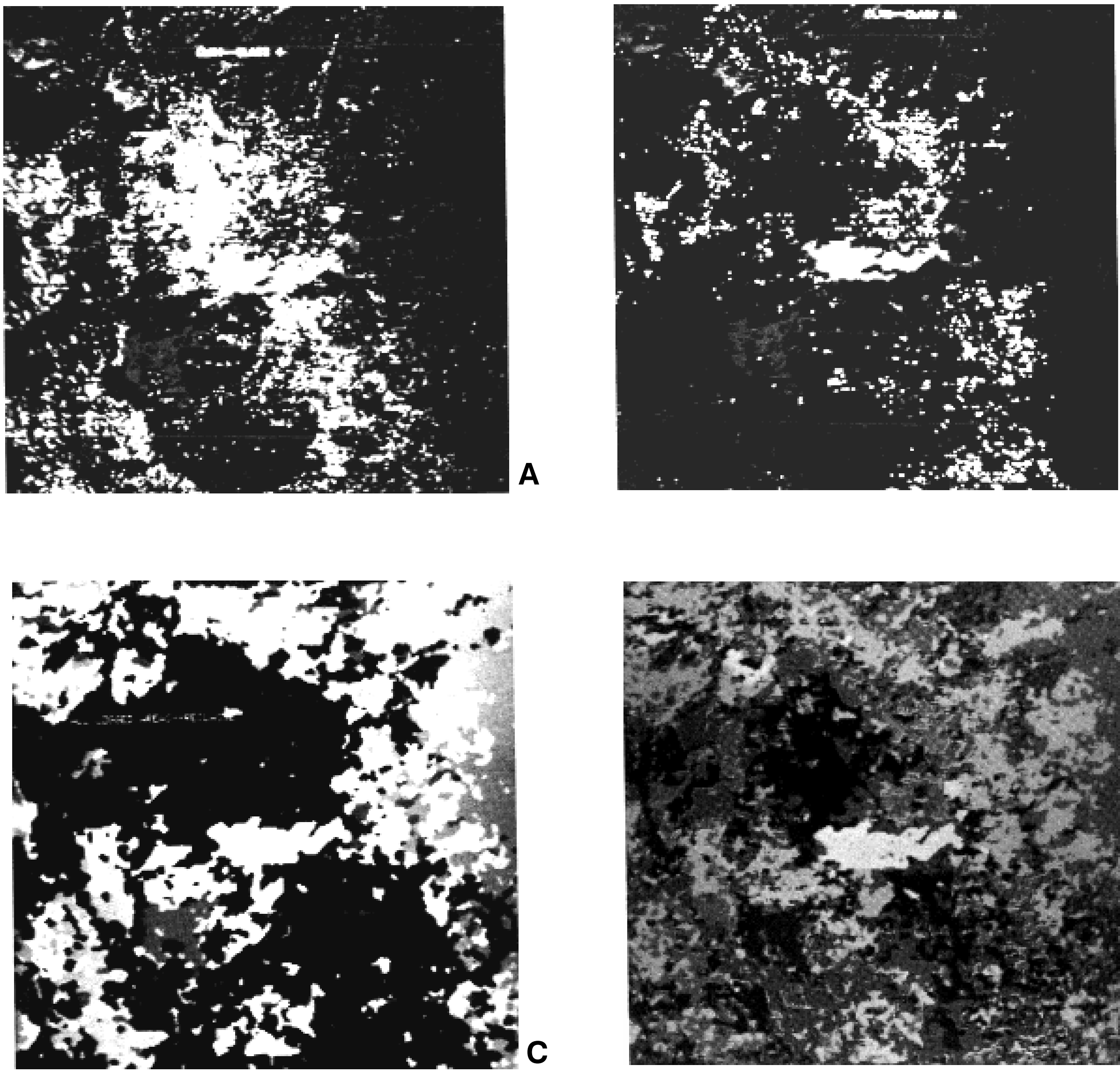


FIgure 9—Landsat images of mule deer range. All images are of the same 29- by 29-kilometer unit of land: A and B. Lightest areas are contrasted mule deer habitats. C. Darkest areas are unlogged, lightest is snow, and other shades are various logged plant communities. D. Final product showing all plant communities, logged and unlogged condition classes, and deer habitats.

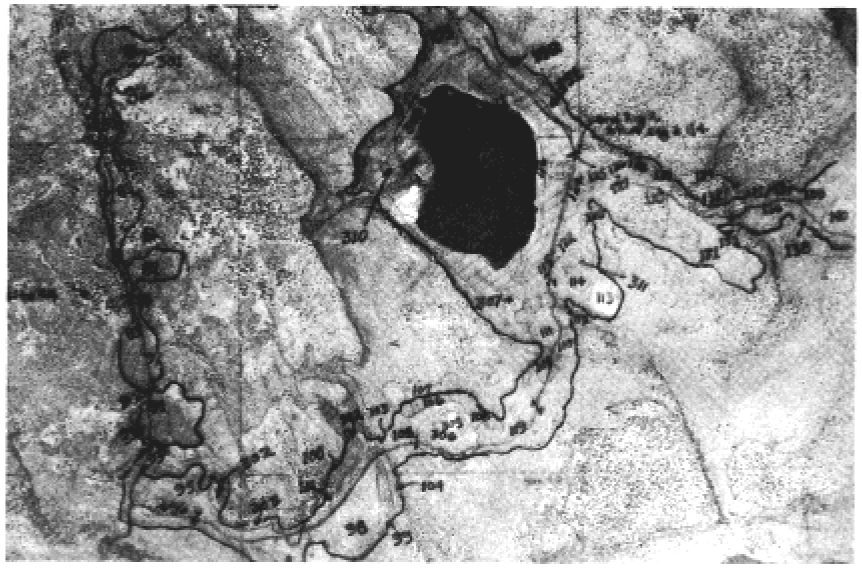


FIgure 1 —Plant community boundaries have been drawn on aerial photographs (2.7- by 4.0-kilometer view shown) around sample habitat stands where field plots were measured. Trainees were shown how ground information was correlated with satellite digital data to produce deer and elk habitat maps for herd ranges in these areas.

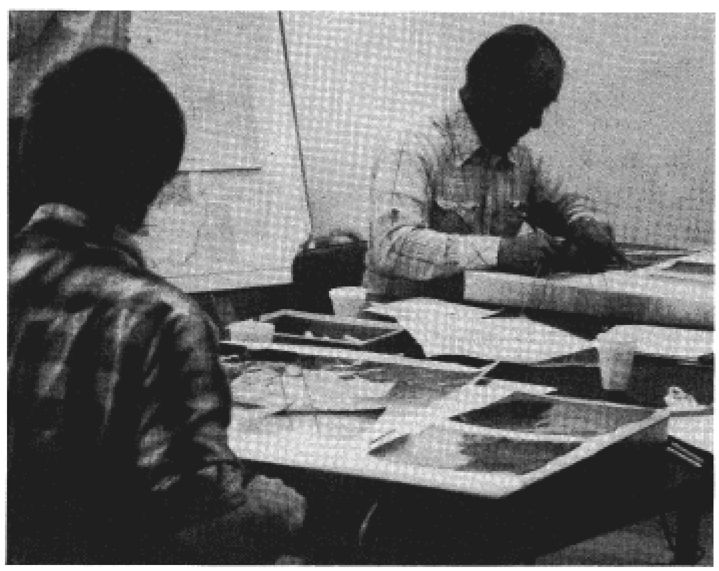


Figure 11—Trainees interpreting double-sample points on aerial photographs; a step in learning to use Landsat-derived deer habitat maps.

The level of sophistication needed to manage wildlife habitat currently (and probably in the future) was easily attained by the computer system. For example, managers normally only map units larger than 4 hectares (timber inventory down to 16 hectares), but the satellite-computer system resolves a minimum of 0.4 hectares and has been used by managers to accurately map at a resolution of 0.9 hectares. Quantitative errors encountered with this system were much less than with older methods of inventory and mapping. Likely risks of error (at various minimal sample sizes) for estimating accuracy were tabulated for managers. With the systems, the manager can check and refine the mapping accuracy (restricted to the maximum correlation of the Landsat Multispectral Scanner data with the habitat elements of interest). To date, over 7.3 million hectares have been mapped.

The cost of using the remote sensing and computer processing system for inventory and monitoring of cover and forage habitat components is less than the use of traditional methods of habitat assessment. For example, 500,000 hectares of deer and elk winter and summer ranges in Oregon were mapped and tabulated with a mainframe computer for about $0.05 per hectare with an overall accuracy of about 90 percent. Programs are now available for running the remote sensing and processing procedures on microcomputers. The amount of and quality of multiple resource work that can be done with the 71- by 71-kilometer parallelogram covered by each data set from Landsat shows the costs of data acquisition and analysis are insignificant when compared with the usual methods of habitat mapping and inventory.

Refinement and Testing—To confirm interpretations made from Landsat, managers were provided with ground-based methods and tools to readily obtain quantitative data on wildlife habitat structure, distribution, and area. Disagreements as to whether specific stands comprised or did not comprise some habitat component usually arose when no data existed. Researchers provided alternate (quick and less accurate) methods by which structural conditions could be estimated from related data (Dealy 1985) (for example, equations predicting crown closure from basal area) for cautionary use when relevant data could not be collected in time for a decision. Researchers also developed techniques and tools for collecting relevant data objectively (for example, collapsible sight-tube for determining sight distance of cover stands). Relative cost of using such techniques and tools was minor if managers were already required to take samples in stands. Each technique and tool was more consistently applied by individuals than the subjective methods being replaced. The management sophistication required was easily attained.

The above tools are being compared with existing methods and criteria for agreement, ease of application, cost to implement, and interpretability. Wildlife biologists are evaluating them on selected areas of Ranger Districts on several National Forests within the Northwestern United States. They are also being tested as part of geographical information systems in several Forest Service regions.

Questions Arising From the Case Study—The main question arising from this case study is whether the majority of managers concerned will adopt the methods, will apply them per se, or will supply their own adaptions, thereby adding to the confusion of foresters and increasing the number of loopholes. Eventually, the necessary expertise with computers, the required machines and software, and the essential data all will exist. Application of these tools for quantifying habitat will depend on the development of specific goals and the desire of resource managers to model future conditions of habitats and populations.

Summary

Deer and timber managers in the interior of Western North America are faced with the major challenge of reconciling the goals of timber production with the maintenance of deer habitat. In the past, the perspectives of managers have tended to emphasize one goal or the other. To successfully meet the challenge, however, forest managers must accept wildlife habitat as a valid and socially justified end to be achieved by the intelligent management of forests and not as a "constraint" on the production of wood-fiber products. Conversely, wildlife managers must recognize the legitimate need by the wood processing industry for a timber supply.

Many forest and wildlife managers in the United States and Canada have made the important and progressive step of conceptualizing an integrated approach for solving the demands for timber and deer resources. Although an integrated approach may not optimize either resource, such an approach offers the possibility of simultaneously producing sustainable yields of both from the land. To make the integrated approach work, researchers must study how the forest ecosystem, including deer and trees, responds to integrated management, and managers must be willing to accept the risks of experimental management (Bunnell 1985) to learn what happens when we play out our best hunches.

How will mule deer respond to integrated timber harvest plans? We have just begun to evaluate their responses. Large-scale, long-term experimental studies should be established. Wildlife researchers must work with managers to carefully decide how such studies proceed and what level of resolution must be reached to adequately assess whether responses of mule deer to forest management are favorable, unfavorable, or neutral.

The two examples of timber-habitat management tools that are described in this paper use somewhat different approaches and are at different stages of development. The timber and mule deer management handbook uses intensive field research and operational harvesting trials to develop site-specific guidelines. The implementation to operations is just beginning. The Wildlife Habitats in Managed Forests and Rangelands Program is now being adopted and evaluated by applications of physiological modeling and satellite imagery to define and map functional habitat units.

The common goal of both tools is to link biological conditions and principles with managerial operations and administration. The measure of success in achieving this goal hinges upon both the applicability of the tools in solving problems and the willingness of resource managers to use the tools.

English Equivalents

1 hectare = 2.47 acres

1 kilometer = 0.62 miles

1 centimeter = 0.3937 inch

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Timber and deer managers have struggled through years of increasing demands and growing conflicts in the interior of Western North America. Integrated management, supported by a sound research data base and effectively communicated to all users, is presented as the only viable approach to an increasingly complex resource future. Two examples of tools recently designed for managers in dealing with timber-deer habitat are discussed.

Keywords: Integrated management, timber management, wildlife habitat management, deer, mule deer.

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