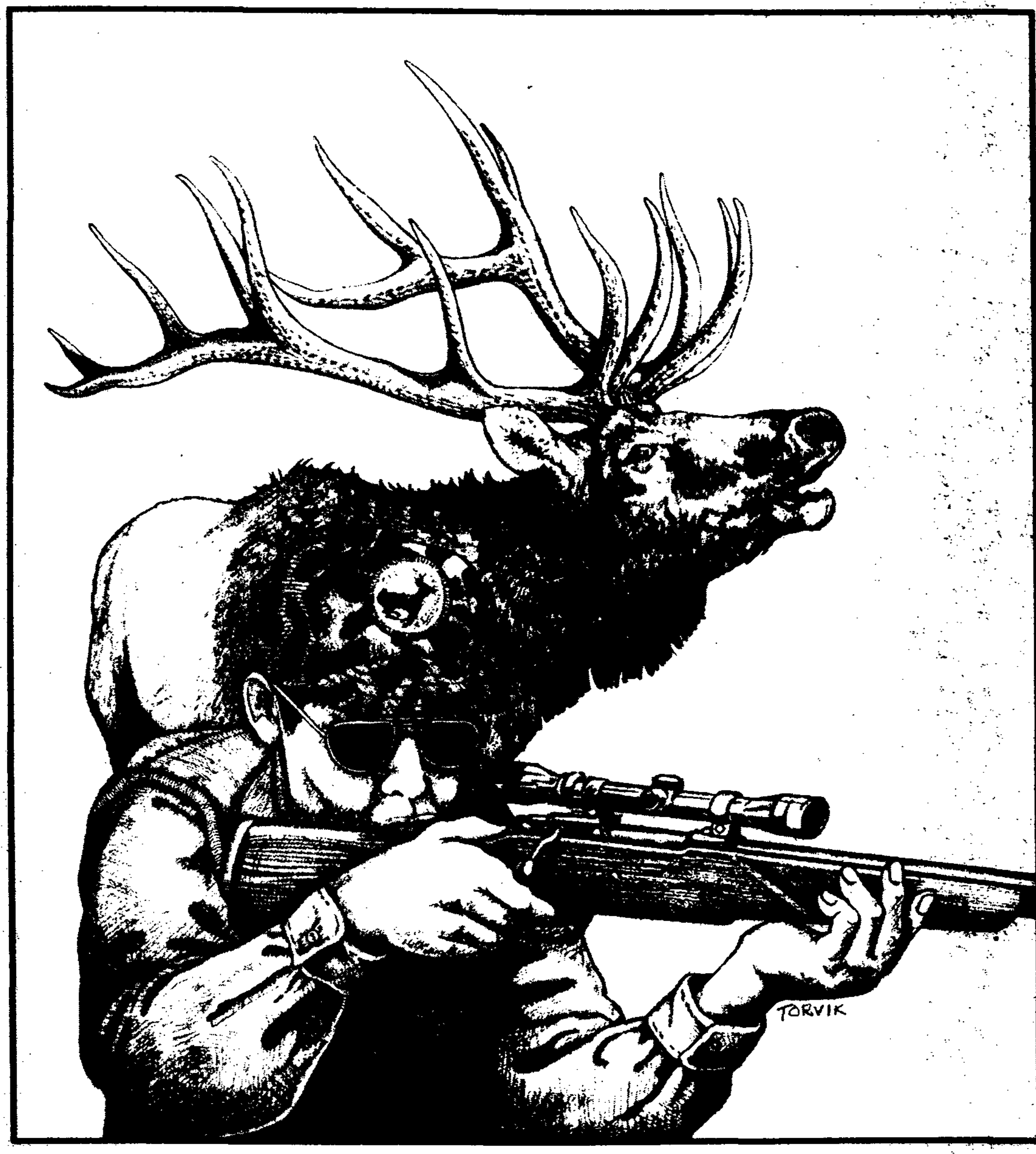
ESTERN STATES AND PROVINCES

E LK WORKSHOP

ROCEEDINGS MARCH 1986

OOS BAY, OREGON, USA



OREGON DEPARTMENT OF FISH & WILDLIFE

PROCEEDINGS
OF THE
1986 WESTERN STATES AND PROVINCES
ELK WORKSHOP

March 17-19, 1986

Coos Bay, Oregon

Program Chairman/Editor: Dan L. Eastman
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Portland, Oregon

Workshop Sanctioned By: Western Association of Fish and Wildlife Agencies

Host: Oregon Department of Fish and Wildlife

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PREFACE

Some wondered why Coos Bay? That was pretty understandable because the 1967 Elk Workshop was in Coos Bay. Portland is handier for some that come by air or when driving from the north.

The workshop was in Coos Bay for several reasons. Coos Bay was a good candidate when Oregon was volunteered in 1984. Winter weather on the coast is usually moderate. An airport is available and that's important to some people. There's diverse and rapidly changing elk country close at hand. The most important reason for Coos Bay was unknown in 1984 when we went to Edmonton. I'd like you to know something about that.

James A. Harper, Jim or Harp, conducted original field research on Roosevelt elk a short distance east of Coos Bay in 1963 to 1968.

Jim spent four years in the Navy before earning his Bachelor's degree from Oregon State University in 1951, and then he went on for his Masters at Humboldt State University. There was a brief stint as a research project leader for the Illinois Natural History Survey, following which Jim returned to Oregon to work on a Ph.D. with pioneering research on Roosevelt elk. A number of publications resulted from his investigations. One of them, Ecology of Roosevelt Elk, was created by Jim for popular reading as well as a technical reference. It was published under a Pittman-Robertson contract in 1971. It was out of print and stocks were depleted.

Jim left Oregon briefly in 1969 for Alaska to serve as Chief of the Wildlife Research Division during a period of political turmoil that resulted in his temporary appointment as Director. With politics as they were at that time in Alaska, Jim returned to Oregon as a Wildlife Planner in 1970, followed by Assistant Wildlife Division Chief, then Division Chief, Oregon Department of Fish and Wildlife, in January of 1984.

Jim was taken from us on October 7, 1984. He was 52. All of us that knew and worked for him and with him felt a great loss. From his accumulation of writings, notes and tables aimed at a new Roosevelt elk publication, 17 of his coworkers set about the task of updating his 1971 publication in time for the 1986 elk workshop. That was no small undertaking. With a grant of $500 from the Rocky Mountain Elk Foundation, I'm pleased we could offer each workshop registrant a complimentary copy of Ecology and Management of Roosevelt Elk in Oregon.

The 1986 Western States and Provinces Elk Workshop was dedicated to the memory of Jim Harper.

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INTRODUCTION

Detailed planning for the 1986 Western States and Provinces Elk Workshop commenced a year in advance. Member states/provinces were asked to concur with a proposal to meet immediately preceding the Northwest Section conference, THE WILDLIFE SOCIETY. The intent was to conserve trips for many in the N.W. Section. The Section meeting offered opportunities for overflow "Elk" papers. The week beginning Sunday evening, March 16, and ending noon on Friday, March 21, was set as the target.

A key representative for each state/province was selected to act as liaison in forwarding announcements to appropriate potential participants, arm-twisting some papers and compiling status reports. These representatives were regularly contacted. An advance announcement with program format, travel instructions, room costs, reservation instructions, dates and call for papers went out September 20, 1985, to representatives and a wide array of federal agencies and academia. The workshop was listed in TWS newletters schedule of activities beginning in September. In spite of this effort, some expressed ignorance of the meeting dates.

The program was complete by December of 1985, and it was mailed out to representatives and various agencies. A program in hand is often vital to some in getting trip approval. It's incumbent upon a program chairman to take his job seriously and complete planning tasks well in advance. At the same time, agency trip approvals limited to program participants seem unjust when program space obviously is limited and listening is one aspect of the information - sharing objective.

On Sunday evening preceding the start of the workshop, the social kegger sponsored by AVM Instrument Company drew a good crowd. By mid-day on Monday, there was a record 211 registrations and attendance was near 250.

The first mornings program started with an opening and introduction to the workings of elk workshops. State/provincial representatives were upfront so they could be identified, and the gallery was behind. Dr. John R. Donaldson, Director of the Oregon Department of Fish and Wildlife and President of the "WESTERN" gave a welcoming address. A featured presentation following that gave insight into the workings of the Rocky Mountain Elk Foundation.

A very impressive poster session was in place throughout the proceedings, and Steve Logsden was there with his art and handcrafted items.

Mid-way in the technical sessions, a field trip was scheduled to give an overview of habitat effectiveness rating considerations. That subject occupied all Monday afternoon to convey state-of-the-art information to all workers. It was an impressive undertaking to bus over 200 persons and box lunches around local elk country. The sun was bright and it worked beautifully, thanks to some last minute arranging by south coast biologist, Bill Hines.

There were 168 persons at the buffet banquet. Dr. Jack Ward Thomas gave us words of wisdom. We had prizes. It's not customary to have prizes, but this program chairman is known for often being non-traditional. There were art items and memberships donated by Steve Logsden and the "FOUNDATION." Most went as simple door prizes to those with a banquet ticket. Highlight of the evening for this program chairman was awarding a rather earthy prize to the Oregon State Police photographer who entered a sturgeon, but the one and only photo, in the photo display. After he was sufficiently worked over, his real award was a regular one-year membership in the Rocky Mountain Elk Foundation.

Films and videos relating to elk were on tap one evening. At the same time, several of us gathered in one of the conference rooms for a roundhouse discussion on biological importance of bulls and management strategy to assure hunting escapement goals are met. This was real workshopping.

A business meeting involving state/provincial representatives was conducted following the banquet. Information was given on registrations, fees collected, costs, etc. It was announced a speedy publication of a Proceedings was planned. Receipts and a $500 grant from the Rocky Mountain Elk Foundation would cover costs.

The business of sanctioning again with the Western was discussed but no instructions had been received following an inquiry as to what was needed.

It was suggested the next workshop focus a bit more on "workshopping" and a bit less on formal papers. That will be a job for the State of Washington and Rolf Johnson, hosts for the 1988 elk workshop.

I was pleased with the conference facility, the record-breaking turnout, great cooperation of session chairpersons and presenters, and the fantastic weather for our field trip. As I told the group early on, stress comes to a conference planner when attendance falls below the estimate. When we topped 150 and headed for over 200 registrants, that was a welcome challenge. And, I had great help. Thanks for coming.

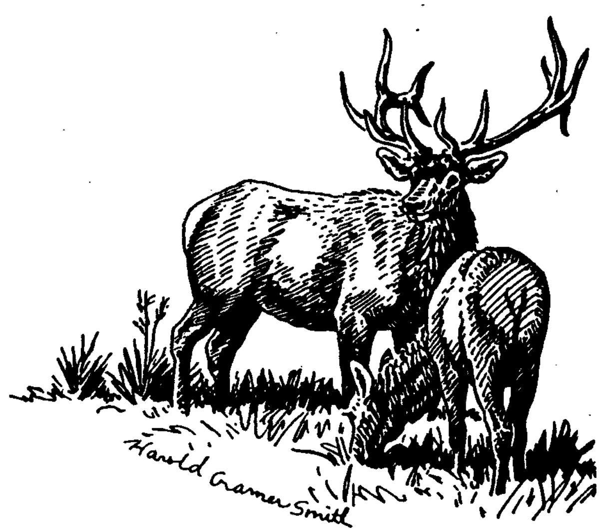
Dan L. Eastman
Program Chairman

STATE AND PROVINCIAL REPORTS

Each state/province was asked to submit a written status report generalizing highlights of the elk situation and a completed questionnaire. The questionnaire was a follow-up complementing an extensive survey of the continental elk situation reported in 1984 by Bob Hernbrode of Colorado.

At the 1986 elk workshop, Bob Hernbrode's instructions to state/provincial representatives was, "in no more than ten minutes, give us the highlights of the situation without covering the written report details." Representatives probably did not expect to see their oral report in this Proceedings.

For each state/province that offered status information in any form, the elements follow in this section beginning with the oral report (substantially edited), written report and questionnaire in the order of workshop presentation.



BRITISH COLUMBIA

ORAL REPORT - Doug Janz

Essentially, we have three major pockets of range within the province. We have about 3,000 Roosevelt elk on Vancouver Island, about 18,000 Rocky Mountain elk in the east Kootenays and another 7,000 in the northeast portion of the province or eastern slope of the Rocky Mountains.

Generally the herds are increasing, stable to increasing especially in the east Kootenays. That's indicated in the trends in the provincial harvest which has gone from approximately 2,000 elk in 1981 to almost 4,500 in 1984. Concomitant with that, we have a hunter success that's been increasing, approximately 17 percent in 1981 to 31 percent in 1984, the most recent estimate. Hunter days per elk, corresponding with that, have declined from an estimate of 52 days per elk harvested back in 1981 to 28 days per elk harvested. And with that decline in hunter days per elk, we have more participation in total hunter days from an estimate of 105,000 hunter days in 1981 through to about 124-125,000 recreation days in 1984.

Briefly, going back to the three major pockets or units of elk within the province, Kim Brunt and I will be giving papers at this conference so I'm not going to go into any detail. I'd like to mention though that most of the information over the last five years has led to a cooperative research program jointly funded between the Ministry of Environment and Ministry of Forests.

This will look at the interactions of potential silvicultural practices and intensive forestry on wildlife habitat, specifically deer and elk habitat. Similar to forest management trends throughout the Pacific Northwest, the future for Vancouver Island is the second growth forest and intensive forest management. We have to do our job to try to produce wildlife habitats in those intensively managed forests. So a lot of information like that Kim Brunt will be presenting this afternoon on our preliminary habitat model is based on some research with this program over the last five years. It's called the Integrated Wildlife Intensive Forestry Research Program. We call it "IWIFR", and a lot of other things too.

In the northeastern portion of the province, the average harvest over the last four or five years has been 225-250 animals. It's a relatively inaccessible area; 40-45 percent of that harvest is by the guide-outfitters for the nonresidents. It's a real important piece of territory for the guide-outfitters along with a lot of other species. Elk are a very important species for the guide-outfitters. Regulations are primarily three-point and larger bulls. The management prescriptions there over the last few years have been related primarily to response to forest fire suppression.

They're doing a lot of prescribed burning, getting into more transplant activities over the last couple of years, and also, you may have heard some mention of some wolf predation and wolf control going on up in the northeast section of the province a couple of years ago. That's been stopped, at least for the current year, by our Minister and we're not sure what the future holds. Johnny Elliott and a few other biologists up there are concerned about the effects of predation, not only on elk but more so on moose and sheep.

In the east Kootenays, I think a lot of you people know Ray Demarcy, the godfather of the east Kootenay mafia. He gave me all kinds of quotes to offer you today. In his own modest way he says "tell those guys that Ray has done it again in the Kootenays, done this and done that." So I'll give you a bit of an idea of what he has to offer. There's no argument about the results. Most of the increase in trends and provincial harvest is related to the harvest coming out of the east Kootenays. That's where most of our elk occur, and that's where most of recreational harvest takes place. First of all for animal management in the Kootenays, Ray is emphasizing a selective harvest strategy. Over the last few years he's been working first of all on bulls. Bull harvest is primarily an open season, but it's three-point plus to allow escapement. He's been increasing his cow and calf harvest in response to increasing elk numbers, but also to up his bull ratios post-season. As an example, in 1984, with an estimated harvest of over 4,000 animals in the east Kootenays, about 1,500 were bulls of which 50 percent were six-point plus. About 50 percent of the other harvest was made up of juveniles (calves) and there's been a lot of educational priorities there in terms of convincing the hunters that they should take some calf elk. The remaining 23 percent of the harvest has been made up of cows. The antlerless component of harvest is all under limited entry (permit system). So we're dealing with a lot of permits in some of these areas. In 1984, he had 2,200 antlerless permits (cow or calf). For calf-only, he had almost 7,000 permits, and there's about 20 percent success rate on the calves; 40-50 percent on the antlerless permits. What Ray's real proud about is his post-season composition. He says, "tell those guys I'm getting 35 bulls per 100 females post-season, and that's what it's all about." He's trying to get more of a balanced sex and age ratio in the post-season population.

One of the efforts in the Kootenays resulting in increasing populations, Ray feels, is related to 1974-78 when they were doing some winter feeding. There's been a lot of coordinated planning going on between the ranchers, foresters and the wildlife agency. He does have, with the increasing elk herds, some problems in the Rocky Mountain trench with so-called homesteader elk conflicting with the ranchers. Those are being dealt with through our regional problem wildlife committees.

Speaking for our northern biologist in terms of what's happening on Vancouver Island, there's lots of good things happening with management. Over the last ten years, we've had pretty nice green, mild winters. That's pretty hard to beat. That really helps the populations.

One final thing; we're getting away from game checks, not only because of restraint but also we've introduced sort of a provincial tooth-return program offering a bit of incentive to the hunters. They get a little badge back saying "we've participated in wildlife management." Most of our age structure information from the harvest is based now on a tooth-return program. We're getting away from actual game checks out in the field.

One final shot; in B.C. we have something called Habitat Conservation Fund. It's funded by a three dollar impost on all fishing, hunting, trapping and guide-outfitter licenses. That money is specifically earmarked for fisheries and wildlife habitat enhancement projects. Both sections are spending close to a million dollars a year throughout the province. Given the way our regular operational budgets have been going, thank God we've got that sportsman-sponsored fund or we wouldn't be doing much at all.

WRITTEN REPORT - B. C.

British Columbia has an estimated 28,000 elk. Most of these elk are found in three different areas of the Province.

ROOSEVELT ELK

There are about 3,000 Roosevelt elk on Vancouver Island. The population there is stable to increasing and is hunted under a limited entry draw system.

There is a small number of elk, presumed to be Roosevelt elk, in the coastal portions of southern B.C. north of Vancouver.

There were an estimated 120 Roosevelt elk taken by 190 hunters in 1985.

ROCKY MOUNTAIN ELK

The majority of the Rocky Mountain elk are located along the west slope of the Rockies south of Jasper National Park. Smaller populations are found in the watersheds of the Peace River and Muskwa Liard River. There are scattered small bands of elk in various locations in the southern interior and about 100 Roosevelt elk on Graham Island in the Queen Charlotte group.

There were an estimated 3,555 Rocky Mountain elk taken by 14,800 hunters in 1985.

In the Kootenay area of the Rockies, a selective harvest program is in effect with a three-point plus open bull season and limited entry permit hunting for antlerless elk. We have permits which allow the taking of either a cow or a calf, and other permits which are good only for a calf.

The mean age of the bulls taken is 4.2 years. About 77 percent of the harvest is composed of bulls and calves with cows making up the remaining 23 percent.

Resident elk in some of the low elevation agricultural areas are causing complaints by ranchers.

We have been conducting habitat improvement by controlled burning and improved grazing programs.

We have controlled wolf populations in areas of northeastern British Columbia where wolf predation was keeping elk populations from increasing in spite of mild winters and improved habitat.

We have conducted several transplants to establish elk in areas of their former range where present conditions appear to be favorable and there is little potential conflict with existing agricultural use.

Doug Janz

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: Doug Janz — B. C. (State or Province)

No. of Wintering Elk (note species): 3,000 Roosevelt — Rky. Mtn. 25,200 — Comment:

Bulls/100 Cows (winter) 32 — Range 16 to 40 — Comment:

Calves/100 Cows (winter) 42 — Range 20 to 60 — Comment:

Resident Tags, Rifle* 17,305 — Bow N/A — Total 17,305

Non-Resident Tags, Rifle* 850 — Bow N/A — Total 850
(*incl. muzzleloader)

Grand Total 18,155

Comment: No special license for primitive weapons, bow and muzzleloader, etc.

Take of Bulls, Rifle 2,203 — Bow * — Total 2,203

Take of Antlerless, Rifle 3,362 — Bow * — Total 3,362

Grand Total 5,565

Comment: Antlerless includes 2,074 calves.

Bull Hunter Success 12 — Total Hunter Success 31

How is Harvest Data Obtained: Resident by Hunter Survey, Non-resident by Guide Declaration

What Census Methods Used (Sample Size) Both ground counts and aerial.

Percent of Hunting by Drawing: 45% of hunters and 55% of elk taken.

Contact Person for Mgt./Research Information: W. Macgregor - Management; D. Eastman Research

Other Comments:

Ongoing Research Subjects and Investigations:

Elk - Intensive Forestry Interactions.

Recent Elk Publications:

Intensive Forestry Effects on Vancouver Island Deer and Elk Habitats. Problem Analysis 1985 Vancouver Island Roosevelt Elk/Intensive Forestry Interactions - progress report.

ALBERTA

ORAL REPORT - John Gunson

Recently I was told to write an elk management plan for Alberta. We're going to have our first comprehensive management plan for elk that goes into all the various aspects of elk ecology, problems and so on. I did prepare the status report which has all of the usual numbers and harvest statistics and I'm still planning on talking to some of those.

In preparing this management plan, which is about two months from completion now, I think we should have a fairly comprehensive document. It will be the first provincial management document for elk in Alberta.

In reviewing many aerial surveys biologists have done in the province over almost 30 years, there are hundreds of survey reports from people going up in a helicopter and either counting elk, or counting moose and seeing some elk, or doing sheep surveys and getting elk information of various types. We covered information for each wildlife management unit, of which there are a hundred and some in the province.

Most of our elk are along our western foothills. We came up with an estimate of about 13,000 elk in the province for late winter, the period of the elk surveys. It's interesting that almost half of those elk are in a very small area of the province, south of Calgary on a strip of land 100 miles wide and about 200 miles north and south. North of the Bull River in Calgary, the habitat really changes. The availability of forest grasslands is not anywhere near what's found south of the Bull River. There's less snow accumulation in the southwest, the grasslands are more extensive and the elk populations are more productive and of much greater density.

I think both reproductive performance (reproductive rate) and survival of calves are two real problems for elk and elk managers in Alberta. A lot of you may have 60 to 70, perhaps more calves per 100 cows in your mid-summer counts. South of Bull River where our best habitat is, we have several thousand animals classified in summer counts over the last six or seven years. Those annual indices range from 40 to 57 calves per 100 cows; now this is in our best habitat. Further north, you might know the area of Rocky Mountain House west of Jasper National Park at the north end of Banff National Park where the forest grasslands are much dispersed and elk populations are more dispersed. The mean index is about 26 calves per 100 cows in mid-summer. We have a study on wolves and elk in the area where hunters have been complaining about few elk and too many wolves for almost 15 years. The Brazeau and Nordegg River areas and Big Horn River area are all very famous for hunting elk. There was much better elk hunting there 20 years ago after wolves were removed in the 1950's and fires in the '30's and '40's really made some good elk habitat. But since that time it's matured. In this study area in 1985, by the last week in July we had 6 calves per 100 cows, that was all that was left. We could find packs of about 14 wolves at that time. We could actually find them without telemetry. They would be camped right with the nursery herds of elk. So, we think much of the drop in production was due to wolf predation.

On bull ratios, we went through 18,000 elk observations and selected out about 7,000 observations, where most of the elk were classified in winter. We ended up with a range from 5-30 bulls per hundred antlerless elk. However, most of those, with one or two exceptions, were less than 12 bulls per hundred antlerless. The problem with some of that data, it seems to me, is that the nature of mature bulls being isolated from the cow/calf herds in winter must put some sort of bias on those estimates. It seems to me that where there's more forest cover, you're less apt to see the bulls. In many cases, the bulls that are with the cow/calf herds are spikers. The further north you go in Alberta, the more forest cover there is and perhaps bull ratios are more biased from that standpoint. So, maybe there are more bulls in some of these more northern populations.

The status report does have information on harvest, various types of seasons, antlerless elk seasons, male authorization seasons, trophy authorization seasons, general male seasons and so on. That sort of detail is in the status report along with information on hunter demand, number of licenses, number of permits of various types that have been allocated, the demand for them and also data on hunter success from surveys in the '70's and '80's. There's also information on the extent of depredations that we get from our compensation program; the wildlife damage fund that reimburses landowners for damage from big game animals.

WRITTEN REPORT - ALB.

POPULATIONS

Numbers

Numbers of elk on provincial lands in 73 Wildlife Management Units (WMU's) were estimated from recent aerial surveys and other observations to be about 13,000 during mid-to-late winter. Approximately 46 percent of these occur in foothill and mountain habitats south of the Bow River (Calgary). Only one major "herd" occurs north of the Bow, that being the Ya Ha Tinda herd of up to 1,100 elk, most of which summer in Banff National Park. Other major "herds" include the Pekisko and Highwood herds of 400-500 elk each, the Oldman River herd of 1,300, the Oil Basin herd of 400 of Waterton Lakes National Park and adjacent areas, and the Cypress Hills herd of 800 elk that ranges into neighboring Saskatchewan.

Production (Table 1)

Annual summer (late July-early August) cow/calf counts over eight WMU's in southwestern Alberta during 1977-82 varied from 40 to 57 calves/100 cows with a mean of 44 (N = 3,448 antlerless elk). Production indices in more northern populations are more difficult to determine because of forest cover, but an index of 26 calves/100 cows (N = 1,197) was observed during July-August in mountainous habitats west of Rocky Mountain House.

In some western and northern populations, calf proportions may decline rapidly. For example, in 1985 the calf/100 cow index declined from 24 on July 6 to six during the last week of July in a remote mountain habitat east of Jasper National Park. Much of that calf loss was believed to result from wolf predation. Low reproductive rates, of 30-40 calves/100 cows at birth, in these western mountain habitats, may be related to gradual encroachment of forest and brush cover on grassland ranges.

Table 1. Summer calf production and bull/antlerless indices in Alberta.

Area	Year	Period	N	Bulls/100 Antlerless	Calves/100 Cows
Southern	1977-82	early August	812	11	38
Calgary	1977-82	early August	2,636	23	46
Rocky Mountain House	1983-84	late July, August[a]	1,197	11	26
Edson	1983-84	[b]	164	9	33

[a] Calf indices near the First Range west of Nordegg area were: 1983 - 33; 1984 - 25 to 22; 1985 - 24 to 6.

[b] June, 1983 - 53 calves/100 cows.
July, 1984 - 13 calves/100 cows.

Bull Ratios (Table 2)

Data on bull ratios were taken from winter counts of 18,035 elk. During some winter surveys, classified counts were not attempted because of rough terrain, forest cover and isolation of mature bulls from the cow herds. Based on classification of 7,044 elk, bull/100 antlerless ratios were, with few exceptions, lower than 12 (range 5-30).

Table 2. Bull/antlerless elk ratios observed on winter surveys in Alberta.

Hunting Regime	Management Area or Zone	Years	N	Bulls/100 Antlerless
No hunting	526	1981-84	116	8
Archery only	410	1974-83	568	16
Trophy-Auth.	BG5	1980-82	3,048	10
Trophy	BG5	1974-79	703	11
	BG4	1983	1,183	5
	BG4	1982	222	30
Any Bull	BG3	1978-80	182	12
	BG3	1982-84	363	7
	BG2 (354,356)	1980-83	209	8
	BG2 (358,359,522)	1981-84	450	5

HUNTING MANAGEMENT, DEMAND AND HARVEST

Management

During recent years, hunting of elk in Alberta has been regulated by general male seasons in most Big Game Zones. In addition, antlerless authorization hunts, initiated in 1974, allow the harvest of cows and calves on a limited-entry basis. Hunting of bulls in some mountain zones has been restricted to trophy bulls with five or more antler points per side. A limited-entry male authorization hunt occurred for 3 years (1980-82) in Kananaskis Country south of Calgary in order to control distribution and numbers of hunters in a popular recreation area.

In more remote zones, bull seasons open in September to allow hunting during all or part of the rut. Seasons generally are in November in those zones adjacent to the settled parts of the province. Bowhunting of elk is allowed in special pre-rifle seasons, usually for three weeks during the rut, and in three special archery WMU's.

Demand

During 1972-77, hunters were limited to either an elk or a moose license, and numbers of elk licenses purchased varied between 14,701 and 19,189. Since 1978, when this restriction was removed, elk hunters purchased between 28,995 and 35,935 licenses annually, of which 1.2 percent were non-residents. In addition to an average of 31,806 general male elk licenses purchased annually during 1978-1984, a yearly mean of 2,685 antlerless authorizations (range 1,895 in 1979 to 3,608 in 1982) were issued during that period. During these seven years, applications for antlerless elk authorizations totaled 106,598. Average annual success in this draw was 17.6 percent (range 13.7-29.5 percent) with a total of 18,798 authorizations issued (ave. = 2,685/year).

Effort and Success

From returns of a mailed questionnaire during 1974-76, resident hunters averaged 69,331 elk hunting days per year with 5.5-6.8 days per hunter. Over the three years, an elk was harvested for every 56 hunter-days. Results from a mailed questionnaire involving 1984-85 hunters were 243,100 hunter-days and 88 days of hunting per elk bagged. Preliminary results from a telephone survey of 1985-86 elk hunters indicated estimates of effort and harvest similar to that of the previous year.

Based on numbers of licenses (= 203,985) and registrations (= 13,626) during the 10 years 1975-84, overall calculated elk hunting success in Alberta was 6.7 percent. However, not all elk harvested are registered. Using a correction for 76 percent registration compliance (see Harvest section) actual overall success was 8.8 percent. Success of non-residents, who must be guided, was greater at 13 percent during this period (417 elk/3,199 hunters). Success of antlerless elk hunting averaged 29-33 percent during six years for which data was available. Success in trophy bull zones was five percent in the three years of the trophy authorization hunt in Kananaskis Country and four percent in a general trophy zone. In summary, approximate success rates were: antlerless - 30 percent; non-residents - 13 percent; trophy - 4-5 percent; overall - 9 percent.

Harvest

Records of total provincial harvest by both residents and non-residents since the initiation of compulsory registration in 1975 ranged from 640 in 1975 to 1,905 (residents = 1,840) in 1984. Results of a mailed questionnaire in 1984 provided a resident provincial harvest estimate of 2,777 or 34 percent more than were registered. According to registrations, residents harvested 97 percent and non-residents three percent of the provincial kill.

Of 13,542 registered elk with records of sex, 9,472 (70 percent) were males and 4,070 (30 percent) were females. Annual variation in sex proportions in the harvest were small with females comprising between 24.5 and 35.4 percent.

Collection of "incisor bars" for age determination began in 1974. Of 11,211 elk registered during 1978-84, age was determined on 10,713 (96%). Age structure of harvested males (N = 7,253) was different from that of females (N = 3,151). More old females (to 23.5 years) were taken than old males. Sixty-one percent of the males were yearlings or two-year-olds, whereas these two age groups comprised only 28 percent of the female elk. The youngest five age groups (calves to four year olds) of female elk were about equally harvested.

DEPREDATION MANAGEMENT

During recent years of average winter severity, approximately 125 elk damage complaints were received annually by the Division. Most (66 percent) involved feedstacks damaged during winter. During occasional severe winters, numbers of feedstack depredations increase by a factor of two or three. Significant damage to pastures has occurred at various seasons in local areas with large herds.

Damage to "crops" (feedstacks and pasture excluded) by elk are estimated by crop insurance adjustors and compensated under the Wildlife Damage Fund. Average loss on 30 claims involving elk during 1980-83 was $3,261 or about $73 per acre damaged. Individual claims were as high as $12,044 for damage to 229 acres of wheat or $53 per acre. Loss per acre ranged as high as $238 on 26 acres of barley rated at 91 bushels per acre. Total provincial estimated "crop" loss during these four years was $97,834 or $24,459 per year.

Losses to agriculture by elk are relieved by compensation, fencing, scaring, intercept feeding and relocation. Compensation, which paid up to $70 per acre in 1984, averaged $1,174 per claim during 1973-83. Additional annual compensation costs with inclusion of stacked feed were estimated in 1985 to vary from $115,000 to $2,250,000 per year depending on winter severity.

The Fish and Wildlife Division supplies paige-wire and steel posts for permanent fencing and loans snowfencing for portable fences where feedstacks are damaged by elk. This co-operative program in which government provides the material and the producer the labour was initiated in 1975.

Traditional scaring devices such as propane exploders and cracker shells, etc. are being replaced by microwave detector-scarers. These units sense movement and create sudden noise and light during the approach of elk to a feeding site. They are loaned to complainants.

Intercept feeding was initiated during mid-winter, 1984-85, when approximately 600 elk were fed for about one month at a cost of $23 per elk. Intercept feeding will be utilized as an integral component of damage prevention during winters of severe weather.

Elk are trapped at chronic damage sites and relocated. Cost per elk relocated at two sites in 1985 was $445.

TRANSPLANTS

Recovery of Alberta's elk population in the early 1900's from severe over-harvest and severe winters during the late 1800's was amplified by releases from Manitoba and Yellowstone National Park. Approximately 402 elk were released from the two areas by 1920. During the 1930's several releases from captive herds in Alberta occurred and during 1950-1979 an additional 651 elk were released from protected populations in National Parks. These programs of transplantations have continued in the 1980's with another 301 elk released at six locations.

John R. Gunson

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: John R. Gunson — Alberta (State or Province)

No. of Wintering Elk (note species) + - 15,000 — Comment:

Rocky Mountain Elk - Goal is to double population by 1999

South - 12 (n=4,698)
Central - 7 (n=1,646)
North - 4 (n=304)

Bulls/100 Antlerless (winter) (Calves + cows and maybe some spikers) — Range 3 to 33 — Comment: Antlerless elk may indicate a few spikers

Calves/100 Cows — Summer 40-50 South, 20-30 North — Range __ to __ — Comment: Bow licenses required to hunt during archery season.

1984 Resident Tags, Rifle* ____ Bow — Bowhunters must have general license, can hunt with this license during rifle season as well — Total 35,276 + 80 Cypress Hills Special

Non-Resident Tags, Rifle* ____ Bow — Total 527 NR
(*incl. muzzleloader)

Grand Total 35,883

Comment: 3,500 antlerless licenses included in 35,276

Bow license is separate from rifle (to hunt during archery season)

	Rifle	Bow		A	B
1984 Take of Bulls			Total	1,747	1,365
Take of Antlerless			Total	742	533
Total	1,822 / 15++++	49 / Other 19	Grand Total	2,513	1,905

Comment: Hunter days - x=7.62 (Range 1-60) Total days hunted = 15,411
No. of Hunters = 2,022
All WMUs 1984 Sample - those hunters who answered that question.

Bull Hunter Success: 4.1% from Compulsory Reg. Total Hunter Success: 5.3% from Compulsory Reg. but incomplete quest. returns indicate this may be slightly higher.

How is Harvest Data Obtained? (A) Mailed questionnaires

(B) Compulsory Registration. In 1985 Alberta is using a phone questionnaire survey.

What Census Methods Used? (Sample Size) Winter range counts by helicopter.

Percent of Hunting by Drawing 9.9%

Contact Person for Mgt./Research Information: John R. Gunson, Gerry Lynch, Harold Carr, Mike Watson

Other Comments: Wolf/elk project in Nordegg-Brazeau R. area to determine kill rates and effect on prey.

WASHINGTON

ORAL REPORT - Rolf Johnson

In 1984, the Washington Department of Game developed a new plan to allocate deer and elk hunting opportunities. We call that plan Resource Allocation. We decided at that time it would be implemented for three years, and then we would choose a new course of action or stay with the current ones. The major changes affecting elk hunting are weapon selection, stratified elk seasons, elk areas, quality hunts and enhanced primitive weapon seasons. I would like to go through each one of those individually.

Hunters were required to select one type of weapon for hunting elk, and to hunt elk only with that weapon throughout the season. Three choices were: modern firearm, bow and arrow and muzzleloader. The objective was to reduce hunter crowding during the modern firearms season. Results of the '84 and '85 seasons indicated there was much less crowding, but there were fewer hunters.

The next major element was stratified elk seasons. Modern firearms hunters have had stratified elk seasons in the Yakima tag areas since 1979. In 1984 we initiated stratified elk seasons or early and late seasons in each of these various tag areas. We have four tag areas in Washington. First of all, the hunter must select which elk area he wants to hunt. Then he has to select whether he wants to hunt early or late. Those that hunt early get the first crack at the big bulls, and about 70-80 percent of the bulls are taken during the first season. Only those who choose the late tag area have an opportunity to apply for one of the special cow permits or some of the branch-antler bull permits. We vary the number of days available for early versus late hunting. That way we vary the number of participants; those who will select to buy an early or a late tag. We have almost half of the people selecting early and late. In that way, we reduced hunter crowding a great deal too.

The third element is elk areas. As I mentioned before we have elk areas for modern firearm hunters starting in 1979. Now we have elk areas for the muzzleloader and the archer as well. We decided that it was only fair that if the modern firearm hunter had to be restricted to an elk tag area, the primitive weapon hunter had to be as well. We have designed seasons for bowhunters and muzzleloader hunters in each elk tag area.

Another major element of the resource allocation plan is quality hunts. We went around the state and talked to various user groups and asked them what they wanted in elk hunting. One common thread that came through their discussions was they wanted quality, and quality means different things to different people. We've implemented road management programs, we've implemented permit-only restrictions, but one of the other aspects of quality hunting is branch-antler restrictions. Nine of the elk units, that's about 10 percent of the elk units in our state, have a three-point minimum antler restriction. Three other units are managed by three-point minimum and permit-only hunting. In addition to these, we have a bugling season for a very few permits, about six areas and 45 permits with five-point minimum bull elk hunting. These are high quality areas. Branch-antler restrictions have been very popular with the hunters. However, we still have some sublegal animals being taken. The problem is the dummy wanders in and doesn't know that this is a branch-antler unit. Or, he doesn't know the boundary and so we have had some problems in that regard.

Archery and muzzle opportunity are the other elements where we've expanded in the last couple of years. We do have an early archery hunt on the eastside for 11 days, and on the westside for 15 days. The first four and five days respectively are bull only, followed by either-sex. We also have a fairly liberal late archery opportunity with 31 hunts available. For muzzleloaders, we have ten elk units open early and ten late.

The major changes in resource allocation in 1984 and 1985 are still being evaluated. About 80 percent of our hunters are modern firearm hunters and they take about 91 percent of the elk. Archers make up about 9 percent of our hunters and they take about 7 percent of the elk. Muzzleloader hunters make up about 3 percent and they take 2 percent of the elk. Hunter reaction to these seasons is being evaluated at the present time. It appears that hunter take is down slightly from previous years.

I will say for the future that an Initiative to the People has been filed with the State Legislature, and this is a plan to collect one-eighth of one-percent on the sales tax. If this passes, the State Department of Game will be General Funded and we will take in about $38 million a year. Much of that money will be spent for buying lands. Elk habitat is certainly one of the major things that we want to buy lands for, particularly in the Blue Mountains. So, we're hopeful that next November when the voters go to the poles, they will approve Initiative 90 and we will have general funding for wildlife.

WRITTEN REPORT - WA

In 1984, the Washington Department of Game developed a new plan to allocate deer and elk hunting opportunity that became known as Resource Allocation. This plan will be carried out for three years and then a thorough review of these seasons completed before 1987 hunting seasons are developed. The major changes affecting elk hunting are--weapon selection, stratified elk seasons, elk areas, quality hunts, and enhanced primitive weapon seasons. Let me elaborate on each of these changes.

Weapon Selection (Either/Or Concept)

Hunters are required to select one type of weapon for hunting elk and hunt only during the season for that weapon. The three choices are modern firearm, bow and arrow, and muzzleloader. The objective here was to reduce hunter crowding during the more popular modern firearm season. Hunters not successful in a rifle season, for example, could not go hunting again in a late archery or muzzleloader hunt. Results of the '84-'85 season indicate weapon selection requirements cut down on crowding problems encountered during rifle hunts in recent years.

Stratified Elk Seasons

Modern firearm hunters have stratified seasons in each of the four elk areas. These are early and late hunts in each elk tag area. Washington elk hunters must select one elk tag area and then also select the early or late hunt in that tag area. Hunters who buy an early tag get the first hunting opportunity but only those who buy a late tag are allowed to apply for an antlerless elk permit. Those who buy the early bull tag forego the opportunity to apply for a special permit. Hunter participation in earlyvs. late tags is influenced by days of hunting provided in each hunt. Early tagholders have the opportunity to hunt three to five days before "late" tag hunters. While 70-80 percent of the bulls are taken in the early hunt, bull hunter success averages only about 11 percent. Hunters drawing a special cow permit average better than 50 percent success and this provides incentive to draw nearly half the hunters into the late tag category.

Elk Areas

The boundaries of the four modern firearm elk areas have also been used in the development of archery and muzzleloader seasons as well. Like rifle hunters, archers and muzzleloaders have to select one of the state's four elk areas and buy the appropriate elk tag for that area. In late seasons, archers are allowed to hunt in any tag area.

Quality Hunts

During the development of the resource allocation plan, hunters called for an increase in quality bull areas. Road management and permit only restrictions have been initiated in several elk areas. Another aspect of quality elk areas is branched-antler restrictions. Nine of the elk units are now managed under a three-point minimum regulation. Three other elk units are managed by permit only along with three-point restrictions. In addition to these, six areas are open during an early bugling season to permit hunters (total 45 permits) for bulls with at least five points on one side. Branched-antler regulations have proven very popular in the last couple of years but the taking of sublegal animals still occurs. In most cases, however, hunters violating a branched-antler regulation are not aware of the boundary or point restriction rather than misjudging point number.

Archery and Muzzleloader Opportunity

One concept in the allocation plan was to provide additional early archery and muzzleloader opportunity. In 1985, there was an 11-day early archery hunt on the eastside and 15-day western Washington early archery hunt. The first four and five days, respectively, were for bull only while the remainder of the early archery hunt was either-sex. Washington does offer a fairly liberal late archery opportunity with 31 hunts available in 1985. A total of 10 elk units are open to early muzzleloader opportunity while a similar number of late muzzleloader hunts are available. The early primitive weapon seasons have resulted in considerable controversy but little impact on hunter numbers or harvest has resulted.

The major changes in Resource Allocation enacted in 1984 and 1985 are still being evaluated. Modern firearms hunters make up 88 percent of the elk hunters while archers are a distant nine percent and muzzleloaders only 3 percent. Modern firearms hunters took 91 percent of the elk while archers took seven percent and muzzleloaders just over two percent. Hunter reaction to these seasons is being evaluated at the present time. The total harvest appears to be down only slightly from previous years.

PRESENT STATUS

Almost equal numbers of Roosevelt and Rocky Mountain elk are present in Washington. Population estimates are 26,550 Roosevelt and 24,100 Rocky Mountain elk. Eastside elk numbers are remaining stable but western Washington herds are declining slightly in the wake of development and timber management activities. As a result of branched-antler restrictions, limited access, and permit-only regulations, the bull/cow ratios are improving in some areas. In the Mount St. Helens area for example, bull counts have increased from one to two bulls per 100 cows prior to the eruption to over 20 in post-season herd composition counts. Research studies are currently being conducted by Evelyn Merrill of the University of Washington on the energetic basis of elk forage and cover in the St. Helens area.

Rolf Johnson

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: Rolf Johnson — Washington (State or Province)

No. of Wintering Elk (note species): Roosevelt 26,550; Rocky Mtn. 24,100. Comment: Attempts will be made to increase both species if funding is available for damage control.

Bulls/100 Cows (winter) 5 Avg. Range 1 to 30 Comment: Extremely high percent of bulls taken in open areas, permit only units have good bull ratios.

Calves/100 Cows (winter) 40 Range 30 to 50 Comment: Ratio's vary widely and average figures are just a guess.

Resident Tags, Rifle* 74,158 Bow 7,832 Total 81,990

Non-Resident Tags, Rifle* 855 Bow 41 Total 896
(*incl. muzzleloader)

Grand Total 82,886

Comment: 1984 was the first year of "Resource Allocation" in which hunters had to choose one method of hunting. Hunter numbers decreased about 9 percent.

Take of Bulls, Rifle 5,673 Bow 207 Total 5,880

Take of Antlerless, Rifle 2,780 Bow 435 Total 3,215

Grand Total 9,095

Comment: We use a 10 percent questionnaire with 3 wave follow-up for statewide and regional totals. Game Harvest Report cards are used to allocate harvest to GMU's (60 percent return).

Bull Hunter Success: 7 percent Total Hunter Success 11 percent

How is Harvest Data Obtained? Same as above.

What Census Methods Used? (Sample Size) Washington conducts very little aerial surveys for elk but most is done in the Blue Mountains. These are post-season herd composition counts. Some pre-season surveys are being conducted.

Percent of Hunting by Drawing: 6 percent

Contact Person for Mgt./Research Information Rolf Johnson 206-753-2084 600 No. Capital Way, Olympia, WA 98504.

Other Comments: The coalition for Washington wildlife is submitting an initiative to the people that would bring in about 38 million dollars. Plans are being developed to emphasize survey and inventory habitat acquisition.

Ongoing Research Subjects and Investigations:

Energetic basis of elk forage:cover relationships of Mount St. Helens. Evelyn Merrill, R.O. Taber and K.J. Raedeke, Univ. of WA., Seattle (Final report will be out next year.

Recent Elk Publications:

PhD Thesis - Max Zahn - Use of thermal cover by elk on a western Washington Summer Range, Univ. of WA, Seattle.

OREGON

ORAL REPORT - Al Polenz

With our Roosevelt elk, one of the comments on the form is we're trying to increase populations. We have quite a bit of habitat that's still unfilled in western Oregon and we're attempting to fill this by trapping and transplanting and by a very modest antlerless harvest. Only a small number of permits are available for taking antlerless animals in damage areas.

Our hunting seasons are similar to what was described for Washington. We have separate bow and rifle seasons. The bow season generally starts in late August and runs for about 30 days. Rifle season is split into two periods. Rifle bull hunting, first period, runs 4-5 days, then there is a break followed by a 7-9 day second period bull season. Following this we generally have antlerless seasons. In the Rocky Mountain elk area, these can be fairly extensive, on the order of 30-50,000 permits available per year, allowing the taking of cows and calves.

We're approaching some drastic changes in Oregon for elk hunting management that should start taking place this year. We'll probably be having three elk tag areas available. We have had two; you elect to hunt either western Oregon or eastern Oregon. This year, we're going to further complicate matters by having a Cascades elk tag. You would choose to hunt either the coastal area of western Oregon, the Cascades, or eastern Oregon. You could hunt only one of these. The Cascades may have an early season starting in mid-October and running for an unknown period of time. We won't set our seasons until the end of May.

We're going into limited entry on a substantial basis in Rocky Mountain elk. We've had a considerable problem with low bull ratios and hunter crowding in quite a few of our management units. We're going to address this problem and hopefully solve it. We're going to limit the number of hunters first period in some of the more popular areas with wide open hunting during the second bull period in these areas. Others, where we're trying to maintain a higher bull ratio, we're going to probably limit the number of hunters in both periods, or we'll have just one hunting period for bulls and limit the number of hunters during that period.

We also have these three point areas, two in western Oregon and one in eastern Oregon.

We have had considerable discussion with archers and from archers. They generally hunt either-sex elk at an earlier time prior to the rifle season. This has caused some conflict, or at least perceived conflict, between the two user groups. Hopefully this has been settled pretty much by maintaining status quo.

WRITTEN REPORT - OR

Roosevelt elk inhabit that portion of Oregon west of the Cascade Mountains while Rocky Mountain elk are found east of that mountain range. The majority of the Cascade Mountain's elk are classed as Roosevelt, but there has been some mixing of the two at various times in the past.

Roosevelt elk populations are steadily increasing as a result of expansion into available unfilled habitat. Rocky Mountain populations are being held relatively stable with the use of antlerless elk hunts.

Private land damage problems are scattered throughout elk habitat areas but are most severe in northwest and northeast Oregon. Portions of northeastern Oregon have been most troublesome because of recent severe winters, land use changes and land use planning decisions. The poor economic conditions in the livestock and timber industries appear to be contributing damage factors.

Oregon elk hunting begins about the third week of August with a general month long archery season. General rifle seasons start near November 1. The two period general season, adopted in 1979, continues. Beginning in 1986, Oregon will issue elk tags for three different hunt areas. The Cascade tag will be valid for a nine-day, mid-October hunt; the Coast tag for a two-period November hunt of four and seven days and the Rocky Mountain elk tag for a two-period October-November hunt of five and nine days. Hunters will be able to hunt only one of the three areas and only one of the time periods. Scheduled damage control and population reduction hunts occur at various times between August 15 and March 1. These are either sex or antlerless elk hunts controlled by area and permits. Limited entry general rifle season hunting will occur in 38 percent of the 71 management units for the 1986 season.

Elk hunter numbers continue their steady increase, with an all time high of more than 133,000 hunters afield during the 1985 season. The total 1985 harvest of over 20,000 elk was the second greatest on record. The average annual harvest since 1980 has been 19,500 elk, with antlerless harvest comprising an average 40 percent of that total.

Research effort on Rocky Mountain elk involves final report writing on the elk cover study and planning for the elk/deer/livestock equivalency project. This work will determine the forage use relationships between the three classes of animals and will result in the determination of AUM equivalencies. The Roosevelt elk habitat mapping project is now training managers on habitat inventory and assessment as related to forest management strategies and options.

Al Polenz

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: Al Polenz — Oregon (State or Province)

No. of Wintering Elk (note species) 52,000 R.M. 43,000 Roos. Comment: 1985 estimate, R.M. elk stabilizing with mgt. objectives, trying to increase Roos. elk.

Bulls/100 Cows (winter) 8 Range 3 to 18 Comment: Both species have similar ratios, trend seems up for R.M., holding for Roos.

Calves/100 Cows (winter) 33 Roos. 40 R.M. Range Roos. 17 R.M. 18 to 51 58 Comment: Roos. usually lower and tend to cycle (nutrition), R.M. below desired level.

Resident Tags, Rifle* 113,000 Bow 15,000 Total 128,000

Non-Resident Tags, Rifle* 3,300 Bow 700 Total 4,000
(*incl. muzzleloader)

Grand Total 132,000

Comment: Demands presently flat or down slightly, probably due to economy. Five percent non-resident cap being considered.

Take of Bulls, Rifle 10,020 Bow 560 Total 10,580

Take of Antlerless, Rifle 5,730 Bow 730 Total 6,460

Grand Total 17,040

Comment: No 1984 kill data, new telephone harvest survey for 1985 not yet complete.

Bull Hunter Success 10 percent Total Hunter Success 13 percent

How is Harvest Data Obtained? Formerly questionnaire, 1985 will be first telephone survey with help from Idaho.

What Census Methods Used? (Sample Size) Systematic aerial (mostly) trend counts in February-March (31,515 elk in 4,422 mi.), winter herd comp. (random) 18,698 classified, some pre-season herd comp.

Percent of Hunting by Drawing: 12 percent

Contact Person for Mgt./Research Information: Al Polenz, (503) 229-5477 Oregon Dept. of Fish and Wildlife, P.O. Box 59, Portland, OR 97207

Other Comments: An elk plan for 1986-1990 proposes to increase limited entry to 50 percent of the opportunity to increase bull ratios and solve some unit crowding.

Ongoing Research Subjects and Investigations:

A model to Evaluate Elk Habitat in Western Oregon. Michael J. Wisdom, U.S. Bureau of Land Management, Coos Bay, Oregon. Habitat Effectiveness Index for Elk on Blue Mountain Winter Ranges, Jack W. Thomas, Pacific N.W. Forestry and Range Experimental Station, La Grande, Oregon 97850

Recent Elk Publications:

Management of Wildlife and Fish Habitats, Forests of Western Oregon and Washington Supervisor of Documents, U.S. Gov't Printing Office, Washington, D.C. 20402

Male Breeding Efficiency in Roosevelt Elk of S.W. Oregon, Wild. Res. Report 15, Oregon Department of Fish and Wildlife

Elk use and Availability of Cover and Forage Habitat Components in the Blue Mtns., N.E. Oregon, 1976-1982, Wild. Res. Report 14, Oregon Dept. of Fish and Wildlife

Grazing Relationships of Elk, Deer and Cattle on Seasonal Range in N.E. Oregon. E. Oregon Agricultural Research Center, Union, Oregon

IDAHO

ORAL REPORT - Lloyd Oldenburg

Our elk populations are continuing to increase, or possibly to stabilize. We've gone from harvesting about 4,100 elk ten years ago in 1976 to 1985, when we harvested about 15,600, of which perhaps 11,000 were bulls; 23 percent hunter success statewide.

As Jack Donaldson said earlier, as you get more good things you get lots of social and political problems. We've had a real generous share of both. We've spent about $400,000 so far this winter on depredation control, baiting and some feeding. We didn't do any of that when we were harvesting 4,100 elk. This is basically the typical haystack, winter wheat and grapefield type depredation that we're running into. Since December, we've had 18 depredation hunts, which is something new to our state.

Last year we had the first, this year we had 18. Next year we'll probably have a lot more, judging by what's been going on. We will be increasing our antlerless and either-sex tags for controlled hunts this year to more than 12,000 permits. Last year, we had 10,000. Probably we will have 12,000 this year, and that seems to be escalating because we have general bull hunting in most all of the southern part of the state.

During the past year, we've completed the second edition of our five-year plan for elk. We've also done this for other species. This is not operational. Our Commission policy is to follow the plan. It's used everytime we do something; it's not a shelf ornament.

Our research people are into an elk sight ability project. They're trying to validate what percentage the number of animals that are seen when we do our herd count. The study is done by putting lots of radios on. If any of you are interested in details and that, Jim Hunsworth is research biologist on that project.

I want to mention that Lou Nelson, who is a staff biologist in our Boise office, will be making a presentation on economics tomorrow afternoon. He finished a very in-depth economic survey in cooperation with the Rocky Mountain Forest and Range Experiment Station at Fort Collins using our 1983 data. He did it on a net worth basis and it's coupled to the value of the day of hunting.

WRITTEN REPORT - ID

Elk populations in Idaho have continued to increase over most areas of the State. Harvest in both general hunts and controlled hunts has also increased with 1984 and 1985 statewide harvest being approximately 15,600 animals each year. This compares to 4,100 animals harvested statewide in 1976.

Increases in elk populations have caused social/political problems as animals eat and destroy growing and stored crops on private land. The Department spent about $300,000 during the winter of 1985-1986 servicing complaints from farmers and ranchers. Actions include fencing or paneling stored crops, fencing fields, using scare or hazing tactics, baiting and/or feeding, issuing limited kill permits, and having special hunts in local problem areas. Eighteen hunts were set between December 1, 1985, and February 15, 1986. One general either-sex archery season was open January 1-19, 1986, in a sagebrush/grass winter range with interspersed farms and ranches. There are about 10,400 controlled hunter permits proposed for the 1986 season with most of these permits being for antlerless animals.

The demand for elk tags by nonresident hunters has increased rapidly recently. The total quota of 9,500 tags sold out by September 20, 1983. The quota of 9,000 regular nonresident elk tags available January 1, 1986, were sold out March 20, 1986. There were also 1,000 nonresident regular elk tags held back and placed on sale August 1, 1986. There also were 1,500 panhandle nonresident elk tags available in 1986. All tags are sold on a first-come-first-served basis.

There were 33 management units open for general archery hunting in 1985. In 1986, there will be 55 units open for archery hunting.

The 1986 regulations prohibit anyone who draws a controlled hunter permit from hunting in any general, archery, or muzzleloader elk hunt in 1986.

The following compares 1986 elk regulations with 1985:

COMPARISON OF PROPOSED 1986 TO 1985 ELK SEASONS

Type Hunt	1985	1986	Change	Percent Change
General elk	1,239* unit days	1,353 unit days	+124 days	10%
Archery elk	1,004 unit days	1,929 unit days	+925 days	92%
Muzzleloader elk	66 unit days	127 unit days	+61 days	92%
Controlled hunt permits	10,395	10,190		2%

* One unit day = one management unit open for one day of hunting.

There is a new publication, "Net Economic Value of Elk Hunting in Idaho" by Cindy F. Sorg and Louis J. Nelson, available from Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado 80526 (Resource Bulletin RM-12).

Lloyd Oldenburg

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: Lloyd E. Oldenburg — Idaho (State or Province)

No. of Wintering Elk (note species) 125,000 Rocky Mt. Comment:

Bulls/100 Cows (winter) 30-32 Range 18 to 45 Comment:

Calves/100 Cows (winter) 36 Range 25 to 60 Comment: Population where we have very high calf/cow ratios is difficult to census because of very large groups of animals.

Resident Tags, [Rifle] 68,417 Bow* (est. 9,500 archery hunters) Total 68,417

Non-Resident Tags, [Rifle] (*incl. muzzleloader) 9,964 Bow* (est. 2,700 muzzle-loader hunters) Total 9,964

Grand Total

Comment: Sixty percent of bull harvest is 5 point or larger. Don't have separate tags for rifle, bow and muzzleloader. *Must purchase archery stamp/** muzzle-loader stamp. Residents, nonresidents purchase same stamp.

Take of Bulls, Rifle 10,784 Bow 740 total Total 11,524

Take of Antlerless, Rifle 3,919 Bow 160 total Total 4,079

Grand Total 15,603

Comment: We don't have sex breakdown on archery/muzzleloader harvest.

Bull Hunter Success Unknown Total Hunter Success 21.5

How is Harvest Data Obtained? Telephone survey plus mandatory check in panhandle region. In 1985, 29,530 elk hunters (trips) were checked.

What Census Methods Used? (Sample Size) Herd composition plus sightability factor.

11,368 harvest in general hunts.
Percent of Hunting by Drawing: 3,335 harvest in controlled hunts. Seventy-four hunts with 10,190 permits in 1985. These permitees can also hunt in any general hunt.

Contact Person for Mgt./Research Information: Lloyd E. Oldenburg, P.O. Box 25, Boise, ID 83707.

Other Comments:

Ongoing Research Subjects and Investigations:

Sightability to determine accuracy of herd composition and census counts; habitat use by bulls seasonally; hunting mortality rates of bulls.

Recent Elk Publications:

None

MONTANA

ORAL AND WRITTEN REPORT - John Firebaugh

Elk are distributed primarily in the forested areas of western and central Montana, but also occur in the Missouri River Breaks of northeastern Montana. Land ownership status where elk occur is 73 percent public, 2 percent state school and 25 percent private. Approximately 80 percent of the elk harvest occurs on public land, which is almost entirely national forest.

In most areas where elk exist in Montana we are currently experiencing modern day population highs. In many locations private landowner's tolerances have been reached or exceeded and further population increases could cause severe crop depredation problems. Although the department has acquired 18 big game management areas over the years (168,702 acres deeded and 66,452 acres leased), mostly for winter range, only about 10 percent of all elk use these areas.

In recent years, hunting demand for elk and the supply of elk has been increasing in Montana. The number of elk hunters reported afield has fluctuated somewhat from 1975-1984, but averaged 86,800 between 1975-1980 and 91,300 between 1981-1984. The 1985 statistics are not yet available but in 1984, 86,400 hunters reported hunting elk in Montana. The elk harvest averaged 12,500 between 1975-1980 and 15,600 between 1981-1984. In 1984, 18,500 elk were reported harvested and all indications are that the 1985 season was at least as successful. Percent success averaged 15 percent between 1975-1980 and 17 percent between 1981-1984. In 1984, 21 percent of the elk hunters were successful.

The 1975 legislature placed a ceiling of 17,000 on the sale of non-resident elk licenses. This quota has been achieved earlier each year and was sold out in six days in 1985.

The statewide objective for 1990 is to provide 801,400 days of elk hunting annually at a hunting success rate of 17 percent with an average effort of 47 days per elk harvested. This is translated into a sustained harvest goal of about 17,000 elk.

The 1985 elk hunting season involved 129 elk hunting districts covering a little over 23 million acres, or approximately 25 percent of Montana. There were basically five types of hunting regulations. These included: 1) archery only (most hunting districts during the special archery season and 2 districts during the general rifle season); 2) either-sex hunting (1 H.D. had season-long either-sex hunting while 27 districts had short either-sex (usually eight days) followed by antlered bulls only; 3) antlered bull hunting with most areas having the harvest of cows and calves regulated by permits (74 districts); 4) branch-antlered bull hunting in 7 H.D.; and 5) permit only hunting in 20 H.D.

Elk hunting usually begins during the first week of September with a general archery season that lasts about five weeks, and continues with a general rifle season that begins in late October and runs five weeks through late November. An early rifle season opens September 15 in portions of the Bob Marshall and

Lincoln-Scapegoat Wilderness areas. There are two prescheduled late hunts by permit only starting in mid-December and ending in mid-February that take place in the upper Yellowstone and Gallatin drainages just north of Yellowstone National Park. Over 90 percent of the elk harvest, however, occurs during the general rifle hunting season. Depredation hunts during late summer-early fall and winter often occur to control elk causing crop damage.

The Montana resident pays $10.00 for an elk license and an additional $2.00 for a conservation license. Another $6.00 must be paid to hunt elk with a long bow and arrow during the special archery seasons. Beginning in 1986, the non-resident elk hunter will have to pay $350.00 for the combination license that includes elk, deer "A" license, black bear license, authorizes hunting of upland game birds and fishing. It also gives them the privilege to buy some special tags (grizzly bear, mountain lion, archery stamp) and apply for others (antlerless elk, moose, sheep, goat and antelope).

Current Research

Current research emphasis on elk involves two full-time studies and several shorter term studies in various hunting districts.

A management/research project was initiated in 1982 in the Elkhorn Mountains near Helena. This effort is in cooperation with the Helena National Forest (U.S. Department of Agriculture). Elk habitat relationships and population dynamics are being evaluated by this project.

A long-term research study was initiated by the Montana Department of Fish, Wildlife and Parks beginning in 1983 to also address elk management concerns and give the "Quality Hunting Issue" more biological information. Its objectives are:

1. To determine the effects of alternate hunting strategies and various harvest rates on elk population dynamics and habitat use due to the steady increase of hunting pressure and loss of habitat security.

2. To test the hypotheses that when mature bulls (2 1/2+years) make up less than 5 percent of an elk population during the breeding season, the net reproductive success will be less compared to when the population has more than 5 percent mature bulls.

3. To assist biologists with evaluating existing elk population data and utilize the results from this study to better manage and understand the effects of various harvest rates and hunting season types on elk population dynamics.

Radio telemetry is being used on a broad scale in a number of hunting districts to help us better understand seasonal distribution, movement patterns, observability indexes, and population trends.

As results from these studies become available, more light will be shed on the reproductive value of older bulls and the effects of various harvest rates on elk population dynamics and habitat use. This will provide the department with information on which to recommend future management of Montana's elk populations, and to provide for productive and healthy populations.

Recently, some sportsmen in Montana have expressed concern that there aren't as many big bulls as there used to be. This a valid perception in some areas, especially those hunting districts were habitat security is low. In other areas, although sportsmen believe there are fewer older bulls, data indicates there are as many older bulls now as there were 15-20 years ago. However, due to the large increase in hunters, there aren't as many older bulls to go around as there used to be, resulting in the perception that fewer older bulls are present. The "problem" seems to be one of hunter satisfaction and demand rather than biological. We are currently not aware of any areas in the state where production of calves has been reduced due to a low ratio of older bulls to cows.

But, due to the large increase in hunters, there are not as many to go around and this contributes to the perception by these hunters that there are fewer big bulls. The problem seems to be one of hunter satisfaction rather than a biological problem at this time.

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: John Firebaugh — Montana (State or Province)

No. of Wintering Elk (note species) Rocky Mtn. Elk ______ Comment: Montana does not make a statewide population estimate for elk; however, the population trend has been up for the last several years.

Bulls/100 Cows (winter) 5-10 Range 3 to 20 Comment: Varies considerably across the state depending upon habitat security and management goals.

Calves/100 Cows (winter) 35-45 Range 20 to 55 Comment: Varies considerably depending upon winter range habitats, snow depths, etc. Typically northwestern Montana has the lowest ratios while southwestern and central Montana have higher ratios.

Resident Tags, Rifle* 94,000	Bow 11,053	Total 105,053	
Non-Resident Tags, Rifle* 17,000 (*incl. muzzleloader)	Bow *	Total 17,000	
		Grand Total 122,053	

Comment: *Nonresident archery tags are not broken out but are included in the resident total. A maximum of 17,000 nonresident elk licenses for elk hunting can be sold due to legislation.

Take of Bulls, Rifle 11,662	Bow 532	Total 12,194	
Take of Antlerless, Rifle 6,804	Bow 245	Total 7,049	
		Grand Total 19,243	

Comment: The 1984 harvest was the highest elk harvest on record. Antlerless permits issued are increasing in most areas to stabilize and in some cases reduce the population.

Bull Hunter Success 16 percent Total Hunter Success 21 percent (Rifle season)

How is Harvest Data Obtained? Resident elk hunters are randomly sampled through a phone survey. Nonresidents are randomly sampled through a mail survey.

What Census Methods Used? (Sample Size) Approximately 40 percent of the elk license buyers are sampled. When 100 or less antlerless permits are issued in a hunting district 100 percent are sampled. Whenever 100 are issued, a smaller percentage is sampled.

Percent of Hunting by Drawing: 17 percent (14,905 antlerless permits issued, and 86,443 total elk hunters).

Contact Person for Mgt./Research Information: Terry Lonner, Roy Huffman Building, Box 5, MSU, Bozeman, MT 59717

Recent Elk Publications:

Hammond, G. et. al. 1984. Elk Monitoring and Mitigation Project along the BPA 500 Kv Transmission Line. Annual Progress Report for 1984.

Lyon, L.J. et. al. 1985. Coordinating Elk and Timber Management, Final Report of the Montana Cooperative Elk-Logging Study, 1970-1985.

Marcum, C.L. et. al. 1984. Final report of the Chamberlain Creek Elk Study, 1975-1984. Univ. MT, Missoula.

WYOMING

ORAL REPORT - Roger Bredehoft

All our nonresident permits are by application and limited quota. The numbers are determined by the percentages of the residents who hunted general the year before. Archers have to purchase a rifle license. Nonresidents must draw a rifle license first to be eligible for an archery permit. You could hunt anywhere from 15 to 60 days pre-season.

Muzzleloaders are mostly in areas with a limited quota permit. Here, you're restricted to both area and time of year, but they are very limited. The number of special permits and seasons are decided by the warden biologists in various districts where these occur. So they do vary greatly.

I see that Doug Crowe has been quoted several times here as one of our major spokesmen, and most certainly people management is the major limiting factor of management in Wyoming. We do pay damage; we pay quite a bit of it. Probably the most limiting constraint on our elk population at this time is appeasing the landowner and the damage problem within the state. We could hold more elk than now but we cannot afford the damage that we would have to pay if that population did grow.

Most of our population simulations are done on computers now. We're very busy with computer modeling. We've come out with a new model. Everybody had to go to Cheyenne to model and now there is a computer center in every one of our game districts. So, now that we have split up into seven different areas to make our computer modeling more efficient and more accessible, the biologist and the warden can do a little management.

Our research right now in Wyoming has been mostly disease-oriented. In the Jackson Hole area, we're working on brucellosis and scabies in the elk. Jackson Hole area doesn't just mean the Fish and Wildlife refuge. We have quite a few feedgrounds in the Grays River area, Alpine and in that area in general.

Another research project that we just finished was one that has to do with distribution of elk. As you're probably all aware, Wyoming has a considerable amount of mineral resource, oil and gas, and research has been mostly in the overthrust area where we're getting a lot of different types of exploration into areas where they've never been before. Larry Erwin was the major professor for this research, so if you have any questions I'm sure that Larry would be willing to answer.

I'm going to mention Jackson because I think Jackson probably receives just about as much pressure as the Flats, or at least in our country they do. Herd numbers are down in both the Teton and Yellowstone herds this winter at the Fish and Wildlife refuge in Jackson. We have something going on there, it's a collection of all existing data for the Jackson herd. There's going to be some recommendations as to what we can do to manage this herd more effectively, you might say stabilize it. Over the years it's gone up and down, up and down. Study data includes harvest strategies, feeding strategies, kinds of hunt, percentage of antlerless permits and so on. Mark Boyce, who is with the University of Wyoming is collecting all this data and is going to make recommendations. It's my understanding he will have a publication out on this about next year. If any of you are interested in that you can reach Mark Boyce at the University of Wyoming, University Station, Laramie, Wyoming. I'm not sure of the zip over there.

WRITTEN REPORT - WY

Wyoming manages 40 elk herd units within a Planned Management System, where each herd has objectives for wintering (posthunt) population, harvest, hunters, success, recreation days and days spent per harvested animal. Currently, those objectives are to maintain: a wintering population of 65,045 animals; harvest 16,920 elk; 73,659 hunters; 33.4 percent success; 303,532 recreation days and 15.9 days spent per harvested animal.

In 1985, there were 45,809 elk hunters that harvested 13,809 elk at 30.1 percent success and spent 19.0 days per harvested animal. This resulted in 262,371 total recreation days. At the current return to the state's economy of $1,549 per harvested elk, the state gained $21,390,141 from elk hunting. After elk management costs, the Department's income from elk hunting was $378,217.

During 1985-1986, there were an estimated 65,385 wintering elk. There are currently 4,013 square miles of winter range designated critical, while the total habitat occupied by elk in Wyoming is 29,644 square miles. At the 1982 workshop, 27,600 square miles of total occupied elk habitat were reported. Elk habitat did not necessarily increase, only the amount that we identified as occupied elk habitat.

MANAGEMENT

Wyoming continues to use population modeling to estimate elk numbers. Recently, AT&T personal computers were purchased for the field offices. We use POP-II, developed by John Bartholow, Fossil Creek Software, Ft. Collins, CO. and have found it to be a tremendously useful tool. Problems still exist with population boundary definition and simulation models can be used to evaluate these problems.

Seasons vary from 15 days to 3 months and we have used various opening dates, limited quota and general license types to achieve the herd objectives. As special interest groups increase in size and number, so do the number of conflicting season restrictions, which generally desire more bulls available for harvest. Some of these limitations include muzzleloading, archery, spikes excluded and five-point antler restrictions. The problem we have seen with some of our spikes excluded seasons is that after several years the "trophy" bull segment decreases or disappears and the younger branch antlered bull segment increases, when the objective was to increase the number of "trophy" bulls. Resident hunter pressure also decreases and the outfitting groups have become increasingly fond of antler restricted seasons for obvious reasons.

PROBLEMS AND RESEARCH

As the economic recession continues, increased timber harvest quotas are being demanded, as an offset measure, in areas where forage:cover ratios have already been exploited to levels below U.S. Forest Service guidelines. Consequently, as some of these affected elk populations have decreased, so has elk harvest, the number of available licenses, recreation days and the revenue generated to the state's economy.

Oil and gas exploration continues in the overthrust belt in western Wyoming and two studies have addressed elk response to different exploration activities.

First, elk response to oil and gas drilling activity was evaluated on a calving area in Snider Basin. The results were that elk moved calves out of the area at earlier ages, calves were moved away from drilling activity, elk avoided the active drill site and avoided meadows visible from high traffic volume roads.

Second, a recently completed study evaluated elk response to seismograph exploration. This study demonstrated that seismic activity did not displace elk from their seasonal home ranges. However, elk were displaced an average of 3/4 mile within their home range. Declines in the reproductive rates and population size were not observed during the study. The displaced elk moved into dense forest cover areas (> 70 percent canopy) and used habitats with reduced forage. It was undetermined, but possible, that elk may increase nocturnal activity and use prime feeding areas at night. Also, how chronic stress affects elk remains to be determined.

An evaluation of our 1967-1981 elk sex and age classification data showed that herds where artificial winter feeding is conducted annually average 34.01 calves:100 cows post hunting season while free-ranging herds averaged 49.25 calves:100 cows post season. We suspect the reduced ratios are due to brucellosis and we've experimented with implant innoculations on feedground elk. It is hoped that we can reduce the number of infected elk. It's too early to evaluate the changes in productivity.

Lee M. Wollrab

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: Roger Bredehoft — Wyoming (State or Province)

No. of Wintering Elk (note species) 55,000 R.M. — Comment: Post-hunt 1984 population estimate. Population objective 69,000.

Bulls/100 Cows (winter) 15 Range 4 to 40 Comment:

Calves/100 Cows (winter) 50 Range 30 to 65 Comment: Low ratios mostly found in feedground areas.

Resident Tags, Rifle* ____ Bow ____ Total 49,247

Non-Resident Tags, Rifle* ____ Bow ____ Total 7,435
(*incl. muzzleloader)

Grand Total 56,682

Comment: 1984 license sales data.

Take of Bulls, Rifle ____ Bow ____ Total 8,111

Take of Antlerless, Rifle ____ Bow ____ Total 6,532

Grand Total 14,643

Comment: Forty percent of bull harvest is spikes. 1984 harvest data.

Bull Hunter Success ____ Total Hunter Success 27 percent.

How is Harvest Data Obtained? Mailed questionnaire survey. Ninety percent confidence limits by herd unit.

What Census Methods Used? (Sample Size) Aerial trend counts, usually late winter, fixed-wing or helicopter, winter herd composition, and some pre-season herd comp. (ground).

Percent of Hunting by Drawing: 35 percent

Contact Person for Mgt./Research Information: Rex Corsi 307-777-7604, 5400 Bishop Boulevard, Cheyenne, WY 82002.

Ongoing Research Subjects and Investigations:

Use of Ivermectin for Scabies - Sybille Research Center

Use of Strain 19 Pellets for Brucellosis in Elk - Elk Refuge, Jackson

Effects of Seismograph Activity on Elk Distribution - M.S.

CALIFORNIA

ORAL REPORT - Don Koch

I don't want to beat the proverbial dead horse, but everybody has talked about people problems and we certainly have that in California. It makes it a rather interesting situation where the demand for elk hunting is real high. In 1984 we offered 100 either-sex Roosevelt elk permits and we had over 13,000 people apply. Fortunately, I was one of the lucky. This year we're going to offer one hunt in California, and it's going to be ten permits, so you can imagine the demand for that.

We have a very vocal segment of our population that believes elk, especially Tule elk, should be for nonconsumptive use only. They have managed to get state law passed which requires the Department of Fish and Game to relocate Tule elk throughout the state. We don't authorize a take of Tule elk until their numbers exceed 2,000. We need a 400 calf drop this year. We're trying not to lose control in the management of Tule elk as their numbers approach 2,000. There is strong sentiment and these people may try to lobby the legislature and get the number increased to 4,000. We have a situation now where, of 17 Tule elk herds, seven are causing significant depredation problems. California does not pay any damages nor do we allow depredation permits to take offending Tule elk. Essentially, the ranchers and farmers are asked to sort of grin and bear it. Needless to say we've been threatened with lawsuits.

Currently, we have four ongoing research projects involving elk. We have one in Humboldt County, a two-year study to develop a management plan for that herd and three survey-inventory studies on various herds. There's one major study we're just entering into to determine deer and Tule elk interactions.

WRITTEN REPORT - CA

There are approximately 5,600 elk in California (1,500 Rocky Mountain, 2,500 Roosevelt and 1,600 Tule). Ninety-five percent of the Department of Fish and Game's management activities are directed towards Tule elk. Current state law prevents the Fish and Game Commission from authorizing the take of Tule elk until their statewide numbers exceed 2,000. Additionally the law requires that the Department relocate Tule elk in an effort to increase their numbers. This law has resulted in massive Tule elk relocations and monitoring programs. For example, the Department relocated over 250 Tule elk in 1986. The cost of the 1985 Tule elk management program exceeded $350,000. Currently the Department is contracting through various state universities to monitor three Tule elk herds and is in the process of developing a study plan to investigate interactions between Tule elk and deer in California (in 1984 over 13,000 applications were received for 100 elk tags). The Department is currently evaluating all management options in anticipation of exceeding the 2,000 Tule elk threshold in the near future.

The Department, in cooperation with Humboldt State University, is currently monitoring a population of Roosevelt elk in Humboldt County. The final product of this effort will be a management plan for this elk herd which is found on private timber company lands. It is anticipated more monitoring of elk herds will take place in northern California over the next few years. Hopefully, the result of these investigations will provide for more recreational use, both consumptive and non-consumptive, of the state's elk resource.

Don Koch

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: Donald Koch — California (State or Province)

No. of Wintering Elk (note species) tule: 1,600   R.M. 1,500   Roos. 2,500   Comment: ____

Bulls/100 Cows (winter) ____ Range 30 to 52 Comment: Tule elk composition counts only - 16 herds.

Calves/100 Cows (winter) ____ Range 16 to 40 Comment: Tule elk composition counts only - 16 herds.

Resident Tags, Rifle* 100   Bow ____   Total ____

Non-Resident Tags, Rifle* 0   Bow 0   Total 0
(*incl. muzzleloader)

No 1985 elk hunts in CA   Grand Total 100* (1984)

Comment: State law prevents hunting Tule elk until their numbers exceed 2,000 - Special R.M. hunt resulted 13,000 applications for 100 tags.

Take of Bulls, Rifle 34   Bow ____   Total ____

Take of Antlerless, Rifle 15   Bow ____   Total ____

Grand Total 49

Comment: Twenty-nine of the 34 bulls were 5 pts. or better - Hopefully we will have a 1986 hunt.

Bull Hunter Success 34 percent   Total Hunter Success 49 percent.

How is Harvest Data Obtained? Mandatory check station.

What Census Methods Used? (Sample Size) Tule elk - fixed wing and helicopter counts. Currently we are developing census techniques for Roosevelt elk through contract with Humboldt State University.

Percent of Hunting by Drawing: 100 percent

Contact Person for Mgt./Research Information: Don Koch, Department of Fish and Game, 1416 Ninth Street, Sacramento, CA 95814.

Ongoing Research Subjects and Investigations:

Monitoring (daily - radio - telemetry) 3 Tule elk herds.

Monitoring Roosevelt Elk in Humboldt Co. via contract with Humboldt State University.

Recent Elk Publications:

Tule Elk Report to the CA Legislature.

ORAL REPORT - Grant Jence

Utah in the past has not had many elk. By the turn of the century, with settlement, development and the advent of livestock introduced into the state, we've pretty well eliminated all the elk except for a small remnant population in the northwest corner of the state.

To re-establish elk, we started an interstate transplant program 1912-1925 and we brought in 200 head of elk and located them in 10-12 areas. So these were small herds, sometimes a dozen head here and there which meant a real slow start. Then, from 1929 to 1950, we moved another 165 head of elk around within the state. Still, we're dealing with quite low elk numbers.

The first hunt started in 1925. From then until 1966, the elk hunting in Utah was pretty limited. In 1966, we only had 2,302 elk permits with 910 elk harvested. It was pretty limited. The bull:cow ratio was great; the cow:calf ratio was great, but the opportunity was not there to hunt elk. Very few people could participate, and we had little backing and little interest in elk hunting in Utah.

Utah had always traditionally been known as a mule deer state. In 1967, we changed our management of elk to a general bull season and this caused quite a stir. Prior to 1967, you had to draw a permit on a quota system with a five-year waiting period. If a person drew a permit, then he'd have to wait five more years for the opportunity to apply for another. My father drew one in his whole lifetime.

When we went into a general bull hunting season in 1967, we estimated there were 6,000 elk in all of Utah. This kind of strategy proliferated until 1970 when almost the entire state was under this management system with basically 15 hunting units. We shifted the hunting pressure off the cows and onto the bulls. Before, with the system of drawings, there was always enough antlerless permits issued to suppress the herds. We more or less had a stacked deck against elk in the state. We had substantial resistance to elk increases. There was a lot of resistance from land management agencies and livestock communities. So, the elk program was suppressed. People mused, "there's a lot of hunters in the field with a chance to eliminate elk." Well, it didn't work that way.

Elk populations increased in number and expanded, and as the interest grew for elk hunting, the hunting pressure increased, which resulted in pushing elk into new areas. So, in 1986, we've gone from 13 management units with 6,000 head of elk to approximately 30,000 elk in 33 management units. We feel like we're on a roll right now, and if we can keep the momentum going for the next 5-10 years, we'll push these herds to 50-60,000 elk.

Reasons for success in the last few years have been essentially twofold; some of our old-timers have retired and the younger guys are a lot more interested in elk. And, we've had a definite change in interest from the public. We have lots more support for elk, and a lot more interest in elk hunting. The representatives from the land management agencies who are making the decisions come from a diverse background instead of just agriculture, I'm not being derogatory about ranchers, but if you're raising beef, you don't raise elk. There's definitely been a shift in the livestock community and among private landowners. Now a lot of them are seeing elk as an asset instead of a liability. The old thing of economics and politics is back into it instead of it just being ecology. One of our board members has been on the board of the game control for 17 years, as a woolgrower representative. He leased his property to elk hunters last fall for $20,000. All of a sudden, that's an asset and he was real easy on us last year on our recommendations. So, things have changed.

The general bull season has been good as far as numbers and distribution of elk in the state, but there are drawbacks. With almost all the hunting pressure on the bull segment, we've turned bulls over quite rapidly. In the 1985 season, 72 percent of our total harvest was made up of yearling bulls. Most people in Utah in the past didn't have an opportunity to hunt, so I suppose they're real happy just being able to kill an elk. However, we're getting a greater demand each year for people wanting to kill mature animals in the trophy class. We're starting to set more of these areas aside.

We're developing elk management plans for all our units presently. We're getting public input to determine their desires in providing a diverse experience, not just an opportunity for hunting elk; not just one type of hunting but addressing different strategies to meet their demands.

<u>WRITTEN REPORT</u> - UT

Elk were prevalent throughout the mountainous areas of northern and central Utah prior to settlement by European man. Unrestricted hunting following settlement eliminated most of the elk from Utah by the turn of the century. Only a remnant population remained in the Uinta Mountains.

To re-establish elk in the state, interstate elk transplants were initiated. Between 1912 and 1925, 200 head of elk were brought into the state, mostly from Yellowstone National Park and Jackson, Wyoming, and they were released in ten areas around the state. Between 1929 and 1950, an additional 165 head were relocated within the state on 12 areas.

Elk hunting opportunity prior to 1967 was very limited. In 1966, 2,302 elk permits were issued and 910 elk were harvested. Permits were issued under a quota system on a unit basis. A permittee had to draw for the opportunity to hunt and a five-year waiting period was imposed on all elk permittees.

In 1967, part of the elk management units were put into a general season bull permit hunting strategy, and by 1970, the majority of units were being hunted under this system. At the inception of general season bull permit hunting, the state's elk population was estimated at about 6,000 head. Under the permit quota system, sufficient antlerless permits were issued each year to keep elk herds suppressed from 1925 to 1966.

During the past 20 years, substantial progress has been made. Elk numbers have increased from about 6,000 head on 13 management units to approximately 30,000 head on 33 management units. Hunter numbers have also increased to about 30,000. By putting most of the hunting pressure on the bull segment, the herds were released and started to expand. With increases in elk numbers and hunting pressure, elk moved into adjacent areas. Due to a combination of natural movement and transplants of more than 800 animals since 1973, elk now inhabit the majority of suitable range in the state. If this trend continues for the next five to ten years, the majority of habitat should be filled with a total population of 50,000-60,000 head.

At least part of the success for increased elk numbers in the state can be attributed to a change in attitude towards elk. Utah has traditionally been a mule deer state. There has been some resistance to increasing elk numbers by past Division of Wildlife Resources employees and there has been a substantial amount of resistance from the livestock community and land managing agencies. Many landowners now perceive elk as an asset instead of liability. Personnel in land managing agencies now come from a diverse background, not strictly from agriculture. Also, elk hunting is becoming very popular in Utah. Hunters are demanding more opportunity.

General season bull permit hunting has been good for increasing Utah's elk herds; however, it does have some drawbacks. With most of the hunting pressure on bulls, this segment of the herd is turned over rapidly with 72 percent of the 1985 harvest being yearling bulls. Most elk hunters in Utah are happy with being able to kill an elk. However, there is an increasing demand for more mature bulls and the opportunity to hunt under less crowded conditions.

Utah is presently developing management plans for each of its elk units. Various methods are being used to get public input and an attempt will be made to provide a diversity in hunting opportunity to try to satisfy the desires of the various publics.

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: Grant K. Jense — Utah (State or Province)

No. of Wintering Elk (note species) 30,000 R.M. 1985 estimate Comment: We are trying to increase elk on the majority of management units.

Bulls/100 Cows (preseason) 19 Range 6 to 38 Comment: We are turning over our bulls on general season units at a rapid rate. We have good bull/cow ratios on limited permit areas.

Calves/100 Cows (winter) 51 Range 39 to 60 Comment: Generally averages about 50; may decrease slightly during dry years.

Resident Tags, Rifle* 27,878 Bow 2,082 Total 29,960

Non-Resident Tags, Rifle* 602 Bow Not broken out Total 602
(*incl. muzzleloader)

Grand Total ______

Comment: Two hundred and fifty (250) muzzleloader permits were available for the first time in 1985. Total permit sales are slowly increasing.

Take of Bulls, Rifle 4,586 Bow 147 Total 4,733

Take of Antlerless, Rifle 856 Bow 42 Total 898

Grand Total 5,631

Comment: Utah's elk herds are slowing increasing and permit numbers and harvest are somewhat paralleling the increase.

Bull Hunter Success 18 percent Total Hunter Success 20 percent.

How is Harvest Data Obtained? By mailed questionnaires with one follow-up.

What Census Methods Used? (Sample Size) Aerial trend counts are made with a Cessna 185 aircraft on each management unit. Winter concentration areas are searched under good snow cover.

Percent of Hunting by Drawing: 8 percent

Contact Person for Mgt./Research Information: Grant K. Jense (801) 533-9333, ext. 276 1596 W. North Temple, Salt Lake City, Utah 84116

Other Comments: Management plans are presently being developed for all management units. A goal is to balance limited permit (quality) hunting opportunity with general bull hunting.

Ongoing Research Subjects and Investigations:

Utah has ongoing research at Hardware Ranch that deals with elk productivity. Various drugs being used for tranquilizing and immobilizing elk are being tested at the ranch. There are presently two telemetry-migration and habitat use studies on two National Forests to assist land managers in land use management decisions.

Recent Elk Publications:

Comparison of InVivo and InVitro Digestibility of Forages by Elk. Journal of Animal Science, Vol. 58, No. 4, April 1984.

COLORADO

ORAL REPORT - Jim Olterman

Colorado is in the same boat with many of the other reports that I've heard here today. In fact, I could just about substitute the Colorado report for some of those. We're in the throes of some significant changes in elk management in Colorado at the present time. We, as managers, all know that there's a whole spectrum of management prescriptions that will work, or can be made to work.

Our Wildlife Commission this year thought of one that hadn't been thought of, so, we have a brand new system to work with in Colorado. We're going to go to a lot more quality-type elk management. The people of Colorado are telling us everyday that they want to see that type of management. They're a little bit frustrated with hunting spike bull elk. In the past, we've managed for maximum turnover rates in elk populations. We've had unlimited bull hunting and we've watched bull:cow ratios decrease to extremely low levels, in some cases as few as two bulls per 100 cows post hunt. The public is finding that unacceptable, so our Commission did respond this year with a three-part system that will be in place for at least the next three years in Colorado. There will be a combined season offering deer and elk to be hunted at the same time. A hunter must select one of three seasons. If he hunts deer, he must hunt his deer and elk at the same time. The first season will be a five-day season restricted to four-point bull elk and larger statewide with a few exceptions. The second season is 12 days. It is also restricted to four-point bull elk and larger. There will be some antlerless licenses offered on a drawing basis in that second season; there will be no antlerless licenses in the first season. The third season will be a nine-day season, and managers have the option of going with an extension of the four-point restriction if it's necessary to increase bull:cow ratios. There are a couple of reasons why we might want to do that, and I'll mention those briefly in just a second.

The Commission just elected to implement pretty much as we recommended this year. We're going with 34 units this year with the four-point restriction in all three seasons. So, there will be no yearling elk taken in any of those units. That means we'll have about one-third the kill in Colorado that we've experienced in the past. We have an additional 23 units that are being managed on a quality basis, totally limited licenses for antlered and antlerless elk. The goal in these units is to achieve about 35 bulls per 100 cows posthunt. We've reduced the hunting pressure significantly in those units. In some cases, like one of the units I manage, we've gone from almost 3,000 bull hunters to 300. We're getting an instant response in terms of surviving bulls. The hunters can look for two things if they draw a license in one of those units. They can hunt in relatively uncrowded conditions. It's really a thrill for people to be able to go out and hunt for almost the entire season and never see another hunter.

And they will have opportunity, and the longer the strategy is in place, to take a good quality bull elk. We're going to put some elk from these units into the Boone and Crockett record book in the next few years, there's no doubt about it. We're really starting to see some response in these areas. So, the public has made those demands on us and I see the Division of Wildlife responding to that.

Obviously, we're going to see a reduced harvest rate in Colorado. Elk hunting is big business there, it's controversial. We're looking at license revenue in 1984 of $11.6 million just from elk hunters. That's a total $34 million budget if you count federal aid, so elk is big business rivaling the ski industry. It's about a $1 billion industry in Colorado if you do all the things that economists do with the money.

In addition to these rifle seasons, there will be archery hunting, which is a very liberal season, August 16 through September 20. The August portion is bulls only. The antler restrictions that are in place for the rifle hunters will also apply to the archery and the muzzleloader hunters. So, if this restriction applies to a unit, it applies to everybody who hunts in that unit. Muzzleloader hunting, with a few exceptions, is essentially statewide September 7 through September 20, with 5,000 licenses. The new thing this year will be either-sex licenses. So that will be a real meat hunt. I expect to see the applications go up.

We are working under a preference system in Colorado. If an individual does not draw a license to hunt in one of these limited units this year, he gets a preference point for next year's drawing to be ahead of those that did hunt this year. Eventually, he will get a license if he keeps applying for a particular unit of his choice. He's going to get one as he builds more and more points. We have enough licenses for muzzleloaders, it's about an every other year hunt when applying for an elk muzzleloader license. If you don't draw one this year, then you'd just about be guaranteed getting one next year.

I do think there are certain biological considerations, and those of you who have done some law enforcement know that there are two types of evidence required if you deal with civil court. You have to present a preponderance of evidence. If you're dealing with criminal court, you have to provide evidence that is greater than a reasonable doubt. If you're a manager in wildlife, you only have to deal with preponderance of evidence. If you're a researcher, you have to go beyond a "shadow of a doubt." So, the manager, and most of them are field biologists, believe that we are seeing some biological problems associated with these extremely low bull:cow ratios. I've been weighing calves that we get in our trapping operations the last two or three years. I've weighed about 100 calves in the last two years and I've seen weights from 141 to over 300 pounds. To me, this means that we're probably dealing with three age classes of calf elk in Colorado, and there's a lot of them in each age class. Some of these calves are being born as late as August, and those little guys aren't going to make the winter. We think this is a relatively new thing and we associate that with these very low post-hunt bull:cow ratios. In other words, we're relying on yearling bulls to do the breeding in Colorado in many cases. It's going to be very interesting to see if changes occur as we go into this new type management.

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: Jim Olterman — Colorado (State or Province)

No. of Wintering Elk (note species): Rocky Mountain 132,325 Comment: This is the 1985 post-season population objective.

Bulls/100 Cows (winter) 17.6 Range 2.7 to 88 Comment: Many major elk populations suffer from chronic low bull/100 cow ratios that result from long term heavy male harvest.

Calves/100 Cows (winter) 55.6 Range 41 to 67 Comment: We feel low bull/100 cow ratios are having a negative effect on calf survival.

Resident Tags, Rifle* 113,934 Bow 6,937 Total 120,871

1984 Season

Non-Resident Tags, Rifle* 39,181 Bow 3,674 Total 42,855
(*incl. muzzleloader)

Grand Total 163,726

Comment: License sales are down from 1983 levels as a result of a license fee increase.

Take of Bulls, Rifle 17,023 Bow 733 Total 17,756

1984 Season

Take of Antlerless, Rifle 11,449 Bow 580 Total 12,029

Grand Total 29,785

Comment: In 1984 we saw nearly the same total kill with 15 percent fewer hunters.

Bull Hunter Success 17 percent Total Hunter Success 21 percent.

How is Harvest Data Obtained? Random mail survey.

What Census Methods Used? (Sample Size) Pre-season sex and age ratio counts (3-5,000)

Post-season sex and age ratio counts (45-50,000).

Computer simulation models (POP-2)

Percent of Hunting by Drawing: 39 percent — All Muzzleloading; Archery & Rifle Licenses in Quailty El Areas; All Antlerless Licenses

Contact Person for Mgt./Research Information: Management: Bob Hernbrode

Research: Len Carpenter

Other Comments: In 1986 we are recommending that all over-the-count license sales (those sold by license agents with no limitations) be sampled by a telephone survey.

Ongoing Research Subjects and Investigations:

G. D. Bear - Elk Population and Ecology Studies

D. S. Freddy - Evaluation of Elk Harvest Methodology (first year)

D. L. Baker and N. T. Hobbs - Impact of Elk Winter Grazing on Livestock Production (first year).

Recent Elk Publications:

Baker, D. L., and D. R. Hansen. 1984. Comparative digestion of grass in mule deer a elk. This manuscript was published in J. Wildl. Manage. 1985. 49(1):77-79.

Bear, G. D. 1984. Expanding telemetry collar for elk calves. Colo. Div. Game Info. Leafl. No progress was made on this manuscript.

Bear, G. D. 1985. Mark-recapture method applied to elk population estimate. J. Wil Manage. The second draft of this manuscript is being prepared.

ARIZONA

ORAL REPORT - Raymond Lee

Some of you are probably wondering how elk even got to Arizona. About the 1890's, Arizona was home to Merriam's elk. The species became extinct in about the late 1890's. From then until about 1913, Arizona apparently had no elk at all. One of our elk biologists in 1913 ordered 86 elk from Yellowstone. Those were transplanted into the White Mountain area of Arizona, and it's from that transplant that all of Arizona's herds have pretty much originated.

The first elk hunt in Arizona was held in 1935. We had 276 limited entry permits and we continue our limited entry permits now. We harvest about 145 bulls. The hunts continued the same way until 1958 when we came up with a trophy bull hunt. This was a four-point or better, and this is the same way we run our trophy bull hunts now. We're looking at a trophy fee in the future for our trophy hunts. The demand is extremely high and we're attempting to get the hunter in the pocketbook a little bit to see if he wants to pay for the opportunity to take a trophy bull.

About the beginning of the 1980's, most of the states went to a planning program. This is something Arizona did as well with their big game strategic plans; five-year plans. At that time Arizona identified a population of 10,500 elk in approximately 7,000 square miles of habitat. Eighty-three percent of that land was U.S. Forest Service land and only 11 percent was private land. Annual harvest was determined to be about 12 percent of the total population, and archery harvest was set at 15 percent of the total harvest. We recognized several problems, one of which was use of any elk permits to obtain optimum population levels. Last year we went away from any elk permits to an antlerless permit. Now we have only bull and antlerless permits. This allows us a little bit better control of our harvest as well as more permits.

During that original planning, we looked at research into elk movements, wounding rates and crippling losses for the different weapon types. We also attempted to standardize management guidelines with hunting seasons and permit numbers, or a way to determine permit numbers. This led us to our elk management guidelines, which determined our survey times and effort, also our permit recommendations, what our bull:cow ratios should be pre- and post-hunts and they also dealt with elk depredation.

Arizona, like I said, has only 11 percent of the total habitat on private land. Like California, we make no depredation payments. Elk are considered an act of God; if you have them on your land and they're eating it up, that's too bad. I'm sure that like most other states, we are going to be drawn more actively into depredation work of some sort in the very near future. Our harvest levels for the last several years have been increasing spectacularly. 1983 was a record harvest; 1984 was a record harvest, and this year, 1985 was a record harvest for us. The numbers that you have in your handout were from last year. Updating those somewhat, our total harvest increased to 3,957, almost a 1,000 elk increase over the last year. Our hunt success requirement last year was 52 percent, about the highest I saw in the various states.

We are now into our 1986-to-1990 strategic plans; they have not been passed by the Commission yet, so while we're almost into our 1986 seasons or the permit setting period of it, we are not working on those plans yet. Those plans recognize 16,500 elk, a nearly 60 percent increase, but the habitat has dropped from 7,000 to approximately 6,000 square miles. Our survey trends for the last 12 years indicate an increase in total elk surveyed from about 1,200 to 2,200, but we also have an increase in spikes per 100 bulls from 35-45 and a decrease in the bull:cow ratio from about 38 to 30 per 100. This suggests that we're potentially overharvesting or harvesting in excess of what our bull recruitment rate is. Applications during this period have increased 157 percent. Fortunately, the harvest has increased 156 percent so we're not doing too badly there. Essentially all of the increase in permits in these 12 years, a 48 percent increase, has been in the archery sector.

Muzzleloading demand; we have a 200 permit muzzleloader hunt. Basically we have six applicants for each permit. In archery we have about two applicants per permit, and in firearms we have about 13 applicants per permit.

We have a great increase in elk numbers. We attribute this primarily to range practices and timber harvest practices. They've increased the timber cutting in Arizona and this has opened up a lot of areas. Unfortunately, while it's good for elk, it's very bad for other species, particularly the turkey. The new management plans will give us a basic management alternative, a vulnerable species alternative, and what we call an alternative species proposal. These are set on the number of bulls per 100 cows that we're looking at seeing in pre- and post-hunt ratios, a success factor as well as an age factor in the harvest. Potentially 25 percent of the elk harvested would be two years old or older.

Things we're seeing in the future: Arizona is extremely active in wildlife prostitution. We have ten special permits, but we sell permits for revenue. We've been running them through a conservation organization and they've been raffling or auctioning them for us. In the past couple of years, we've been getting about $150,000 a year from that. The Rocky Mountain Elk Foundation did an extremely good job for us this year. The permit they raffled went for $17,505. With the two permits that we had for elk, we raised over $22,000. The monies are earmarked for elk management projects. Primary research we're doing right now involves an elk collared with a transmitter which interacts with the French NASA-Argo satellite. This is satellite tracking of elk or big game species at its finest. It's provided us with a great deal of movement information and has also provided us with a lot of expertise in international relations as well.

WRITTEN REPORT - AZ

HISTORY

Through the 1890's, Arizona was home to the Merriam's elk. This species became extinct in the late 1890's. From then until 1913, there were apparently no elk in Arizona. The Winslow Elk Lodge transplanted 86 elk from Yellowstone in 1913. Another 217 elk were transplanted from 1913 to 1928; these transplants formed the basis of today's herds.

The first elk hunt was held in 1935 with 276 permits issued and a harvest of 145 bulls. September trophy hunts were added in 1958. Elk harvest and hunter numbers have been steadily increasing since 1935.

PLANNING

During the late 1970's, Arizona, like many other states began an active planning program. This program resulted in a document entitled "1980-85 BIG GAME STRATEGIC PLAN." These plans addressed the state's ten big game species. The section on elk identified the following points: (1) A population of 10,500 elk; 6,884 square miles of habitat, comprised of 83 percent USFS land with 11 percent private land. (2) An annual harvest estimated at 12 percent of the population. (3) An archery harvest set at 15 percent of the total harvest. (4) Regulation of the use of "Any" elk permits to obtain optimum populations levels. (5) Recognition that significant populations of elk occur on Indian Reservations. (6) Research was needed to study elk movements and to determine crippling losses for different weapon types. (7) Standarized guidelines for determining hunting seasons and permit numbers must be determined.

Standarized procedures were developed in the form of "ELK MANAGEMENT GUIDELINES" in 1983. These guidelines addressed such management activities as surveys, permit recommendation procedures and depredation complaints. Guidelines for these subjects were established as follows: Surveys - prehunt surveys would determine recruitement rates and herd composition; these surveys would be run 8/15-9/20 from vehicle, horseback, or foot; a 20 percent population sample is considered adequate. Posthunt surveys would determine population levels and wintering areas; these aerial surveys would be run 12/15-3/15. Permit Recommendations - Posthunt surveys should result in Bull:Cow ratios of 15-20:100 and a 25:100 ratio on preseason surveys the following year. Permit recommendations will not be issued on the basis of hunt success. Elk depredation on private lands - in cases of significant depredation, elk will be discouraged by fencing, harrassment and added forage on adjacent public lands. Special hunts may be authorized. Where problems persist and the elk are desirable, land acquisition will be attemped.

The second generation of the BIG GAME STRATEGIC PLANS were established for 1986-90. These new plans emphasized the following points for elk: (1) A population of 16,500 elk; 5,900 square miles of habitat comprised of 81 percent USFS land with 11 percent private land. (2) Survey trends for 12 years indicate an increase in total elk surveyed (1,250 to 2,250); an increase in spikes:100 bulls (35 to 45) and a decrease in bulls:100 cows (38 to 30).

This data suggests a harvest of bulls slightly greater than recruitment. (3) Appplications for permits increased 157 percent - Fortunately harvest increased 156 percent. Essentially all the increase in permits has been in archery. (4) Muzzleloader demand was 5.7 applicants for each permit. Archery demand was 2.41 for Any, 1.42 for Antlerless and .81 for Bull. Firearms demand was Any 13.01, Antlerless 9.11, Bull 2.54 and Trophy Bull 13.9 applicants per permit. (5) Increases in elk numbers have been attributed to increased timber harvest in the forest (though this appears particularly detrimental to other species, primarily turkey). (6) Management will be accomplished on a herd unit basis with the following criteria: Basic management will result in a 10-15:100 bull to cow ratio on post-hunt surveys; at least 25 percent of the total post-hunt bulls will be two years old; rifle hunt success should be 20-35 percent (Bull), 20-50 percent (Trophy Bull), and 30-70 percent (Any). Alternative management will result in a 20-35:100 post-hunt bull to cow ratio; 25 percent of the bulls should be more than two years. Vulnerable Species management will result in 25+:100 bull to cow ratios post-hunt.

HARVEST

Harvest levels for the last several years have been steadily increasing. During the preceding five years, firearm permits have averaged 6,116 and archery permits averaged 3,604. Total elk harvest averaged 2,783 with bull harvest comprising 74.3 percent of the total at 2,067. Firearm hunt success averaged 39.5 percent, with archery success running 10.1 percent.

The totals for 1985 reflect the increase in permits to 10,720. Total harvest increased to 3,957 (2,106 bulls) with a firearm hunt success of 52 percent (13 percent archery). These 1985 totals represent historical highs for Arizona.

FUTURE

Arizona is presently involved with several exciting new ideas for funding and research. Special permits were allocated for auction to provide funds earmarked for elk management projects. The sale of these two such permits produced $22,350, with over $17,500 coming from one permit. Our research branch presently has a collared elk with the transmitter interacting with the French ARGOS satellite. This satellite tracking of elk movements has provided a great deal of new information to us - not the least in international relations.

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: Raymond Lee — Arizona (State or Province)

No. of Wintering Elk (note species) 16,000 R.M. Comment: Forestry practices and favorable weather are allowing significant increases in elk numbers to the detriment of Department/rancher relocations.

Bulls/100 Cows (winter) 30 Range 22 to 40 Comment: Management guidelines call for post-hunt ratios of 15-20:100 and pre-hunt ratios of 25:100. These guidelines have not been met due to increased antlerless harvest to demonstrate department intentions to control elk numbers.

Calves/100 Cows (winter) 54 Range ___ to ___ Comment:

Resident Tags, Rifle* 6930(200)(2) Bow 3,810 Total 10,942

Non-Resident Tags, Rifle* ___ Bow ___ Total ___
(*incl. muzzleloader)

Grand Total 10,942

Comment: No tags are set aside by residency requirements; 200 tags are muzzleloader only; 2 tags are "fundraisers", producing $20,000.

Take of Bulls, Rifle 2,059 Bow 311 Total 2,370

Take of Antlerless, Rifle 533 Bow 92 Total 625

Grand Total 2,995

Comment: This represents Arizona's record elk harvest.

Bull Hunter Success 27.2 percent Total Hunter Success 31.5 percent

How is Harvest Data Obtained? Mailed questionnaire sent to each elk hunter. Returns average 65 percent.

What Census Methods Used? (Sample Size) Winter helicopter surveys classify approximately 2,500 animals. Horseback and foot surveys are systematically run for population trends.

Percent of Hunting by Drawing: 100 percent

Contact Person for Mgt./Research Information: Raymond Lee, 2222 W. Greenway Road, PHX, AZ 85023. 942-3000 x237

Other Comments: Arizona presently offers muzzleloader only, archery only and trophy bull hunts along with its general firearms seasons for bull-only or anterless-only permits.

Ongoing Research Subjects and Investigations:

Effects of timber management practices on elk.

Elk seasonal ranges and migrations. Richard Brown, Arizona Game and Fish, Research Department.

Cattle-elk interations in the national forest. Paul Krausman, U of Arizona.

NEW MEXICO

ELK STATUS
1986 Western States and Provinces
Elk Workshop

Attending Representative's Name: ______________ New Mexico
State or Province

No. of Wintering
Elk (note species) 30,000 ______ Comment: Very rough estimate.

Bulls/100 Cows (winter) 15 Range 6 to 40 Comment: Sample size may influence ratios in same units.

Calves/100 Cows (winter) 37 Range 16 to 63 Comment: Sample size may influence ratios in some units.

Resident Tags, Rifle* ______ Bow ______ Total 10,123

Non-Resident Tags, Rifle* ______ Bow ______ Total 2,222
(*incl. muzzleloader)

Totals: 10,194 2,106

Grand Total 12,345

Comment: Resident, non-resident license sales are not available by weapon type.

Take of Bulls, Rifle 1,986 Bow 71 Total 2,057

Take of Antlerless, Rifle 700 Bow 614 Total 1,314

Grand Total 3,371

Bull Hunter Success ______ Total Hunter Success 29.3 percent

How is Harvest Data Obtained? Questionnaire survey mailed to 100 percent of elk licensees.

What Census Methods Used? (Sample Size) Random aerial survey for winter herd composition - 1985 (January) survey classified 6,098 animals in 13 units at 15 bulls/100 cows/37 calves

Percent of Hunting by Drawing: 100 percent

Contact Person for Mgt./Research Information: Wally Haussamen - New Mexico Dept. of Game and Fish, Village Bldg., Sante Fe, NM 87503

STATUS REPORT DISCUSSION SESSION

Question: Montana, you spoke to a threshold of 5 percent bulls, where productivity seems to fall off. May I assume you are speaking about 5 bulls per 100 cows when you use a percentage figure like that?

Answer: I mentioned a hypothesis we will be looking at, or are looking at. When the level drops below 5 percent bulls, that's 5 percent of the population, not 5 bulls per 100 cows.

Question: Okay, I guess. I have a little difficulty trying to equate that with bulls per hundred cows when you don't know how large the component of calves is. Also perhaps you would give us some information for our benefit on your perspective of what the age class composition should be of that breeding bull component.

Answer: That percentage figure you say is going to vary depending on the cow/calf ratios; that 5 percent bulls may differ somewhat from area to area, depending on the sex ratios in the various herds. What we're looking at in this study in southwestern Montana is just if this is a magic number or not, and it's something we are going to test to find out just what changes there may be. It's something of an unknown, I guess. We had to come up with a figure or a number to start with and 5 percent is what we settled on. What was your other question?

Question: For Oregon, we pondered the same thing; where is that breaking point? In the real data from the field, we can find low bull ratios with high calf outputs, we can find high bull ratios with low calf outputs. So, I just wondered if you had any hard data yet that reflects on that bull component, deals with age class, and kind of gives us a stronger handle on whether three bulls per cows, five bulls per 100 cows or one four-plus in the breeding season, if that's the breaking point?

Answer: That's something we've wrestled with a great deal ourselves in Colorado. We have been identifing problems for the last eight years. Bull ratios have been less than 5 per 100 cows at the end of the season. When we looked at the relationship between cow/calf, bull/calf, bull/cow ratios, we found that there is indeed a relationship, but it's not clearcut. In other words, there are other factors involved in this. There are also other issues involved. One is public satisfaction, hunter satisfaction. What we saw is as the bull/cow ratio dropped below about five to seven, we do see a real drop off in calf crops. You also see a great deal of increase in hunter complaints.

So, when we designed our hunt seasons, the criteria that was used this year to satisfy those areas in which we would maintain the antler restrictions, we set an arbitrary number of about eight bulls post-season. That gave us an objective to shoot at, and also it seems to be kind of a line of demarcation where satisfaction seems to be pretty good.

It's one of those basic questions that has always been there, how many bulls does it take, or how many bucks does it take. I think we had two bucks per 100 does post season two years ago in some of that country where we had hard winter followed by a heavy hunter take, then the next year's fawn crop was 61. So two bucks is obviously enough. Biologically, it is not satisfactory, but it is probably enough.

Question: I'm going to take a great risk here and mention bowhunting. Anytime anybody deals with the subject of bowhunting, he risks getting bloody or at least bruised. One of the problems we addressed in Oregon this year has been identified as season opportunists that associate themselves with the bowhunting season, which is long and liberal. The problems that have been identified associated with that season are the use of firearms and hunting without a tag--party hunting, for example, on elk. Most everything else is not governed by tags and is available to hunting. I would like to ask the group of State and Provincial representatives if any of them feel that special bowhunting seasons offered in their respective areas have problems like have been identified in Oregon. Maybe someone has found rules or systems that might effectively discourage these season opportunists.

Answer: I don't know how it operates here in Oregon, but in Colorado we have the one and only hunt concept. If an individual hunts with a bow and arrow during the archery season, then he cannot hunt during any rifle season. That's his hunt for the year. Basically, that's the reason we went to the season structure we talked about. We feel now that we've boiled archery hunting down to the real archery users, the people who are willing to practice with a bow. I think it's cut our wounding loss quite a bit. I think the archery people in Colorado are very happy that we've gone that way too. They think now that their sport presents an image of a much cleaner type individual. It's not a person like me who picks a bow up one day and goes out hunting the next day, not being able to hit my hat on the ground. In fact, I was one of those people who was weeded out when we went to one hunt type season because I'm just not willing to spend the amount of time it takes. I really feel that Colorado now has a fairly clean archery season. We've got five or six Colorado people here who are field guides. I'm sure that they'd be happy to talk about that too.

Question: Ray talked about some studies that documented the differences in wounding loss to the various methodology. I'd be most interested in that because that's one of the things we've tried to wrestle with, one of the things that's never, to my knowledge, been quantified.

Answer: I'm sure most of you are pretty much aware of quite a few of the wounding studies that have been done in the past, primarily with controlled herds in small areas when they were able to have check stations, go back into the field, and look at the results. What we did in Arizona is, we sent out a hunter questionnaire survey card to each of the people who were drawn for archery, muzzleloader, or firearms for elk. We got a very good return on this. We also have hunter check stations in many cases. Realize that the question on the hunter card is "did you shoot an elk that you did not recover"? We are trying not to ask if they wounded one. We're trying to get away from the sociological problems with that. We got a very good return. We did put together a little report that gave differential wounding rates for these animals. What I like to use is the term "wounding rate" as opposed to wounding loss because that gets you a little bit away from, "well an arrow doesn't kill as much as a bullet does," or "a musketball, if it hits and doesn't kill, it's not as bad." What we found, and again this is a voluntary report by the hunters, we found that for every elk harvested and returned by an archer, there was another elk in the field with an arrow in it. Now, whether that elk died or not, we're not making any statements on that. There's just one stuck for every one brought in. That was 12 times what the reported wounding rate was for the firearm.

The next thing that comes out is people say "well the elk is right here 50 yards away or less and you're shooting at it with a bow." "It could be a thousand yards away when you're shooting at it with a gun, you don't know if you wounded it." These are all things we had to look at, but these were the figures that we got back.

Muzzleloaders reported that they had wounded them at three times the rate that the firearms did or one-quarter the rate the archers did. It was interesting to us to see what happened with that voluntary response the very next year. The muzzleloader hunt the first year was considered a very dirty hunt by our field people. Muzzleloaders are a relatively tightly-knit group in Arizona. It was passed around that when they got their survey card the next year to say "no", and results on that dropped approximately to one-quarter of what they were the first year. However, we had kind of tricked them because we had also done it the year before. So, we had two years of data before they were able to make that change. That's the results from our study, and if anybody is interested in it, write to me and I'll try to get the report to you.

Question: Could you repeat those ratios again.

Answer: For every hundred elk out there, for every one that you wound with a firearm, you're going to wound three of them with a muzzleloader and 12 of them with a bow for the same number of animals harvested.

Question: Before you run off, you talked about the satellite telemetry. How many radios do you have out? What are you looking for, just movement, or habitat sites or whatever. Can you just explain what you're looking for and how you're going about it? I don't know anything about that sort of thing.

Answer: The French and NASA got together and launched a satellite called the ARGOS satellite. We have one radio collar out, so hopefully we're not going to lose it any year soon. The radio collar is much larger than normal. It has a transmitter powerful enough to hit the satellite each time it comes over. The satellite then transmits the data to Tolouse, France. Then we try to get the data back from France. It's been difficult but it is coming back to us. Telonics is the one that puts out the radio collar. What we're looking at being able to do is to come up with a system where we can send the signal from the elk to the satellite and back to Arizona. We hope to get that pretty quickly. What we're doing primarily, since this is just a test procedure right now, is we're just seeing if it will work and we're trying to determine home range and movement of the elk. Once we've got that, we're coming up with a series of GIS maps for Arizona and then you can just lay the movement grid over the GIS habitat map. You would be able to determine home range and time spent in each of the different habitats, hopefully.

Question: Is this on a cow, bull, calf, what was it put on? How long is this radio good for before it ceases working?

Answer: It was put on a cow. I'm sorry, I don't know how long the radio is good for. I think it's on the order of three years but I don't know. It hasn't run out yet.

Question: I hear it's a 200-foot antenna that's really causing you some trouble.

I'm curious to ask some of the delegates from Washington, Oregon, Colorado and Montana who have some very extensive seasons now, a lot of special seasons that extend over a good part of the year, if there is any concern or growing concern over the impacts that extended hunting seasons of various forms may have on populations. We know that habitat-use patterns are very much affected by human disturbances in the forest environment, and primarily those are hunting activities. It seems there are a great many areas now where elk are subjected to hunting from late summer through spring and I'd just like to open that up and see what kind of comments we come up with.

Answer: I'm Rolf Johnson from Washington. We are concerned about that. We do have hunts that start as early as the first part of September and end as late as the end of December. We said that we would not have any hunting after December except for damage control. We do have some damage control hunts. We are concerned about the September hunts. We're looking at them, as I said before, in this resource allocation program. We said we'd look at them for three years and then make some judgment as to whether it's had an adverse impact. We haven't made that evaluation yet.

For Oregon, can't add much to what was said. We do have some concern. We are testing effects of early bowhunting in one unit in northeastern Oregon. Archery hunting in Oregon usually opens the middle or the latter part of August. There is some concern of having an effect on calf ratios. Other than that, we're talking about it and thinking about it but nothing has been done yet.

In Idaho, our first archery season actually opens the 20th of July and the last one closes December 31st. However, on a larger basis, we have traditionally had a 68-72 day season. In our back country, there are about nine units that are basically roadless with long seasons since the 50's. Elk production in the area is no different than areas having nine-day seasons. In fact, we probably observe as good a production in those areas as in some five-day season areas with a whole mess of people. I think we're fortunate in having only about 70,000 elk hunters in the state. The key is to not have the great crowds of people like Colorado and Oregon have been enjoying for so long. We have 30 some bulls per 100 cows in those areas. In the back country, we have good calf production. I'd have to ask one of the guys sitting out there. I don't know what the actual count is but I would say it's over 35 possibly as high as 42 or 43. Mike(?) what is it in your section of the back country?

Generally around Big Creek, it's running 40-45.

I was just going to point out that one herd in my country is hunted in July, somewhere around the 20th of July, and those elk are hunted in a variety of hunts this year; last year to the 19th of January. Last year's cow:calf ratio was in the area of right close to 50 calves per 100 cows.

In 1985-86, that hunt actually started the 20th of July and ended the 19th day of January. It's an area where we don't need elk and they've done very well as far as chronic depredation, and they are very productive.

Montana's archery season starts about the 6th or 7th of September. The general rifle season concludes the end of November. We do have some late hunts that deal mainly with either small depredation problems or Yellowstone National Park elk migrating out, which will go on until the middle or latter part of February. We haven't noticed any problems in terms of calf production or survival with these hunts. In Bitterroot Valley, for probably 15 years up until the early 70's, we had general rifle hunts that started the 15th of September and went just about until Christmas. Comparing cow:calf hunts with the cow:calf ratios the last eight or ten years, there's virtually no difference at all. We are looking at an area in southwestern Montana regarding archery hunting and the impact on archers hunting during the rut. That study has just been funded. We will be taking a little more intensive look there, but we really don't see any problems at this time.

In Colorado, the archery season is normally the first season open. Next year it will open mid-August. We do have some seasons that run as late as January 1, and occasionally some game damage hunts even later than that. This is perceived as a big problem by the public in Colorado, and we hear a lot about it. They say you're hunting these animals; you're running them from about mid-August all the way until middle of the winter, they don't have a chance to rest, they don't have a chance to breed, and that sort of thing.

There is an article in the most recent Journal of Wildlife Management about this very thing in Utah. We've talked about delayed breeding possibly being caused by irregular rifle seasons in Utah. My personal belief is that archery and muzzleloader hunting probably are not great factors in changing breeding days, at least for elk in Colorado. The Colorado Commission this year did reduce the number of days in late September that archers and muzzleloaders could hunt, specifically because they and the public at the meeting felt this business of chasing the elk around was serious. They felt they should not be hunting them so much during the rut. The season will end the 20th this year, and next season won't open until October 6th or 7th or 8th.

Personally, I am more concerned about extremely low bull:cow ratios than I am about the longer season, particularly if the archery and muzzleloader seasons are limited entry. We have about 5,000 muzzleloader licenses. I think we have more people out there cutting wood and backpacking and riding horses and things like that than we do hunting. So I don't view that as a big problem. I do have good data in some units on the relationship between calf production and bull:cow ratios. In the upper Rio Grande River valley, I have 20 years of data and I gave a paper at the Elk Symposium in Logan, Utah a couple of years ago about this. It relates more to Dan's question about what level do you start to see a change in calf production or survival. I believe it to be around 8-10 bulls per 100 cows. In the upper Rio Grande, we went for 15 years with more than 55 or 60 calves per 100 cows. We had more than 10-15 bulls per 100 cows. When that level dropped below about 7 or 8 bulls per 100 cows, we've dropped to as low as 25-30 calves per 100 cows. The highest we've had in the last 5 years has been 40-41 calves per 100 cows. So, I personally am more concerned about that bull:cow ratio. I don't know whether it's a behavioral thing, whether the spike bulls are breeding later. As I mentioned earlier, the calves are spread all over the gamut of birth dates now. I don't know if it's behavioral or whether it's biological with those elk, not being capable of breeding the first estrus. We don't know exactly what's going on, but we do have some concerns.

For Colorado, I'd like to comment a little bit. We have two elk movement studies that we've done. Basically, what happens during the archery and muzzleloader seasons is you don't see major distributional changes on elk. They've been fairly large samples. That first day of rifle season, major things happen to elk herds. I think it's a matter of cumulative disturbances that occur as we go to high density hunters and a rifle season.

Bob, I'd like to add a brief comment to that. There's The ElK Workshop report that's available in the poster room for you to help yourselves. The 5,000 people that participated in that process, at least for Oregon, identified excessive season length as something of considerable concern. It may in fact be true, that they don't have the perception that we might have as managers about how big an impact that may be. So, if that perception is there, we probably do owe people the kind of information they need to perhaps soothe their feelings a little bit that the beginning date in August and the ending date in mid-January is not an across-the-board total impact on all our elk herds across the state as some people seem to perceive they are. So, at least we can say clearly that a lot of people do in fact have strong feelings about season length.

Along this line, I think that something clearly needs to be said that a lot of us are afraid to say. We as professional wildlife people primarily referring to the states, we're in the recreation business. No longer are we in the wildlife biology business so much, we're in the recreation business. We meet public recreational demands. That's what we're talking about here. The public has the perception right now that its length of season, especially a lot of that nonconsumptive public. We need to make it very clear that these recreational opportunities result in a minimal disturbance on those populations. We need to focus in those directions with the future of wildlife.

Question: Referring to British Columbia and the calf permits, what happened with that kind of season when hunters are restricted to hunting calves?

Answer: First of all, they're undersubscribed. Most of the LEH permits in the Province are oversubscribed, but calf elk hunts are among the few that are undersubscribed. Usually what happens is an oversubscription in areas like Vancouver Island. The hunter has the option, if he applies for elk on the Island and doesn't get drawn, of saying he'll take a substitute permit. Quite often he'll end up getting a calf permit in the Kootenays. You have a lot of hunters that don't turn up for their hunts, and that's one of the reasons why there is only a 20 percent success rate. That's built into the total number of permits that are allocated. As to what happens to the herds, a lot of units are designed to try to reduce so-called homesteader populations in the Rocky Mountain trench. These resident herds that, as the population builds, have been staying down in the lower Rocky Mountain trench.

These have been causing agricultural problems. The objective of directing a lot of recreation onto the calves and the cows in that specific area is to reduce the herd. Between the hunting season and taking some of those animals as transplant stock for the northeast part of the province, some of the problems are subsiding, although it depends on who you talk to. If you talk to the ranchers, the problems aren't subsiding at all. If you talk to Ray everything is under control. So, it's hard to say. But, I think that type of selective strategy is going to be continued. We will try and hit some of those homesteader elk before the migratory elk come down and mix with them for winter. You don't want to have a massive kill down there cause you're hitting some of the migratory animals that he doesn't want jeopardized in terms of overharvest. The other thing these hunts do is shed some of your recreation away from other hunts and gives some hunters an opportunity to kill an elk period. For some hunters, that's all they want to do. They want to get some meat for the freezer, and that takes some of the pressure off the bulls. That's helped overall to maintain bull escapement. With a bit higher bull escapement and reducing the antlerless component of the population, you're affecting the bull:cow ratios. As a result, the overall structure of the herds post-season is what we'd call a little more balanced with 35 bulls per 100 cows.

Question: How come you offer calf permits instead of just antlerless permits? Don't you have a big problem with illegal kills, shooting yearling cows or adult cows, confusing them with calves?

Answer: I can't really speak on that in terms of the enforcement. Obviously, there are situations where it's happened, of course. A person has a calf-only permit and he'll take a yearling or a cow. It's pretty well up to the discretion of the individual conservation officer. You can get a permit for a cow or a calf, an antlerless permit, so obviously the hunter may select for the mature animals. But again, to affect the population, they want to focus a lot of take on the calf components. I guess there would be some illegal activity going on. You just have to monitor over time and adjust total permits to take in those considerations.

THE ROCKY MOUNTAIN ELK FOUNDATION

ALAN CHRISTENSEN, DIRECTOR OF NORTHERN FIELD
OPERATIONS, ROCKY MOUNTAIN ELK FOUNDATION, ROUTE 3
WILDERNESS PLATEAU, TROY, MONTANA, 59935

Good morning. I'm really happy to be here. I came in last night from Denver and it's really a pleasure to be here in Coos Bay. As Dan mentioned, I'm an Oregon State graduate and a native Oregonian. My parents are still here and I have a lot of roots in Oregon.

When I look around the room, in my professional career I've moved around a fair amount, there's a lot of fine memories here. In fact, I just bumped into Dr. Donaldson. He was my limnology instructor.

I have to tell you about the Rocky Mountain Elk Foundation so that you'll have a clearer understanding. A lot of people who know Montana have a hard time comprehending that our organization is based in Troy. Troy isn't even on most of the Montana maps. Libby is the closest town of any major significance. And, unless you want to go to Libby, you don't just drive through it. So, we're sort of isolated.

The Rocky Mountain Elk Foundation basically was born in Troy, Montana, in early 1984. We're chartered under state and federal laws as a nonprofit, charitable corporation. In concept, the Rocky Mountain Elk Foundation will be for elk what Ducks Unlimited has been for waterfowl. When we say that, it's kind of scary because of what Ducks Unlimited has done; how efficient and how large they are. But, we really believe there is similar potential for our organization.

Some people have pointed out to us that the Foundation name implies a regional focus, but that isn't the case. We are interested in elk throughout their range in North America. I hope that our contribution to help offset some of the costs of the Jim Harper monograph is a clear demonstration of that.

We attained nonprofit status in May of 1984. About six months later, we published our first Bugle. That's our quarterly magazine that perhaps most of you are familiar with and associate with the Rocky Mountain Elk Foundation.

It was the next fall that I began to get involved with the Foundation. Lance Schelvan was editor of the Bugle and a close friend of mine. He came to me with some of their mail and some of the articles that had been sent for publication and asked for some technical advice. So, I began to make reviews and to get very involved with the Foundation. About November or December of that year, we put together a program for our first national convention in Spokane. That was a very interesting experience. My whole career had been spent with state and federal agencies, and I'd never worked with a private organization before. With the Forest Service, when you want to do something you start with the boss, the resource assistant, then the Forest Supervisor. Then, you go to the Rangers and pretty soon you've covered the layers and hopefully convinced everybody the idea is good. Then, maybe something can happen. With our organization, three of us surrounded a bottle of wine in Lance's living room and put together the first convention. There's no hint of a bureaucracy there. We didn't know what to expect in Spokane. We held our convention about three blocks from the United Gospel Mission figuring that if all else failed, we could fill the seats in short order by offering a hot meal. We didn't need to do that. Over 500 people registered for our convention. And in the past year, we've enjoyed the same track record. Every time we've held a meeting, every time we've organized something, we've been overwhelmed by the attendance.

We went through the spring focusing most of our energy on getting our act together, putting out Bugles, and planning ahead. In August of last year, we held our first nonconvention-type meeting, called a fundraiser or workshop, in Flagstaff, Arizona. Workshops we've sponsored have been technically-oriented. We're pulling together biologists, administrators, managers, commissioners or whoever is involved to focus on issues. In Flagstaff, it was the issue of elk and cattle forage allocations and the associated management problems. It was very successful. In August, about a week or two later, we had a fundraiser in Pocatello that was more like a D.U. banquet to raise funds for a specific project. We were able to kick some of that money back to Idaho for an elk transplant. In December of 1985, we had a combination workshop and fundraiser in Kalispell, Montana. I see a lot of guys here that helped put that together to make it work. When I was planning that one, I had aspirations of about 85-90 people at the workshop; we had over 130. I think that indicates the interest in elk. That workshop focused on quality in terms of what kind of herd structures we would have, what kind of hunting opportunity would be offered and what lay ahead for the state of Montana.

I enlisted full time with the Foundation in November of 1985. I intend to work with the Foundation in the future as long as they'll have me. I think there is a tremendous future there. We have a board of directors and a board of advisors. Our advisors include people like Dwight Schuh and Jim Zumbo who are well-known outdoor writers. We also have guides and outfitters. We're going to expand the board of advisors into more technical areas in the future. We have regional meetings and workshops scheduled right now for Flagstaff, Arizona again; Olympia, Washington; Lewiston, Idaho; Cody, Wyoming and Calgary, Alberta. And, that just takes us up to July. At our recent national convention in Denver, we announced the hiring of Gary Wolfe. I don't know if any of you here know Gary, but I'm sure some of your guys in the southwest do. Gary holds a Ph.D. out of Colorado State and he's been the manager of Park Ranch for the last 12 years. Gary's coming on full time for the Foundation in May, working out of Fort Collins, Colorado. He'll be our southwest states coordinator doing pretty much what I'm doing in the northern tier.

We're serious in a constructive way. It's not our goal to replace any existing agencies or people. It's our goal to facilitate, where we can be of help, the best management practices for elk. We don't want to own land, we don't own the animals and we don't want to get up to our neck in the political process. We want to focus in on issues, find out where the needs are, then go after them with money and support where we can. I have a few slides to illustrate what I've said and I'll add a few more thoughts.

There's Rocky Mountain Elk Foundation highway in Troy, and our building is in the background. We hope our logo will become familiar throughout the elk range. We reside in the heart of the Rocky Mountains and close to the Canadian border where one can literally hunt elk right outside the door.

We enjoy a relatively low population area with an abundance of animals. That helps us focus on problems we're having in other areas. We're all hunters, believing in sport hunting, fair chase, quality of experience and a balance between opportunity and quality. We believe in diversity and quality management in terms of the herds. We're concerned about elk in all seasons, when the living is easy and when it isn't so easy. We're interested in all elements of their habitat; food, water, cover, proper mixes readily available. We really believe, and it's been reiterated in our meetings and what we're hearing from the people that show up there, that habitat is the bottom line. No habitat, no elk. In those areas where it seems the best thing to do is to leave the habitat alone, we're not promoting manipulation of everything. There are areas where it's probably best to just maintain the existing quality.

We reside in the heart of some good elk country in northwest Montana. We're kind of smalltown boys in many ways, but a lot of our supporters and members, probably by far the majority, don't live in the heart of elk country. They come from cities and towns, urban environments.

We've found that there is one thing we share, and that's the mystic as this majestic animal draws us together; what it means to us collectively and individually. We all enjoy the experience of the hunt and we all have a viewpoint about what elk and elk hunting means to us.

A major program in the Foundation is publishing the Bugle. We think the Bugle pulls us together, pulls the issues together. It's our goal, through the pages of the Bugle, to inform and involve people as well as to provide a variety of entertaining issues. We're not a "me and Joe" hunting magazine and it's not our intention to become one, although we do sell over the newsstand because it's not a members-only publication. The Bugle is available in about 35 states and four Canadian provinces. We've put over 300,000 copies of the Bugle out now.

We have members in all 50 states, four Canadian provinces and several foreign countries at this time. We hear that people like to see elk and we like to celebrate the species with the art, beautiful photos from all over the range of elk.

Another program is the one of conducting workshops on specific issues. At the Kalispell workshop, we focused on the issue of quality in management and what it means. We had guides, outfitters and hunters on the board. We had corporate timber biologists and state biologists on panels. I felt that some very important information was passed along. At the workshops, we can really tackle issues in small group sessions and get right down to what it is that's needed. This is where we think the Foundation can serve to facilitate. We can provide a neutral forum where issues can be shared, where all sides can be aired. At our meetings, we like to provide some good company and camaraderie where people can share their feelings and experiences on elk hunting and really come together and have a good time.

We usually have art exhibits at our meetings. These pieces of art are for sale and sometimes they are used as auction items, varying from paintings to sculptures. One of the ways we raise funds is through auctions. People bid on and buy items like bronze sculptures and rifles. Also, one of the things we feature are trips where somebody could have what we think might be the ultimate experience in an elk hunt. And then to come back and relive that many times in their memory.

We don't lose sight of our goal to provide funds for important projects, like handing over a check for $17,500 to the Arizona Game and Fish Department, from our most successful fundraiser to date. Indications are we're just starting to gain momentum in addressing a lot of the issues. We've put over $25,000 into projects in four different states and that's just a beginning. It's been a year since we started these functions and we've come into direct contact with 2,000 elk workers and indirect contact with another 12,000 elk enthusiasts in the general public with our exhibits and other public displays. Couple that with nearly 300,000 Bugles that we've distributed and one can understand why we think we're beginning to get a feel for mainstream elk enthusiasts, what they're thinking and what they want; yet recognizing that we've got a lot of maturing of our own to do.

There's tremendous interest, dedication and money among elk enthusiasts. Doug Farrell, Assistant Director of the Wyoming Game and Fish Department, made a point in his address at our Denver Convention that we've passed through an era of environmental consciousness and now we're an era of economics. I was pleased to hear Dr. Donaldson make reference to values because we're interested in raising money to put into the elk resource. It takes money to get the information that we need to meet the challenges. We're into the area of economics. What we think that means is we've got to justify our existence economically. I know that in Montana they're going to take a hard look at that over the next few years. Having worked for the Forest Service for a number of years and being into situations where you're arguing about the value of a particular timber sale and what that means in terms of elk habitat and having the foresters throw at you volumes of board feet per acre and what that means. We need some of that same kind of ammunition.

Secondly, there are lots of knowledgeable folks out there, many who read voraciously and they read much more than Outdoor Life. Many people spend 20 to 30 days a year hunting elk and they may spend two or three times that amount of time out there scouting for elk, just camping in elk habitat. There are some tremendously enthusiastic people out there and they're very knowledgeable. I think in sessions like this and talking among ourselves we tend to take some of the public too lightly. There are some very knowledgeable people out there and you can't pull the wool over their eyes. Those people want substantial communication. They'll give us their support when they understand the issues and the choices. That has come out clearly to me at our meetings. We haven't had any sessions where we've had radical displays of position statements and things like that. Most of our sessions have been a group of people that are listening very closely to what's being said and weighing it heavily. They want to be involved in some of the decisions. They're going to be there to make the input when the time is right.

These people want choices in regard to hunting opportunity. They'll support complex seasons and regulations if there is a good biological basis for it and it's been well explained to them. This came out very clearly in Denver in a session that dealt specifically with that topic. Again, these people aren't dumb. Some of them will hunt in two or three states a year. They'll travel all over the west looking for the best mix. And, a lot of them are content to hunt within their home state. They understand when you come to them and say we can't have a broad open general season anymore; we've got to go to area selections, limited entry permits, and here's why. They may not like to swallow that pill, but if they understand why, most of them are telling us they'll live with that. Biologists as a group must improve their people management skills. That came out very clearly in our session and that's almost a direct quote as well from Doug Crowe in his talk. He feels that we've gone beyond the era of population management and we're into the era of people management. That ties in with competing economic issues as well. We feel that's a role that the Foundation can be very important in. We can inform, we can educate, and we can work with a lot of the publics through our workshops and fundraisers and the magazines. And, we can do that in assistance with and in conjunction with all of the guys out here that I see and ladies in the audience and your agencies that you represent; we want to do that.

DISCUSSION

Question: What's the size of the membership in the Foundation?

Answer: Let me give you just a brief background on that. A year ago our membership was around 3,000. In October, it was close to 5,000. By December, it was 7,000. Now, well when I left Troy, it was 8,000. We called the office from Denver. We had 400 new memberships in the office to process. We probably picked up 500-1,000 memberships in Denver last week. So, we think by early this spring we'll be pushing 10,000 members.

To give some comparison, most of you have heard of the Foundation for North American Wild Sheep. They've been around for ten years and their membership is about 67,000. We're not even two years old.

A little bit of background on the Denver meeting. It's difficult to predict when you're growing as rapidly as we are just what to expect. We planned for 700-1,000 conventioneers, and we think we had about 900. We had 8-10,000 people pass through our public exhibit area in Denver. At our auction, we had probably 600 people in the room and in a four-five hour period, we generated a gross of $120,000. We grossed roughly $200,000 for the whole convention. It was a very expensive convention to put on so we don't know yet what our net will be. Still, the figures illustrate the potential that's out there.

Question: The money that you got from the auction, does that go back to the state that the auction is held in or does it go throughout the whole Rocky Mountain elk region?

Answer: It varies. Some of the items that we auction are hunts that are donated by guides and outfitters. There was one hunt that went for about $9,000. Sixty-five percent of that money goes to the Province that donated the hunt at the request of the guide/outfitter. Most of the offerings that were auctioned in Denver came with some strings attached.

As a new organization, people are watching us and believe me I'm learning a lot in the business world. We know we can generate money for the elk resource. Business arrangements may be required on some of the things that are donated to the auction. Some of the money may have to go back in these business arrangements. We don't always get everything for free. Some of the artwork, some of the rifles, some of the hunts have strings attached.

Some of the money will go to Foundation projects including publishing the Bugle. That's a very expensive proposition. We're looking at about $130,000 a year for publication. We feel it's a very important project, reaching the public.

Question: If I understood you correctly, you said you had a forage allocation workshop in Arizona. What was the product? Was there a report or will there be?

Answer: Yes, there is a summarization that came out. We did not produce proceedings as such.

Mike Cupell, our advisor in Arizona, who was a candidate for Commissioner with the Fish and Game Commission, was in charge of that workshop. We do have some information from that. If you're interested I'd be glad to supply it to you.

We're learning the importance of providing information. We taped all sessions in Denver. To produce a Proceedings from something like that right now would be very difficult for us because of staffing. We think we're going to go with tapes for awhile.

Question: Any closing remarks?

Answer: Remember, we're evolving in our philosophies on some issues and how we run our business. We'll adjust as we learn. We may make some mistakes. It's our intent through local fundraisers and regional meetings to build a fund for specific projects; that's my role as a biologist for the Foundation. Director of Field Operations is an awkward title but that's what I'm doing. I've worked with some of you in this room on identifying specific projects in your state or province. We use that information when we go into a town like Olympia, Washington, which is coming up in about three weeks. The money generated above costs is targeted for the Mt. St. Helens project. We see our momentum growing. We should be a lot more successful in the future. I use the example of Ducks Unlimited and I ask you to realize Ducks Unlimited has been around for 45 years. I'm sure they weren't generating budgets in the millions of dollars initially. We think there's a great future for us; be patient with us.

EAVESDROPPING ON
MONDAY EVENING WORKSHOPPING

* About the Denver Convention (Rocky Mountain Elk Foundation), on the first day we had quite a discussion - about quality elk management. We had four people representing various groups, outfitters, bull hunters and the Division of Wildlife. I spoke about quality elk management as we see it in the Colorado Division.

I think the biggest thing was the considerable amount of discussion from the public and what they expected of us. I think clearly that there is, in my mind at least, a misconception that trophy and quality are the same thing. I don't see those two issues as the same. I basically told them I didn't think the states had room for this in their management plan, which was basically to provide for this unique system that occurs in America where everyone has the right to hunt. A trophy elk management style, and I define trophy elk management as somewhat like the European system. You basically maintain male/female ratios about one-to-one, you shoot the hell out of the females, holding elk populations below natural carrying capacities, and try to shoot animals in the six-eight-year-old range. I said there was no place for that in basic state wildlife management.

We talked considerably then about what was quality and tried to separate that definition. Basically, Colorado has defined it with 20 areas that are managed for what is called quality elk management. That is, by limitation of licenses we are adjusting through time the bull/cow ratios to about 30 bulls per 100 cows post season. That gives us a measurable biological objective that we can shoot at, that we can attain and maintain. Also, to the hunter what that means is that through the limitation of licenses, he has a reasonable opportunity to take a mature bull, if he so chooses, in an atmosphere in which there is low hunter pressure because of the limited licenses.

I emphasize that <u>if he so chooses</u> is a very critical portion of that definition because in those areas, especially when you are at 30 bulls post season, there is really no rationale not to take big bulls. Everyone of us had our own perceptions. My perceptions were I figured I'd shoot cows in quality elk areas because I had the same opportunity as everyone else - hunting in that low hunting pressure situation. I still had a higher chance of taking an animal home. Part of my trophy display was the venison steak on the table.

The group response to that I don't think was all that great. So I'm willing to discuss that with those people, and we did. I basically told them, and I'll try to repeat it to you, that I don't think that they represented the total hunting package that we have to represent. The concern I had with the way I saw the Rocky Mountain Elk Foundation going, and that I had seen our Wildlife Commission going, was a response to this vociferous group of people who were saying that they want to kill bigger bulls. That indeed seems to be a growing thing. But, I didn't think that it was as big as what we were hearing. And, if we listened to our telephones, we would be doing something different. As for examples I used; for the 30,000 - 32,000 cow licenses that we offer every year, we have in excess of 100,000 applications out of the 160,000 elk hunter licenses as well. One hundred thousand of those people apply for cow licenses. Don't tell me that they want to kill a big bull. The chances of drawing a cow license are tougher than drawing one of those limited bull licenses in the quality ek areas, even if you take out the toughest one to draw in, which in Colorado is about 16-to-1 and the bottom one is about four to one. That's still a quality elk area. It's tougher to draw a cow license, on the average in Colorado, than one for "quality" bulls. So, the trophy demand really wasn't there.

Basically, what we came down to in my portion of the discussion was the need to provide a wide variety of opportunity for hunters. How we would do that is what we call the patchwork of opportunities. We provide an archery season; a muzzleloader season. We provide a wide variety of rifle season options so that hunters in some instances have the opportunity to hunt bugling bulls. In most cases they could have antler restriction areas where they hunt big bulls if they so desire. In the future what we would be doing - what changes they would see is, we would measure hunter demands proportional to the total hunters in the state and we would design seasons to meet that proportional demand. That's about where we left it.

A concern I have regarding the Elk Foundation and what I've seen wildlife agencies going to is that they see things like antler restrictions, going to more trophy-type management at the expense of the general hunting public. I think this is really a minority group that is very vocal. They are keying in on the directions that we are going. If we follow those voices this year, the other group is going to come out of the woodwork the next year and we'll go the other way. That's not good long-term management. That was one of the discussions.

We talked about what hunters were demanding, what they wanted. I started out my talk by saying that I didn't know what they wanted, but I really do. I think they want that wide diversity. The Elk Foundation in general is a growing, potentially potent voice out there. It's going to have a big effect on us in future elk management because they are going to be telling us some of the things they want us to do. I'm not really sure that they are going to tell us what the public really wants us to do. I think that's my biggest concern.

* Wouldn't that be a concern with any group representing a special interest, regardless?

* The voice there in Denver was very clearly trophy, quality-type management. I don't think we really want to do that. I don't think that's the right long-term direction for us to go with wildlife management in this country.

* Would you rather see a loose knit group of people out there with a seemingly broad perspective but little or no organization, or would you prefer to hear from an organized and presumably more politically viable group?

* I think what we need to do as wildlife agencies is basically try Oregon's tactic and ask the hunters "what do you want"? Try to come up with quantifiable answers. Try to categorize people into various groups and then

meet that demand with a diversity of opportunity. I think that's the way we're going to have to go. I think that's going to be the trick in the next four or five years. How do we match that diverse demand with our season structures and not jeopardize these resources.

* It all depends on what you call a trophy elk. I heard a definition once, a trophy elk is a dead elk. You know, it all depends on a person's perspective.

* The direction Colorado went this year, and we are affecting about a third of our elk hunters, our general license-buying elk hunters, we went to four-point bull regulations over about a third of our state. We'll reduce our elk harvest next year between 3,700 and 4,000 head of elk. It's basically because people have the perception that a four-point bull elk regulation will make trophy elk. Well, you know we know better than that. The only way you are going to make six and eight-year-old trophy bulls is you don't kill them till they get to be six or eight years old. When you put the kind of pressure that Colorado puts on their elk herds, we're just shifting the harvest from yearling bulls, which in the last few years has been about 50 percent of the bull elk harvest. All we're going to do is shift the harvest to two-year-old bulls and take them out less efficiently than when we offer them as yearlings.

* What's your illegal kill with a branch antler regulation?

* We don't have any experience with that right now. Last year was the first year we did it, and we did it in only one elk herd, the White River elk herd. We affected about 25,000 elk hunters. The White River elk herd draws about 25,000 elk hunters and they kill 4,000 to 5,000 elk, antlered and antlerless. It's the largest elk herd in the state, probably the most popular elk herd in the state. But, it has a chronic low bull/cow ratio; 4.7 last year. When put under antler restrictions, we predicted we'd lose about a third of those hunters. We also figured a third of those would go someplace else to hunt and a third would say "to hell with it, hunted here all my life and I'm going to continue to hunt." That's about what happened. We figured we had between 6,500 and 8,000 elk hunters there. It was really like a busman's holiday. There weren't many hunters around and it was a good thing. It was a pretty clean hunt. Next year is the year thats going to tell. Those hunters are going to come back to the White River en masse.

* They are going to expect a whole bunch of branch antlered bulls...

* We have a party line in Oregon. Basically, the party line is that antler point regulation is not a substitute for limited entry. In fact, it forces it. It will force it in the second year when we have a little stockpile and we are going to have to have limited entry. So, our preferred position is limited entry without point regulation. We have some point regulation in Oregon because it has been crammed down our throat. The bloody battles we've gone through to change that - we've just kind of given up.

* Well, I've never really been a proponent of antler restrictions, but my perception of that changed a little bit after last year. We changed the White River bull elk herd from a post season 4.7 bulls to 15.6 bulls per 100

cows in one year. We took one of our quality elk areas, which started out at about 7 or 8 bulls post season, and cut the number of bull elk hunters by two-thirds, yet we only reduced the harvest by about ten percent. In other words, when we put them through the drawing, we got efficient hunters and they killed elk at a very high rate. We actually changed the bull:cow ratio from 7 to 10, that's all we did in one year.

* The experience in Oregon, and I draw on several places where we've tested it, is that there is some indefinable threshold that we have to find under point regulations that represents about the right number of people, and if there are more people than that, the competition and such triggers carelessness. We lay down sublegals and we've got a bad problem. If it happens that we are dealing with a situation where demand doesn't cross that threshold, we're not forced to limited entry. We went through the same thing on four-point buck regulations. When we didn't have the limited entry constraint, they came with the expectation that it's had time to build a stockpile - here they came, no constraints. We made a mistake. We had to go limited entry. So, we just developed a party line both with elk and deer.

  Mr. Commissioner if you are talking about escaping limited entry with a point regulation, we will recommend it loud and clear for you the second year, and then the third year you're going to be in trouble because that's when the problems are going to occur. We are going to say, O.K. once again we recommend limited entry because of our experience.

* Well, that's interesting because we are going into our second year now and we're basically taking the "let's see what's going to happen" attitude. A lot of our field people are having a great deal of heartburn about what's going to happen to the White River elk herd.

  I know that there is some documented evidence of what I call freeway syndrome - when you get people in there in high densities and a high pressure hunting situation, it becomes a very dirty hunt. I don't know what those thresholds are.

* We're doing some modeling in Oregon, not nearly as sophisticated as yours, (Colorado) and what we're finding with our point regulation is an absence of about a third of the sublegals that should be there in the post-season bull ratio. In some cases we say they can slip them out over the boundary into the next unit. But, in some cases we have some real clean units. And, of course, we've got a little dilemma on one I'm thinking about in eastern Oregon where they "fly" all over the damn place in the summertime and get shot elsewhere. But, it does appear that, by and large, the bull ratio never lives up to what's modeled based on the calf ratio. Maybe that's a real rudimentary system, I mean it's stone-age stuff, but nevertheless that's what our data is telling us. We can't explain those losses if we haven't documented dead animals, sublegals, or documented cases or reports of people moving across unit boundaries with sublegals in order to get into a legal unit. So, it will be interesting, you know, if it happens that Colorado finds out in the second or third year "where are all these sublegals that should be in that post-season population"?

* Well, I think with the high densities of hunters that we deal with, and the massive check station operation that we plan for White River, that at least we'll begin to get some feel for the amount of it that's occurring.

* The thing I guess I'm a little anxious about is, for example, the State of Washington has some three-point regulation going on now in western Washington and they are advocating this kind of regulation. It's not limited entry. I guess, from a hunter's perception, if I'm sitting back and reading the philosophy of management in Oregon and getting a different philosophy from Washington and maybe we'll hear a different philosophy from Colorado, I'm a little confused, as just an ordinary hunter. Is point regulation good or bad? One state, it looks like it's great. I'm reading stuff from Montana I brought back from Boseman a couple of years ago. It's published data on Montana's three-point regulation; here's the good stuff that goes with it. The promise of higher calf ratios because of more bulls during the rut. From the standpoint of us in Oregon, and the party line that we have, it's a little spooky to think of all the Oregon hunters having this in their hands and coming to us to say "why don't we do it here in Oregon, this three-point regulation -- solve our problems."

* Has it been shown anywhere that a high or low bull to cow ratio will produce infertile cows.

* There is some documentation. I think we can show that in Colorado too to some extent. But, it's not a clear one to one relation. It basically shows that there's other things involved in changes of cow/calf ratios as a result of changes in bull/cow ratios. It's not a good clear pattern.

* I would think that one of the results would be a lengthening of calving season with unavailability of bulls.

* We have a paper coming up on that in this session. It's based on conception rates -- not the cow/calf ratio but actual conception.

* Did you say, referring to point regulations and why you went to limited entry, that was to take care of what you feel is the loss of some of those sublegals? What was your rationale for saying you're going to end up there anyway?

* OK, let's assume you're forced into a three-point regulation cause you have to do something about your bull ratios, they're low. So, the first year you've got nothing to offer the hunter. You impose a branch antler regulation and all you have to offer is a bunch of spikes. So he doesn't come. He's smart enough to know that. No problem, you end up with a high bull ratio -- looks great. What's the expectation of those hunters the second year? They see the data; you've got a high bull ratio, didn't shoot any bulls the year before, it's the place to go. And they will come. We expect them to come, and our answer is, before we get hit in the head with some real problems on hauling out salvage elk, and having a big component of missing bulls in the post-season ratio, to go with the best estimate we have about what the right number of people should be for that hunt and have limited entry. Our party line is that if we have a bull ratio problem,

we'll start with limited entry first. If you want to, for some social reason or to increase hunter numbers in that unit, add the three-point regulation, let that come along later. But, putting the three-point regulation on first, to us means you forced limited entry and maybe it might not have been necessary in the first place.

* We have a big resistance in Montana to going to limited entry. Some people want something different than what they have. You tell them how to achieve it and they don't want that either. So, they just want to do something different. We got forced into a couple branched-antler seasons this year with elk that we feel aren't going to accomplish what the public thinks they're going to accomplish. In fact, it may be negative over the long haul because we already have fairly good bulls in that population.

  It's been wide open, whether or not trophy bulls are meaningful, we have plenty of three and four-year-olds but nothing much over. I guess the perception of the public is if you go to branch antlers, you automatically go to bigger bulls. Our Commission listens to that. In that situation, we're guessing that people who normally kill spikes are now focusing on branch-antlered animals and it could get worse than it was before.

* I think Bob has already mentioned, if not here, earlier, that there's a suspicion among the public that when they're imposing a point regulation they're creating a trophy season. You focus the total hunting pressure on that component of the bulls that are your best breeders. The long term yield out of the three-point regulation is going to be substantially less than under all bulls, assuming that you can get the kind of survival that you want. Under all bulls you take a proportion of the various age classes that are there. I don't know where this is leading me, other than the fact that, using Oregon as an example, we have a fantastic natural diversity to deal with. That's what's so pleasant about doing an elk plan here in Oregon. And, the elk plan that we developed says in some areas we have a problem and that's where we'll deal with it. In working through the public process on this, the way was pointed, both for biological and social reasons, to go to limited entry in those problem areas. In the rest of it, basically what we did was identify this natural diversity that we've had for several years, in some cases, 15 bulls per 100 cows. So, we're going to perpetuate that and if it does take limited entry in fact to perpetuate that, then we recommended it. So, we've got a package that, this year, is another step in the direction of full limited entry. But, it's not total full limited entry yet. Yet, it's intended to resolve the problems that we have in some units of bull ratios that are around one and two, and we can't get out of it. We've been in those situations for like seven years, and we don't have any other tricks up our sleeve to make it happen. In most cases we're saying, if the will of the public is that they're too crowded and they're screaming at us about bull ratios, we'll propose limited entry. In going through the public involvement process, that's basically the way it came out. They didn't have any better answers for us either, and they basically agree and, we've got a five-year package now in place.

* What happens the second year. What does the bull/cow ratio do next year?

* Of course it depends on your recruitment. But, your first year of, say two or three bulls it will bump to 15, 18 per 100 cows that season after your first year of three-point regulation. Now, you're going to bring on, without limited entry, anybody that wants to hunt there.

* That's why I want to know what happens now.

* OK, 15-18 bulls per 100 cows. Say you've got an isolated unit and everything surrounding it is two and three bulls per 100 cows like the subject unit used to be. If you do it like in Oregon where we display the statistical data for people to see, it's part of the package in Commission meetings. Whether or not they get it out of the data, whether or not they remember because nobody killed anything there the year before so you've saved everything, however they get their information, the expectation is they're going to home in on that, just like you sent them a gold-plated invitation, in numbers in excess of what used to be there before you had this special invitation to hunt an elk herd of bulls that really wasn't hunted last year because there wasn't anything offered.

* Well, what does it do. I don't know what it does to the population. I mean you can justify that and say, hey that's what you bought, that's what you decided you wanted to do, that's going to be the cost of doing business. If you wanted to hunt dirty like that, that's it.

* In Rocky Mountain elk, we have one unit we've had for several years, 1978, and it's the Snake River Unit, and we carried it for decades with one or less than one bull per 100 cows. We've had the three-point regulation in effect there with limited entry for several years. The expectation is we should have 15 to 18 bulls per 100 cows post season year after year. We have 11 to 12. In recent years we've been experiencing the poorest calf ratios in the history of data that we have in the unit. We don't have this nice correlation of more bulls makes more calves. It's influenced, unfortunately, by the belief, because we put the black bear on the game mammal list and it's a pretty good cougar area, that in this interim period since we used to have no bulls but we had the black bear and cougar and a lot of sheep in the country so the predators had a lot of pressure on them, that in this interim the predators have now taken over as a major concern. Unfortunately, because this unit is almost a total wilderness situation, we're unable to get the reproductive tracts in adequate numbers over a long period of time to see if conception is as good as it always was and it's just a matter of calf survivability because of predators. I can't prove it in that unit. But that's an example where we increased the bull ratio and the calf ratio did exactly the wrong thing. In the Eagle Cap Wilderness Area in the Wallowa Mountains we've always had 15 bulls per 100 cows. We're getting lousy calf ratios there.

* There's two things that are positive. First of all, spikes will probably be the preponderance of your harvest, and people realize this. First thing is to reduce pressure. They'll say you can't get a spike and they haven't seen a branch-antler in 10 years. Second thing is you protect an age class. And, in what I've seen, not so much in elk but in deer, you can get two age classes protected if you go to four-point. If you run that for a couple of years, you will protect one or two age classes to a degree. Now, the

important thing is, well at least in my estimation, you don't run that season for ten years or five years because that's when you start really shoving down that age class. All of a sudden all you're getting is young bulls and you're losing your upper age classes. What you do is run that for a year or two years, then you take it off and put that pressure back on spikes. Whether or not you have a large number of branch-antler bulls or not is not going to increase the harvest on them. Dumb spikes are still going to be there to sustain 30, 40, 50, 60 percent of your harvest. You are going to take the opportunistic hunter, the guy who's going to say "well there's a spike and I'm going to shoot him now even if I've got three days left to hunt because I might not see another bull." If you continue to run that branch-antler season, you're going to make that guy say "I can't shoot that bull so I'm going to have to hunt the extra two days." So, I think the secret is, spikes-excluded season or three-point, the basic thing is not to run them for too long. The idea is to build yourself a couple age classes and then take that off. What you've done is increased recruitment into your branch-antler bulls for a couple of years. You have increased the number that is going into that. Take it off and let them get back on their young bull hunt. Leave those two age classes that you built up, leave them to grow. Then, if you feel like you're losing your branch-antler bulls again, maybe in five years come back. Run the spikes-excluded hunt again to bring those age classes in. Then take it off. If you use it year after year after year, I'm sure you're all aware all you will see is an age structure from pounding on those old-age bulls.

Another thing I was going to mention. You were saying that you don't seem to see the young male bulls in your population models. That's been a concern with me with our models. I don't know how yours are set up, but ours are set up with no differential mortality. In other words, 50 percent of those calves were bulls, 50 percent were cows. No differential survivability or mortality, no differential anything. If you check populations, you know that really isn't true, even though biologically there is a 50-50 chance and that's the way the model is going to be set up. Studies have indicated that cow calves can have a greater survivability than bull calves. Therefore, if you don't plug that into your model, it may indicate you've got more bulls than is the case.

* You know, if we forget the data, forget about differential mortality, forget about all these numbers we play with trying to explain things and we go right to the stuff that's shown in the poster session, we have over 16,000 man-on-the-street questionnaires that didn't discriminate. Workshops brought out people that had a bone to pick, so those had their own bias. Commission and town-hall meetings have their own bias; they bring out people that either want to make a sales pitch for something or they have a bone to pick. But the random survey, our questionnaire result is huge. Very large samples unit by unit. So, forgetting all of the games we play with data, our hunters told us, basically, they don't like three-point regulation. Less than a third of them will support it. And they also told us about this game that we play, doing something for this year or two years in a row and then changing the name of the game the next year is dirty tricks. And, they're getting tired of it. They can't keep up with us and they get in trouble by not knowing what the current regs. are. This adds to the demand

on us to get with a system that we can stay with, one that people can begin to understand. We must quit throwing the screws to them every year. It doesn't matter whether I'm an advocate of point regulation or not; I'm not trying to play that role. If we are going to listen to the public, which we're kind of talking about here earlier as far as the reading coming out of Denver, Oregon has a tremendous sample on what hunters want. And they sure as hell don't want three-point regulation. We use the survey when pressure groups come at us and say that's the answer to your prayers and that's what we want you to do.

* Did you ask them about six-point regulations?

* No.

* The reason I ask is we are considering and have actually proposed this to the Commission the end of this year. It didn't fly, but we haven't given up totally for a season where we have a wide open spike and a six-point regulation. So, you would have to either shoot a spike or a six-point. The philosophy behind it is that up to 30 percent of our yearlings are branch. We want to save that branch proportion of yearlings. They tend to be bigger bulls and we would save them till they become six-points, then they become legal. Those are not old trophy bulls but, they're six points in the three to four-year-old age class.

* The questionnaire didn't answer the six-point question but the workshop people that came at us--the expectation was they're going to ram trophy stuff down our throat. In that massive data with 5,000 people in meetings all over the state, the trophy demand is pretty nominal. It's not a big deal. We can look at the package from across Oregon and say; "hey, you guys that want trophies go over and hunt the southern reaches of the Blue Mountain plateau."

* There's an experience on that. Granato Park next to the Forest Service, well they got into a trophy-bull-only area, once in a lifetime hunt. You can also have cow hunts in there too to control populations. I'd like to see the data. From what I've learned talking to hunters, and some of them have been biologists, they're just taking average bulls out of the forest not trophy stuff. We're talking really big bulls coming out of that Granato Park right next to it. They select them and they've got a hundred. They're paying $8,000 for an elk and they're taking good stuff, or going without. And here these guys are taking small two and three-year-old bulls.

* This started out with a discussion of the concern I had after hearing from that group at the elk meeting versus what I really think the hunters are going to say to us sometime down the road.

* What did the group say? What where they thinking?

* I think it was clear at that meeting. If I were trying to manage an elk herd or a state elk herd, from the 175 people that were at the second session that I talked to, it would have been a very easy thing to do. Our restrictions would not have been enough. We would have gone to mature bull

harvests, limited entry, or something like that. This is all to meet their demands. That's how we got into this other stuff. My concern was that if we responded to that perceived demand, which seems to me to be the direction that our Commission is leading us, then it was fortified by what we heard at the elk meeting. Indeed, there's still a big group of people out there who are silent and they really don't want that.

I kind of put my foot in my mouth the first discussion I was in at an elk workshop. I basically said that Arizona, in 1970, went to totally limited licenses for all big game. I said they weren't really ready biologically or sophisticated enough to do that. Dave Brown jumped all over my case. Dave and I are really good friends. But the case that Arizona has is that they've been limited licenses, limited entry, or whatever you want to call it, forever and they've got a hell of a good elk herd, a hell of a good harvest that comes off of those elk. Maybe, like the rest of us, the elk herd has responded and grown despite us.

You know, there's good information that says limited entry, without any kind of antler restrictions that Arizona's had, has been a hell of a good system. It's produced a good, healthy elk herd. It has a good, healthy, happy elk hunting public. I can't say that the people who hunt Colorado will be a good, healthy, happy elk hunting population cause it's a big hassle, a continuous hassle.

* I think one of the ways of making the elk hunter happy is giving him preference points for future draws. They're beginning to find out that random isn't necessarily a good thing because there's a chance that you may be the one out of ten that doesn't get drawn for ten years. You could be that person, and if you are, you want your chance to hunt elk every ten years.

* Anybody gone to preference points on elk?

* We did and we gave it up. It gets to be a record-keeping hassle.

In Montana there were no tags available in some species for people that didn't have preference points. There were already too many people with preference points.

* The preference point system was dropped on sheep and goats, not because the dire predictions came about, but it was the predictions. People began to look down the road and say "hey, if I don't have ten now, I'm never going to get to hunt." But, it hasn't really happened. We dropped it and things are not much different. What we did was go back this year with preference points and we're going to maximize out at three at that point. I think there's enough turnover that it'll work. I think we need to try it to see if it works.

* So what'll the preference points do for the person with three? Does that mean three times the odds of being drawn?

* No! Everyone with three will be drawn before everyone with two and ahead of everyone with one.

* That's not the same thing as wait period?

* There's no waiting. We just maximize out...

* What's your hunter population, and what's your tag numbers that you're dealing with?

* Muzzleloader, about 8,000 applications for 5,000 licenses. Some of the cow elk units and some of the valuable licenses, I guess the highest one's about 16 to 1. That's an unusual one. Sheep, the statewide average is about 5-1/2 to 1 for rifle and 2-1/2 to 1 for archery.

* What do you do when there's more priority applications than there are tags available?

* If there are five licenses and there are ten people there with five preference points, or three preference points is where we'll peak out, there's a random drawing among those three preference points. The computer automatically rerandomizes those and pulls those out.

* Okay, what about the guy that doesn't draw a tag, does he get a fourth priority?

* No, he gets that third preference point and stays right there.

* Does it keep building and building and building and building...

* I don't know. You can perceive it that way but what seems to happen is that there is turnover. There's not much persistence. When we're thinking of it, I'm just going to keep putting in till I can get there, then I'll be all right. But, most hunters don't seem to be that way. There's not that persistence. They don't blossom like you think they're going to.

* Are these preference points specific to the hunt or hunt number?

* No, generic by species.

* So, if I was a muzzleloader and I applied for a muzzleloader elk tag and I didn't get it, I could then indicate a preference point. If I went for a general rifle tag for elk the following year I'd get another preference point, right?

* It seems to me that in a preference point system, if you've got an application rate of four applications for each license or tag that you are going to end up in a situation with an equal number of preference point people to tags to be issued or exceeding them. Especially true if you're not limiting it to a particular hunt or a special weapon. Granted, there might be some shift of persons not successful for a particular type of species or weapon, say, he's not successful in muzzleloader and he shifts over to rifle.

* He jumps ship.

* Right, that's a possibility. But equally, if you aren't segregating them by weapons, then it seems to me that the shift is not going to have any effect; that you're still, in three year's time, if you've got 3 to 1, I can see that a third of those people each year will cycle through. But, if it's 4 to 1, I think that you can eventually put yourself in a position where you will have, say two year's worth of people competing for one level of tags.

* I think we, as a wildlife agency, and not we necessarily as the biologist, but the Commission and everybody chickened out before we ever got to that point. So, we never really got a chance to see what it could do. They put the bighorn sheep thing in place, did it for three or four years, and people started putting pencil to paper and figuring out what was going to happen in ten years; that their children who were going to start hunting next year would never ever catch up. Now, the Commission's changed the whole thing. We dropped it and left it off for a few years. Now the Commission has changed and we're going back through that same cycle again. We recommended that this not be perpetual motion, the preference point, that we top it out at about three and let's be done with it.

* We used to have the five-year preference point system of sorts. If you were unsuccessful for antelope, it had arithmetic progression which killed us.

  We got to the point where drawings were made up of people with five years of unsuccessful notices. A person that didn't have a series of notices, he didn't even deserve to be there, he didn't get into the drawing. We had to deal with it on a wait period basis to get the number of applicants down to a manageable size.

* Maybe it's easier to go to just a wait period.

* We've been using a wait period for years. We use it in some very popular elk areas in order to cut down the demand for those particular hunts. We don't use the wait period in areas where those that subscribe are somewhat less or close to the number of permits that we authorize.

* Mexico went to a system of recording the number of applicants per unit area which drastically changed the statistics. Now everyone's playing the game trying to get the best odds, and not necessarily the best area to hunt elk.

* For sheep, in Colorado that's been done for years.

* In Washington, we've had the wait period. But, what really worked wonders as far as cutting down on odds, is the upfront fee of $150. It goes with your application and you get all but $5 back. That's cut down the applications for moose from 4,000 to 1,000.

* You've always had to pay upfront in Colorado. The non-resident cheap license is $500, and we don't have any problems with that. Just last year we had our first moose hunt and we had five licenses. The Commission said, "since we're only going to have five licenses, we're going to hold the applications, the fees that you give us until we get enough interest to pay

for the moose hunt and the moose drawing." They were saying something like six or eight months. We have 432 applications for five licenses. It was a hundred dollar license, but that didn't bother anybody. That doesn't deter people, I don't think.

* What do you think the applications would have been if it was $25.

* A million.

* What other things did they talk about at your elk meetings? I think you guys were there.

* We had general sessions in the morning each day and then two concurrent sessions. In the general session, the first was basically an issue of quality. People that were on that panel talked about how a couple of writers can influence the public's perception of quality.

  An outfitter from Wyoming talked about what quality means to the guiding industry.

  The concurrent sessions then were management of elk on southwestern ranches and Indian reservations.

  Another concurrent session was on hunter opinions and what some of the different states or provinces are doing with elk management programs. A lot of the things we've been talking about here. I asked Ray Demarci to be here specifically because of what he's doing in east Kootenays. Nobody in the states wants to take a hard look at that. Of course, they don't have the same parallel situation, but they're shooting a lot of calves and they've seen the mean age of their bull population go up, hunter numbers are up. The population overall is up, production looks real good. They're providing a lot of opportunity and now they're getting bigger bull herds.

* They're doing two or three things at once. Ray's philosophy is that if you make people shoot calves they will select the smallest animals they see and shoot proportionally more female calves. That leaves more male calves to be recruited for next year. Otherwise, if you have just a regular either-sex permit, you shoot the biggest thing you see. You'll shoot a lot of cows or bigger male calves.

  He's doing that and he has the point restriction where he has permits for either three-point or six-point.

* If you draw a bull permit you can get a calf permit as well. So, you can hunt all season for a bull and then shoot a calf. But, if you get a cow permit, you have to shoot a cow. You can't hunt bulls at all.

* Fifty percent of their bull harvest is six points?

* He told me they're 4-1/2 years old. But they're nice, they're big bulls, and 50 percent of their harvest is bulls overall.

* Any type of indication on training the hunters on what a calf is, and how to identify them?

* They went through a lot of that the first couple of years with diagrams and things like that. They absorbed a few mistakes.

  I think you have to keep that in perspective. They have 15,000 elk hunters. They're basically not catering to a broad public base that we especially in Oregon and Colorado face; large numbers of hunters. Harvest objectives are designed to maintain populations rather than to actually let them increase. That's not true with this calf thing. If I wanted to allow my elk herd to increase, the calf thing would work good. But, that's not my objective. My objective is to maintain my population at that level. I've got to kill a few cows, so I'm not interested in the calf thing. To me it's not a good recreational product. We want something that the public really wants.

* One thing that didn't come out, west of Calgary they had a multiple-point bull situation for a number of units, five-point and better for like the last 10 to 12 years. Their reproduction is terrible. Their calf survival is really looking terrible. The question some people are looking at now in addition to wolf predation is what's the age of the cow population? It's an overage cow population that potentially isn't reproducing at optimum. In Idaho, where the Locksaw River splits and the southside is essentially wilderness and roadless and the northside is accessible and logged, there's a healthier overall population on the northside. A lot more cows are harvested. The cow-calf ratio is better, the bull-cow ratios are better. Nobody knows why really, it's a real puzzle to let them cut. But, people speculate that the cow segment's a lot healthier because it's recently harvested.

* Well, if you read McCullough, it's pretty clear when he says it has to happen. We're beginning to look at that for deer. We're going to do some of that testing; compensatory mortality versus non-compensatory mortality with deer populations. You know I've seen those kinds of things in Colorado too. We've got populations that are basically not harvested. I looked at 350 head of elk about two weeks ago that were right adjacent to the Vermajo. It's been locked up and closed off and clearly there were two age classes of calves in that bunch. There you can't say it's hunting pressure on that elk herd that's causing a bimodal calf crop. So maybe it's something to do with weather.

* What do you mean by bimodal?

* You've got calves that are obviously calves in the spring, they're real small scrawny calves. Then you've got a bunch of calves in there that if you don't really know what you're looking at you might think you're looking at yearlings.

* You're talking about post-estrus breeding cycle?

* Yeah, calves that are born as a result of more than one estrus cycle.

* They should be no more than one month apart if you do that.

* One thing we've tried this year for the first time, and we may use it more to get around the issue of competition, is having pre-permits that are available through the drawing only. Our drawing closes or the applications close June 1. So people who would apply to hunt bulls in a particular area make their decision in May when they send in their application. There's no limit on the number that we're giving out. When the fall comes, they have to hold that pre-permit to hunt. So, you don't have people jumping back and forth in different areas. You're also tying it to other licenses so that, unless they have that pre-permit, they can't hunt deer. In some cases, where we have elk and antelope crossovers, which we do in eastern Montana, they can't hunt antelope either without those permits. It cuts down on party hunting and also makes them commit upfront. Hopefully we will reduce pressure, at least for awhile.

* We have a system that's the same sort of thing. All of our big game permits you have to put in by May. We're having something happen a lot different evidently than what you were talking about before. Our trophy hunts, which are four-point or better, have a subscription rate of 13.9 applicants per permit. Our regular bull is 2.4 to one, which shows that there's a lot more people going for the trophy bull permits than the regular bull permits.

* That's a timing thing though, isn't it Ray? I mean those trophy bull areas are September hunts.

* It's a much more desirable hunt.

* I think that's the answer to that demand. I'd bet money that that's the demand.

* One of the things I was interested in was something Dan might have done in Oregon where you're going around to these workshops and you're asking people what they want. One of the things that we're looking at is asking people. What we get is people saying we want a quality hunt. We want a trophy hunt. And, we're kind of asking them, put your money where your mouth is. Are you willing to pay a trophy fee surcharge to get a trophy hunt, like you're saying, in the rut period? Have you addressed that at all and have you found that people want to do that?

* No, we didn't boil this down to things like tradeoffs. We went to the public and we said we're here to listen if it's about elk, elk habitat or elk welfare. Those are the sideboards and that's what we're going to talk about tonight. We've had it all on the wall on big sheets of paper and we didn't argue with them. We didn't try and tell them if you get that you're going to have to pay this price or anything else. We just took the data. The questionnaires that we sent out posed a set of management strategies, three-point regulation, one season, this sort of stuff. We tried to feel the pulse, unit-by-unit, across the state of what the users, right there in the 1983 season, felt about these various strategies, the kinds of things that we could apply. No use throwing things in there that wouldn't work. That got the user in the unit, and then we also polled the universe of hunters across the state and let them choose their favorite unit if they

wanted to focus on it, and answer the same questions. And again, it did not deal with the tradeoffs, that if you want three-point regulation, we're going to put limited entry on it or something like that. It didn't do that. I got a perception out of the elk workshops, that we often fail to give adequate credit to these masses as far as their intellect about what they want and what's going on. I think we underrate them. I was surprised at the numbers of people who came out, even though you've got a few people that are in outer space somewhere, they just arrived from no telling where, that most of them are pretty astute people in their thinking. You get a hunter in a group of 20 people and he's a space cadet, the other 19 people identify him pretty quick and you can tell they lose their patience with his carryings on.

* We found out in most of our public meetings too, that the sophistication of the average hunter is much higher than we frequently give them credit for.

* I was wondering if any of the other states have considered or have a trophy fee of any sort or whether they've thought about that at all.

* We had a limited fee bill in the last Oregon session that was listed as a trophy fee; it didn't fly at all. The basic reason it didn't fly was the connotation of trophy bull.

* What would you call it instead of a trophy fee?

* Well, in hindsight, I'd call it something else right now. I really think that in this state, with some of our limited entry buck areas and bull areas, that people would pay more for that type of experience. Limited opportunity tag?

* We could offer a hunt in the rut for 50 tags for rifles. In this state, I'm not sure what we'd turn up, but we would turn up more than we do for antelope.

* Well, I'm not so sure we should let the public dictate to us at the game agency what is considered a quality hunt.

* Well you know, we're a team of biologists, okay? And, the power in the Wildlife Division of our department is with the biologists. The staff doesn't take the position that we know it all, just send us the data and that's it. We're starting to talk about social issues. When we get away from the biology of this business and start dealing with "we're going to give you 12 bulls per hundred cows because you demand it", It's a social demand. "You want some quality, we won't recommend it as a biological need". We would be asking the biologist to step out of his biological shoes and make some social judgements. We've taken those liberties many times and asked the biologists to make some judgements. A lot of times we will convey this information to our Commission in an arena that says to everybody that's there, "this is a social question and we have a viewpoint on it." "We don't come at you with something that has to be done because it's for the welfare of the animal." "We've got demands for this and that's social." Commissioners, you make your judgements and do it from the testimony that you hear." So, you know, we try to clearly define the way we do business,

we're going to get a good harvest of people if they keep it up. That kind of thing is not a quality hunt. Now, should you regulate for a quality hunt or not. Biologically it's sound. I think hunting should provide for quality, not a turkey shoot.

* In Oregon, we would have no resistance to one of our biologists, no resistance at all for him to say "hey, we've got a problem out here. We've got to have a hunter quota. It's a nonbiological proposal." What we may do is find out how the hunters feel about it, or at least forewarn them to get a reaction. We may go a year and send out a questionnaire or we may lay the proposal on them and see what we get back in the way of feedback. Now, if the roof caves in on us because somebody may not get to hunt that thinks that's the place to go, our Commission may deny us in spite of the crowd. Okay? The biologist is free to make that kind of recommendation. There's no problem there. I'm just saying that when it comes down to a biological issue his first responsibility is to do what he perceives to be biologically correct for the population. And, the social stuff, feed it to us, fine, great, and if it's a part of your recommendation we'll pass it on. But the biological would be the primary recommendation we'd make first and then address the social issues. That's what we're talking about in terms of quotas, special hunts on ag damage and whatever. All of those things that get to the Commission where the final decision lies anyway. I just suggest that the man you hire out there as a professional biologist has to consider that aspect of his responsibility first before he gets carried away on local people demands. They may want a forked-horn mule deer season and the rest of the state is spikes, so he comes on with a forked-horn recommendation. It doesn't fit. What's biologically correct in mule deer management?

* So what's biological, three or five or eight bulls per 100 cows? How does that fit in the biological scheme of things?

* Unfortunately, like it came out this morning, it's still a rather nebulous thing. Our perception of what is safe ground in the way of a bull ratio, in Colorado, may be entirely different than our perception. There is no hard and fast rule. And from one unit to the next there may be some variation because what we count on winter range may in no way reflect what's going on several months later in the rut when you've got elk coming into summer range from all directions that are fed by winter ranges with varying bull ratios from low to high. So, it's not real simple. It's not cut and dried. There has to be a lot of judgement made by the man that's practicing in the field, on what he feels comfortable with from the biological standpoint in terms of herd reproduction.

* You might be doing something biologically to maintain a few bulls out there, but it seems to me it's all being done out of social consideration though.

* We have made a move, in this plan that's basically gone into effect in 1986, in the direction of more limited entry. Most of the state that's under consideration from that standpoint, it's a biological concern. Okay? Two-thirds of the Cascades is a real concern to the biologists involved. Its about the kind of bull ratios they're counting and the kind of recruitment rates we're getting. We only have a small portion of the state, a few in the hub of the Blue Mountains in northeastern Oregon, where we

clearly specified to the Commission that a limited entry on the first of two periods, in order to distribute these hunters evenly between the two periods, was a response to the demands of the hunters to do something about crowding. It was not a biological issue. We clearly pointed out to the Commission that we're uncertain that this will do anything for the bull ratios, but it's responding to the crowding. So, if you're not concerned about crowding don't approve it. That's the distinction I'm trying to make. Most of what we did is because we had a biological concern about a chronic situation of low bull ratios. As long as we were outputting calf rates at what Rocky Mountain and Roosevelt elk traditionally put out over the years, there was no concern. But, we're beginning to see some problems with some closer scrutiny on these herds. We're building up quite a database on reproductive tracts, on what conception rates actually are. We're learning a whole lot with radiotelemetry. We're seeing in our data on just simple calf:cow ratios that in some cases we're hitting lows that we don't have any record of ever having hit that low before. Some of the reproductive data that we're getting is showing some breeding occurring well into November. These tend to be areas in which there's a heavy reliance on yearling bulls to do the breeding.

ADJOURN - IT'S LATE

TECHNICAL SESSION

A FORAGE-BASED MODEL FOR EVALUATING ELK HABITAT POTENTIAL

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Abstract: A forage-based model for evaluating habitat effectiveness for elk (*Cervus elaphus*) was developed for winter range, Packwood Ranger District, Gifford Pinchot National Forest, Washington. The model differs from others because it utilizes environmental stress to determine the desired forage/cover relationship. It can be modified to reflect stress conditions during winter, summer, or both periods. It effectively evaluates silvicultural options by rotation patterns that yield the highest habitat potential over time.

Many methods have been developed using forage production as a key element for evaluating deer (*Odocoileus hemionus columbianus*) and elk (*Cervus elaphus*) habitat. The technique described here involves the use of forage/cover ratios. It differs from other models because environmental stress generates the forage/cover ratio. The stress period can be during the summer and/or winter depending upon geographic location. The example in this text was designed around winter stress, Packwood Ranger District, Gifford Pinchot National Forest, Washington. Information generated from the model was used in the Forest Planning process using FORPLAN. This approach can also be used to generate animal numbers. The periodic use of remote sensing technology such as LANDSAT then becomes a feasible means of monitoring both habitat and animal density.

FORAGE/COVER MODEL

This forage/cover model was developed primarily for deer and elk winter range but also could be adapted for summer range. It was developed because of frustration with the correlation of habitat quality with carrying capacity and animal numbers. The model provides forest and wildlife managers with an approach, utilizing information specific to the manager's operations, for determining sustained rotation patterns and associated forage/cover ratios that yield the highest habitat potential for deer and elk (habitats that are adequate for elk will usually supply the requirements for deer). The model can be used to predict peak levels of habitat potential during the various phases of managed forest succession and results can be plotted to yield estimates of cumulative potential over time.

MODEL DESCRIPTION

A primary requisite of the model is that sufficient quantities of optimal cover be available to maintain elk populations during the most severe thermal stress periods.

To achieve a balance, the model requires that the forage element available in optimal and thermal cover during critical thermal stress periods be sufficient to maintain as many animals as the rest of the winter range supports during non-stress periods. For winter range, the following factors were incorporated into the forage/cover model: temperature stress, wind stress, snow depth, forage quantity and availability, and forest stand structure. Along with these factors, the model has inherent assumptions and limitations.

ASSUMPTIONS

The following assumptions were developed for winter range conditions on the Packwood Ranger District, Gifford Pinchot National Forest, Washington:

1. The relative forage production value for clearcuts is greater than for optimal cover, and the forage production value for optimal cover is higher than for hiding/thermal cover.

2. Elk in the Cascades of Oregon and Washington are considered to be migratory or semi-migratory.

3. The availability of winter range is the limiting factor for elk populations.

4. The availability of hiding and thermal cover is not a limiting factor, but does influence the production of animals by its relationship to forage.

5. The availability of optimal cover during the severest weather conditions is a limiting factor.

6. The size and spacing of cutting units are assumed to be optimum and are not a limiting factor.

7. Elk will normally leave open foraging areas and seek cover for protection when temperatures are outside the animals' thermal neutral zone, identified to be from 20°F. to 60°F. (Miller 1970; Leckenby 1977). When weather conditions persist that drop the temperature below 20°F and/or 18 inches or more of snow covers open foraging areas, elk will feed in optimal cover.

8. One half of the forage production in optimal cover is utilized by elk during non-critical weather periods. Therefore, half of the forage production in optimal cover must sustain the same number of elk during critical thermal stress periods as was supported by all forest stand types during the remainder of the habitat use period.

9. The period during which elk forage is available in the "clearcut" stand begins following logging and terminates when canopy or crown closure occurs.

10. Levels of harassment on elk have been controlled and are not a limiting factor.

11. A portion of the forage produced in hiding/thermal cover will be available during critical weather stress periods.

LIMITATIONS

The model does not consider forage quality, the harassment of wildlife, the relative arrangement and size of forage cover areas, or the physiological responses of elk to thermal stress periods.

DEFINITION

Optimal cover is defined as a forest stand with: 1) four layers (overstory canopy, sub-canopy, shrub layer and herbaceous layer); and 2) an overstory canopy which can intercept and hold a substantial amount of snow, yet has dispersed, small (< 1/8 acre) openings. These criteria are generally achieved when the dominant trees average 21 inches d.b.h. or greater, have 70 percent or greater crown closure, and are in the large sawtimber or old-growth stand condition (Witmer et al 1985). It is important to note that snow falling on the east side of the Cascades comes down in a powdered form. This allows the twigs to protrude through the snow and be available for the animals to feed upon. On the west side of the Cascades, generally speaking, the snow comes down in the wet form smashing the vegetation to the ground so that the forage is not available to animals when 18 inches or more covers the ground, making optimal cover very important.

MODEL VARIABLES

In order for the model to function, there are a number of variables that need to be considered. The variables listed below must be supplied by managers in order to use the model:

1. The length of time that elk normally use winter ranges. This time period will vary by geographic location.

2. The length of time that optimal forage is necessary in specific areas -- the normal length of the critical thermal stress period.

3. The period of available forage in the "clearcut" stand condition. This time period will vary by site class and the intensity of forest management (initial stocking rate of seedlings, fertilization frequency, genetic seedling stock utilized, type of herbicide treatments and frequency, thinning timetable, tree species planted, success and timing of replanting attempts, etc.).

4. The time required to meet the minimum level of optimal cover criteria. This time period varies by site and class and the intensity of forest management.

5. The relative forage production values of clearcuts, hiding/thermal cover, and optimal cover. These values will vary by geographic area and according to management practices.

6. The amount of forage produced in hiding/thermal cover that is available during the severest weather conditions. This amount, although small, will vary according to management intensity.

To illustrate changes in habitat capabilities resulting from the natural vegetative successional processes that occur in a managed stand, values for Packwood Ranger District variables were estimated. The model was then used to predict the results of generalized forest harvest options. The following values were utilized:

1. Elk utilize separate winter and summer ranges for six months each in the Cascade Mountain area (Schoen 1977; Witmer 1981; Harestad and Bunnell 1979). Only those areas below 2,200 feet elevation were considered winter range in the Cascades of the Gifford Pinchot National Forest (Ruediger and Garcia 1980).

2. The lengths of time during the wintering period that elk were solely dependent upon the forage available in optimal cover was one month. The following parameters were used to calculate this period for the Packwood Ranger District, Gifford Pinchot National Forest, Washington:

Temperature	Wind Speed (mph)	Relative Humidity(%)	Snow Depth(in.)	Chill Factor
-3.5°C (25°F)	0-4	70	18	*20°F
2°C (35°F)	5-14	0	18	20°F

The dominant factor in this method for determining thermal stress is snow depth.

*According to standard wind chill factor charts, the above criteria produce comparable stress conditions of 20°F. (Climatological Handbook, Columbia Basin States 1968; Squires 1982 personal communication; Brooks 1985 personal communication.) Over a 15-year period, 30 days per year during the six-month winter period had these conditions.

3. The length of time to reach canopy closure following clearcutting will vary by site class and success of restocking attempts. For purposes of modeling, the periods of forage availability during the regeneration process in a managed stand were assumed to be:

Site Class III - 20 Years

(Brown 1961; Hines 1973; Anderson 1971; Taylor and Johnson 1978).

4. For purposes of modeling, the attainment of an average 21 inch d.b.h. tree stand was used to designate the beginning of winter optimal cover characteristics. In a managed stand, an average of 21 inches is achieved by:

Site Class III - 100 Years

(U.S. Department of Agriculture, Silvicultural Examination and Prescription Handbook 1974).

5. Relative forage production factors were developed from available literature. Clearcuts were assigned a relative forage production factor of 5, optimal cover a factor of 1, and hiding/thermal cover a factor of 0.5 (Harshman 1971; Anderson 1971; Brown 1961).

6. Ten percent of the forage produced in hiding/thermal cover was considered to be available during critical thermal stress periods (Brown 1961; Anderson 1971).

ELEMENTS OF THE FORAGE/COVER MODEL EQUATION

The following equations are used to determine the degree of balance between the forage available to sustain elk during the most severe weather periods and that available during all other periods of time.

Best conditions are met when the number of forage equivalents produced in forage areas equals the forage available in optimal cover areas during severe weather periods.

The values calculated for forage and optimal cover areas below represent forage equivalents which is potential forage produced:

$$(F \times CC \times T_1) + (F \times HT_1 \times T_1) + (F \times 1/2\ OC \times T_1) = (F \times HT_2 \times T_2) + (F \times 1/2\ OC \times T_2)$$

Where:

* F is the relative forage production factor.
* CC is the proportion of area in clearcuts or early seral forage.
* HT_1 is the proportion of area in hiding/thermal cover minus the proportion of area on which forage is available during the critical period.
* HT_2 is the proportion of area in hiding/thermal cover where forage is available during the critical period.
* OC is the proportion of area in optimal cover.
* T_1 is the period that forage is available divided by the period that forage is used in non-critical weather.
* T_2 is the period that the forage in optimal cover is available divided by the period that forage is required during severe weather conditions.

EXAMPLE OF MODEL IMPLEMENTATION

To determine the best sustained forage/cover ratio, the manager should substitute various rotation periods until the model equation balances. Other information used should be based on local conditions and specific forestry techniques.

The following example deals with a managed forest stand on Site Class III land on the Packwood Ranger District in the Cascade Range and assumes a one-month critical thermal stress period during the winter. The rotation option demonstrated is 158 years, which is the best, given the assumptions previously listed. To compensate for inherent variability within Site Class, a 10 percent + and - range should be established for the selected rotation. In this example, optimal forage/cover ratios might be produced with rotations ranging from approximately 145 to 175 years. A 158 year rotation scheme would permit 63 acres to be harvested annually on a 9,954 acre management unit. Figures shown indicate a degree of precision unwarranted by the data but they are carried through here to maintain accuracy in the mathematical calculations. In the final analysis these figures should be rounded.

To determine the percentage of acres in clearcut forage, the number of acres cut per year under the selected rotation option should be multiplied by the time that clearcut forage is available: 63 acres x 20 years = 1,260 acres or approximately 13 percent on the management unit.

To determine the percentage or acreage in optimal cover, the period of time required for the forest stand to attain optimal cover status must be subtracted from the chosen rotation period. This value, in turn, is then multiplied by the number of acres which will be harvested each year:

158 years - 100 years = 58 years
58 years x 63 acres = 3,654 acres or approximately
37 percent of the management unit.

All remaining acreage in the management unit would be composed of hiding and thermal cover.

The forage/cover relationship would, therefore, be:

1,260 acres in clearcut forage or 13 percent
5,040 acres in hiding and thermal cover or 50 percent
3,654 acres in optimal cover or 37 percent
(expressed as 13:50:37)

Continuing with required calculations as previously discussed:

Forage Equivalents Produced

	Forage Areas	Optimal Cover Areas	Where:
Clearcut Forage			
$F \times CC \times T_1$ $5 \times 1{,}260 \times 12/5$	15,120		F = 5 forage equivalents CC = 1,260 Acres T_1 - $\frac{\text{12 months forage avail.}}{\text{5 months forage used}}$
Hiding/Thermal Cover			
$F \times HT_1 \times T$ $.5 \times 4{,}536 \times 12/5$	5,443		F = .5 forage equivalents HT_1 = 4,536 Acres T_1 = $\frac{\text{12 months forage avail.}}{\text{5 months forage used}}$
Forage Produced in Hiding/Thermal Component			
$F \times HT_2 \times T_2$ $.5 \times 504 \times 12/1$		3,024	F = .5 forage equivalents HT_2 = 504 Acres T_2 = $\frac{\text{12 months forage avail.}}{\text{1 month forage used}}$
Optimal Cover			
$F \times 1/2\ OC \times T_1$ $1 \times 1{,}827 \times 12/5$	4,385		F = 1 forage equivalent 1/2 OC = 1,827 Acres T_1 = $\frac{\text{12 months forage avail.}}{\text{5 months forage used}}$
Optimal Cover			
$F \times 1/2\ OC \times T_2$ $1 \times 1{,}827 \times 12/1$		21,924	F = 1 forage equivalent 1/2 OC = 1,827 Acres T_2 = $\frac{\text{12 months forage avail.}}{\text{1 month forage used}}$
Total forage equivalents produced	24,948	24,948	

PROCEDURE FOR EVALUATING DEVIATION FROM THE BEST SUSTAINED FOREST MANAGEMENT (ROTATION) OPTION, OR FROM THE IDEAL HABITAT CONDITION FOR ELK

Model outputs other than those yielding a balance are limiting in terms of either forage areas or optimal cover areas, depending on which side of the equation is smaller. The limiting function is always utilized to determine deviation from chosen benchmarks (the ideal habitat condition, best managed forest condition, or target objective/prescription).

When the value for optimal cover forage area equivalents is smaller, percent deviation from the best sustained managed forest scenario is calculated via division by the number of forage equivalents produced when an actual equation "balance" is achieved (considering the environmental and management criteria for the specific area being evaluated). Deviation from the ideal habitat condition that can be produced under any condition is achieved via division by the respective number of forage equivalents produced when timber production is not a constraint.

When the value for forage area equivalents is smaller, the model gives a conservative estimate of habitat potential since excess equivalents exist in optimal cover areas, and adjustment in the number of equivalents on the forage area side of the equation should be made by use of the following equation:

$$\frac{\text{Excess Optimal Cover Forage Equivalents}}{T_2} \times T_3 = \text{Supplemental Forage Area Equivalents}$$

Where:

T_3 is the months forage is available divided by the total length of the utilization period. Results are then added to the "forage areas" side of the original equation and the adjusted figure is assessed as discussed during situations with optimal cover forage equivalents as the limiting habitat function.

For example, if the forage area side of the equation had been limiting and the corresponding forage equivalents produced were 24,276 (instead of 24,948 as shown), the following calculation is made:

$$\frac{(24{,}948 - 24{,}276)}{12/1} \times 12/6 = 112$$

Where:
Excess optimal cover forage equivalents = 24,948 minus 24,276
$T_3 = \frac{12 \text{ forage equivalents avail.}}{6 \text{ forage equivalents used}}$
$T_2 = \frac{12 \text{ forage equivalents avail.}}{1 \text{ forage equivalents used}}$

Adjusted forage area equivalents then become 24,276 + 112 or 24,488

The example on Page 107 in <u>Forage Equivalents Produced</u> gave the closest "equation balance" possible and is the best viable sustained timber harvest option, considering the model variables utilized. If the chosen rotation had not produced a balance, the adjusted forage area equivalents would have been divided by that balance value to determine deviance from the best managed forest situation.

APPLICATIONS/CONCEPTS

Given the previously listed assumptions, limitations, and values selected for variables, the model was used to determine cutting cycles for a managed stand, Site Class III, that yield the highest sustainable habitat potential for elk.

Figure 1, and corresponding tables, depict relative habitat potential by rotation length for the Gifford Pinchot National Forest under a managed forest optimum on Site Class III lands. Habitat potential increases as the length of rotation options increase, until the optimum sustained forage/cover balance is achieved. Cutting cycles longer than the one where a balance is reached yield slightly lower potentials. Rotation periods prior to the peak yield forage/cover ratios are limiting in optimal cover, while those after the peak yield forage/cover ratios are forage limiting. In general, the best sustained forage/cover ratio in a managed forest on Site Class III on the Gifford Pinchot National Forest with two thinning treatments is a 13:50:37 (1 month critical thermal stress).

Based on information specific to a manager's operation and geographic location, the model could be used to display information as shown in Figure 1, and Tables 1 and 2, to track changes in potential habitat capabilities over time during virgin forest conversion and subsequent timber harvest programs. This procedure would be an integral part of the decision and planning process. Habitat potential could be predicted for any sustained cutting period or management intensity. In cases where timber production is not the dominant land use of an area, the manager could utilize the model to determine forage/cover ratios which would greatly surpass the best sustained rotation option, thereby approaching peak potentials realized only during the virgin forest conversion phase. A combination of dual rotation systems; one short, one long, for different portions of the area could be evaluated and prescribed in such situations.

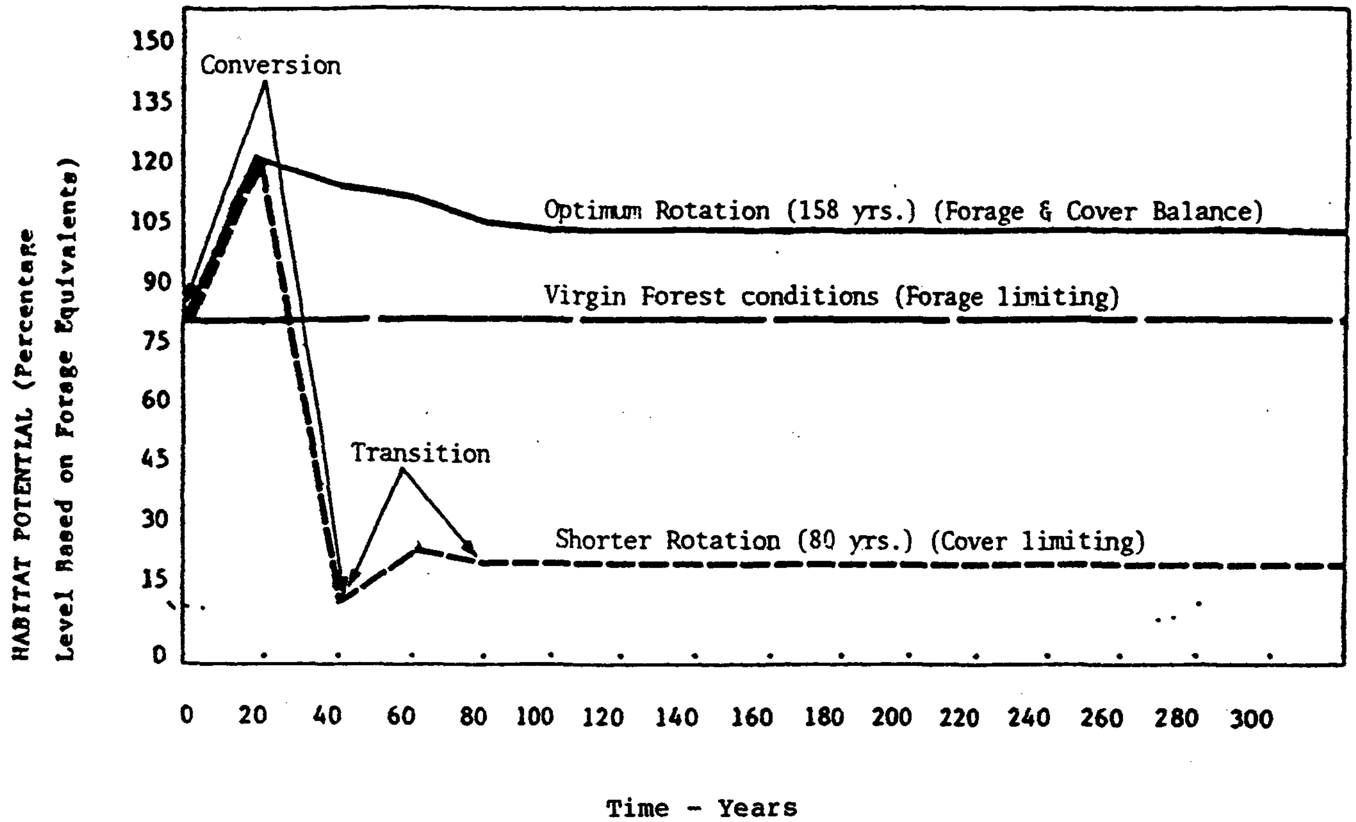
Results should always be interpreted in light of the assumptions and limitations of the model. Values used for variables should be based on the best available data and should be altered as better information is developed. As the state of the art improves, so should the model and its capabilities.

The model demonstrates an extremely important concept: when conversion of virgin forest occurs within a relatively short period of time, a sustained rotation may not be achieved for many years because the new forest stand will mature in blocks much larger than those associated with a sustained yield scenario. The period required to establish the sustained forest program can be referred to as the transition phase (see Figure 1). There is also a transition peak which refers to the elk population peak reached between the peaks that occurred during virgin forest conversion and second-growth management. Most of the commercial forest lands in western Oregon and Washington are either in the conversion or transition phases.

The length of the conversion process and management intensity selected will dictate the extent of the transition phase. When the time span necessary to accomplish virgin forest conversion is identical with the selected harvest rotation, there will be no transition period (see Figure 1) and a peak in habitat potential for deer and elk will be reached during the early stages of conversion. This level will decline during the remainder of the conversion

Fig 1. CHANGES IN HABITAT POTENTIAL

Cascade Managed Stand, Site Class III



Parameters Used: Forage available in clearcuts - 20 years, optimal cover reached at 100 years and the critical stress period - 1 month.

Habitat Potential

________ Managing for a 158-year rotation will allow for the highest forage equivalents from a managed forest standpoint. (See Plotting Points Table 1.)

___ ___ Virgin forest condition

_ _ _ _ _ Managed stand with a 40-year conversion, harvest starts again at 60 years, and an 80-year rotation. (See Plotting Points Table 2.)

When entering a virgin stand, habitat potential will vary during the conversion phase of forest harvest, and will not stabilize until a sustained rotation harvest is achieved on the entire area. This helps to explain the boom and bust situation as depicted above. This has occurred in Western Washington and in other areas.

Table 1. PLOTTING POINTS

Site Class III, 20 years available in forage, 100 years to attain a 21" d.b.h., 1 month critical thermal stress period, 158-year rotation.

Timber Stand Through Time	Forage/Cover Ratio	Forage Equivalents	Percentage Management Optimum
0	0-0-100	19,909	80
20	13-0-87	29,989	120
40	13-13-74	28,728	115
60	13-25-62	27,469	110
80	13-38-49	26,208	105
100	13-50-37	24,948	100
120	13-50-37	24,948	100
140	13-50-37	24,948	100
158	13-50-37	24,948	100
160	13-50-37	24,948	100
180	13-50-37	24,948	100
200	13-50-37	24,948	100
220	13-50-37	24,948	100
240	13-50-37	24,948	100
260	13-50-37	24,948	100

Table 2. PLOTTING POINTS

Site Class III, 20 years available in forage, 100 years to attain a 21" d.b.h., stand, 1 month critical thermal stress period, 40-year conversion, harvest starts again at 60 years and an 80-year rotation.

Timber Stand Through Time	Forage/Cover Ratio	Forage Equivalents	Percentage Management Optimum
0	0-0-100	19,909	80
20	50-0-50	29,862	120
40	50-50-0	2,988	12
60	0-100-0	5,970	24
80	25-75-0	4,482	18
100	25-75-0	4,482	18
120	25-75-0	4,482	18
140	25-75-0	4,482	18
160	25-75-0	4,482	18
180	25-75-0	4,482	18
200	25-75-0	4,482	18
220	25-75-0	4,482	18
240	25-75-0	4,482	18
260	25-75-0	4,482	18

phase and will stabilize at the beginning of the sustained rotation phase. Although shorter conversion periods produce higher peak habitat potentials, they also display a more rapid decline in potential use and stabilize at lower levels than the longer conversion periods. The cumulative habitat potential over time for a 158-year conversion and rotation is much higher than for a 40-year conversion and rotation if measured at a point in time when both options have reached habitat stability.

When the conversion period is shorter than the rotation length, there will be a transition period after conversion and before the habitat potential stabilizes. This transition period will produce a second peak in habitat potential at a lower level than the one that occurs during conversion, but at a higher level than the long-term stable potential. Habitat stability for most rotation options will be achieved when stand conditions on those areas initially harvested during the transition period start developing optimal cover characteristics. When selected cutting cycles are not long enough to allow for the development of optimal cover, habitat potential will be stabilized at the end of a transition period of comparable length to the rotation option chosen. Habitat potential for the shorter sustained rotation options stabilize earlier, but at lower levels than for longer cutting cycles.

The cumulative habitat potential for deer and elk is comparable whether or not the conversion period is equal to or less than the rotation length, if measured at a point in time when both options have reached habitat stability. However, stability in habitat potential will be reached earlier if there is no transition phase. Following the conversion phase, the intensity of management will have a direct bearing on the level of habitat potential eventually sustained.

CONCLUSION

The model provides an approach to determining the sustained rotation pattern and associated forage/cover ratio that yields the highest habitat potential for deer and elk by utilizing information specific to the manager's operations. Its primary requisite is that sufficient quantities of optimal cover are available to maintain elk populations during the most severe winter thermal stress periods. The model can also be used to predict peak levels of habitat potential during the conversion and transition phases of forest succession and these results can be plotted to yield estimates of cumulative habitat potential over time.

The obvious next step of the process is to develop a methodology to relate forage equivalents to "numbers of animals" and/or carrying capacity. This subject is addressed in the Roosevelt Elk and Black-Tailed Deer Guidelines for the Willamette National Forest by Harshman, 1985.

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DISCUSSION

Question: How do you deal with habitat effectiveness per se? How do you deal with such things as roading, or avoidance of crucial areas because of human disturbance?

Answer: Let me point this out again, because it appears I did not make it clear. This is one component. Roading is another component, and size and spacing is another. This component gives you the cover/forage ratio. It tells you how much optimal cover you have to have, and how much forage you have to have in clearcuts.

This afternoon others are going to speak about other components. I have been involved with a HEP model (Habitat Evaluation Procedure) on elk and we identified eight habitat components.

Question: Ray I have asked various members on the Gifford Pinchot National Forest this question and in some ways I can answer parts of it. From the information that I have read on elk, and I am not an expert on elk, it's been my understanding that when you get a 21 dbh (diameter breast height) stand at 100 years or so, what you really generally wind up with in a natural stand is canopy cover layer with some shrub layer underneath, but not a lot of snow interception. So, I am curious about how you are going to develop optimal cover when you have reached a 21-inch dbh stand?

Answer: Our silviculturists have told us that if we start with a clearcut, we can develop the four-layered characteristics of optimal cover. This would mean we would start with less than 400-600 trees per acre. What we have been looking at are natural stands. It takes natural stands longer to develop the four-layered characteristic.

Question: Is that going to be economically feasible?

Answer: Yes, as far as we can determine there wouldn't be a problem in developing optimal cover economically.

Question: Is that also going to be done in stands that are currently in this age category that don't have layering?

Answer: We have been working on some natural stands that don't have the layering effect. We have been planting some brush species within some of these stands that have been thinned to develop this layering. How successful this process will be in developing the layering, I'm not quite sure. Once a natural stand reaches about 60 years of age, when you try to manipulate it, it doesn't really give you the necessary results. We are working on these types of stands to see if we can resolve this problem.

Question: A couple of short questions with short answers for you. You say that the model tells you what the cover/forage ratio is for a given area once you harvest timber, is that correct?

Answer: Well, you can determine your cover/forage ratio immediately and, determine if you are at the balance point. If you are not, depending on the information, you can see how close you are to that balance. You can determine what you have to do to improve the ratio. Like I have pointed out, the model handles only one component. You have to look at size and spacing and harassment as individual components.

Question: What is the cover/forage ratio that you are trying to obtain?

Answer: The one I was showing here was basically 13 percent in forage and 37 percent in optimal cover.

Fifty percent will be in hiding and thermal cover. This is the very best you could do with a one-month stress period in the southwest Washington Cascades.

Question: Is that figure sustainable?

Answer: That is correct.

Let me add one other thing. If you are thinking about applying this data on the eastside of the Cascade situation, it is going to be difficult. Keep this in mind.

Question: How does your model deal with forage quality within the forage component?

Answer: We addressed it in forage quality. We said we would give a forage equivalent ~~forage~~ to a clearcut of 5, optimal cover 1, and hiding/thermal cover .5. Now, you need to look at your situation and determine if this data is even in your ballpark. That is the ballpark for us, but that may not be for your area. If you can improve the optimal cover value, maybe you can reduce the amount of optimal cover you have on your area. Does this answer your question?

Question: Well, maybe you can clarify it. Then in the model, it assumes that the forage quality underneath optimal cover is equivalent or better than the forage quality available out in a clearcut?

Answer: No, we said the clearcut has five forage equivalents, optimal cover 1, and hiding and thermal cover .5.

Chairman: I'd like to make a number of comments. One of them, I'd like to reiterate what Ray said concerning specific applications to your own areas. One of the frustrations we've encountered is trying to interpret everybody's approach. I doubt very much that there is a single approach that will work everywhere. So, while the model itself or the technique might work, I think we're all going to be faced with gathering data which are relevant to the area being worked. I think one of the examples of a key variable is snow. To try to use a model or approach which assumes that snow is an important variable, if you're on the south coast of Oregon, that may or may not be the right idea. Nonetheless, if you're on Vancouver Island or somewhere else, it might be a very important element.

The other issue I'd like to comment on for a second is forage quality and cover. I have to tell you that one of my frustrations is that the relationships between forage and cover are often times considered to be either/or when, in fact, I think most of us recognize that high quality forage or quantity and quality forage can mitigate deficiencies in cover. In some cases, adequate cover can mitigate some deficiencies in forage. It's really very much a relationship. It's not an either/or. We don't either have cover or have forage. I know that most of the people, probably all the people today, would agree with that. I think what this tells us is that we have really not had adequate research conducted in these westside forests dealing with forage quality, dealing with a cover and forage relationship in terms of what it really means to the animals from an energetics perspective. I think we're probably not anywhere near as far along that way as the folks that are more accustomed to working with Rocky Mountain elk.

SEASONAL RANGE HABITAT SUITABILITY INDEX MODELS FOR VANCOUVER ISLAND ROOSEVELT ELK

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Abstract: Models for the assessment of Vancouver Island Roosevelt elk (*Cervus elaphus roosevelti*) seasonal range habitat suitability are presented. The general physiographic characteristics, preferred forage availability, and interspersion of seasonal forage and cover requirements of an area are considered in the calculation of habitat suitability index (HSI) values. Mathematical relationships are presented to develop seasonal HSI values on spring ranges, summer/fall ranges, and low and high snowpack winter ranges. A discussion of the problems and proposed future development of the models is included.

The Integrated Wildlife-Intensive Forestry Research (IWIFR) program was initiated in late 1980 to examine the influences of intensive forestry activities on Vancouver Island's black-tailed deer (*Odocoileus hemionus columbianus*) and Roosevelt elk (*Cervus elaphus roosevelti*) populations. Field work on the elk portion of this study was initiated in early 1981 and currently the first phase of the program is nearing completion. A major product of this phase of the research project will be a handbook of deer, elk and forestry interactions. The models presented here were developed using the results of the IWIFR and many other research projects. More detailed versions for application of the models will be presented in the handbook.

Salwasser (1985) identified four things required to integrate wildlife habitat concerns into multiple-use forest management. One of these was a model which could relate forest conditions to wildlife outputs. The general purpose of developing these models was not only to provide a method of quantifying elk habitat suitability, but also as an educational tool to identify for forest managers, who are our most influential wildlife habitat managers, the basic seasonal requirements of elk and the positive and negative impacts their activities can have on elk habitat. While the key target audience for these models is forest managers at the planning level, wildlife habitat biologists will also find them valuable. The models will probably be most useful in the preparation and review of 5-year logging development or silvicultural plans, where a number of different management scenarios and the resulting indices of elk habitat quality can be assessed.

Procedures are outlined here for calculating seasonal elk habitat suitability index (HSI) values for assessment areas located on spring ranges, summer/fall ranges, and low and high snowpack winter ranges. Seasonal differences in component relationships within the models reflect seasonal changes in forage use and cover requirements.

Most elk on Vancouver Island are migratory. The models were developed primarily for migratory elk herds, but are considered applicable to the smaller, less numerous non-migratory herds which also occur here.

ACKNOWLEDGEMENTS

The models and relationships presented here have gone through a number of versions and many individuals have provided useful input. Doug Janz acted as project leader for the elk study from which the models were produced, and has provided useful direction throughout their evolution. Dana Becker and John Youds worked with us as project biologists in the collection and analysis of data used in model development. Les Peterson produced computer simulation models used in developing the hiding cover assessments. Brian Nyberg, Dr. Fred Bunnell, and other members of the Technical Working Group of the Integrated Wildlife Intensive Forestry Research program provided input and helpful criticisms on earlier drafts of the models. Sheila Marshall ably typed the manuscript and tables.

MODEL OVERVIEW

The models presented here demonstrate a method to assess the relative value of elk seasonal range habitat suitability by calculating HSI values ranging from 0 to 1.0, with 1.0 representing optimal conditions. The general topographic and inherent vegetative characteristics, forage abundance, and interspersion and ratios of forage and cover types are considered in the calculation of an overall Seasonal Range Suitability Index (see Fig. 1) for an assessment area.

Different relationships apply between habitat suitability assessments on spring ranges, summer/fall ranges, low snowpack winter ranges, and high snowpack winter ranges. The two Snowpack Zones which have been delineated on Vancouver Island (Fig. 2) are based on average snow depth and duration.

MODEL STEPS

A series of 10 steps are followed in the application of the models to obtain an overall Seasonal Range Suitability Index for an assessment area. The same steps are followed regardless of the seasonal range of use of the assessment area. However, different relationships will apply due to changes in seasonal forage, cover, and forage/cover ratio requirements. The steps are outlined here to illustrate the stages involved in calculating the habitat suitability indices, and in more detail in the following section on model application.

Step 1. Delineate the assessment area and determine the applicable model (spring range, summer/ fall range, Snowpack Zone A winter range, or Snowpack Zone B winter range.

Step 2. Determine the Seasonal Range Potential Suitability Index (HSI_1) from the general topographic and inherent vegetative characteristics of the assessment area.

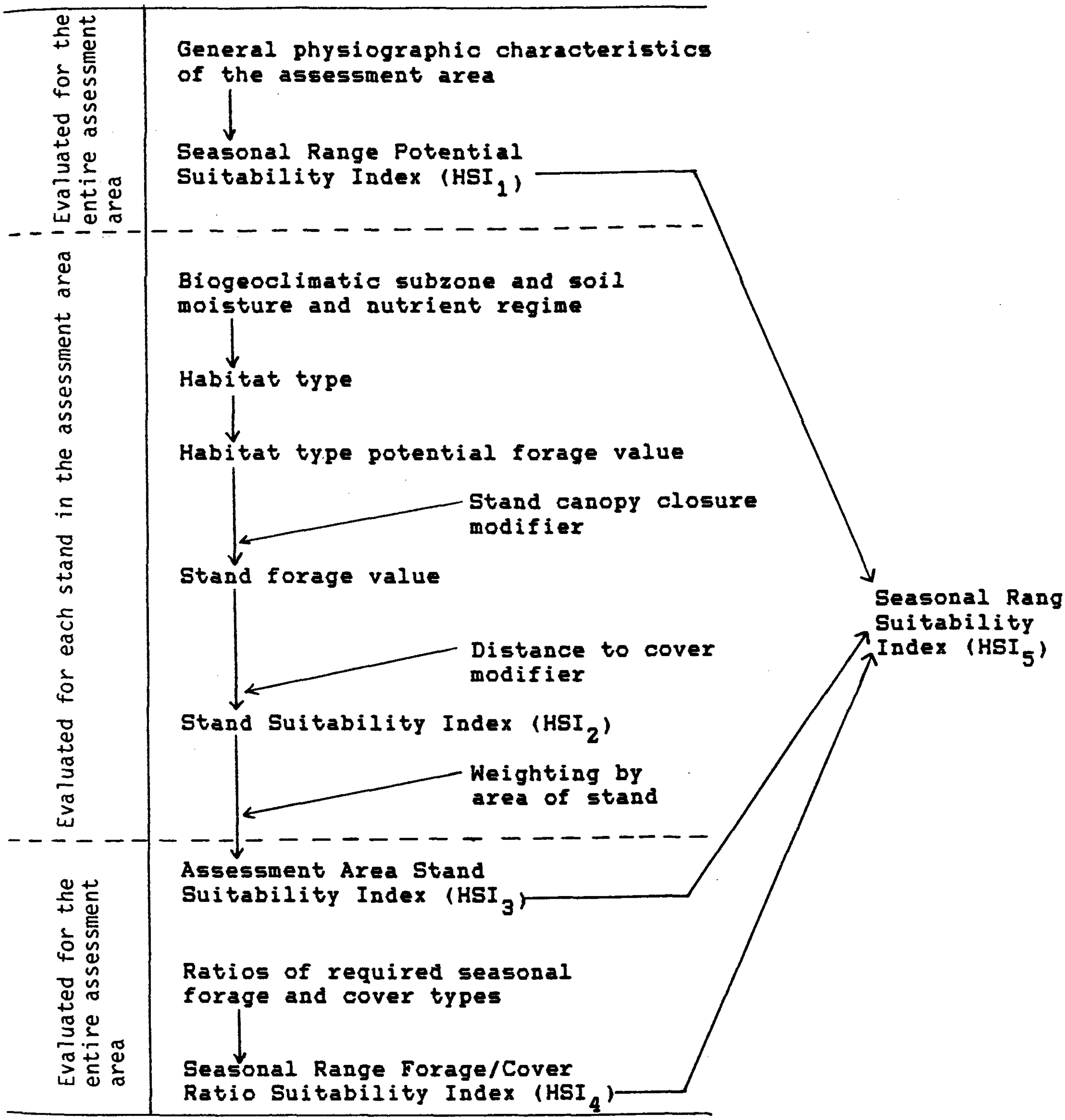

Figure 1. The general relationships in the seasonal habitat suitability index models.

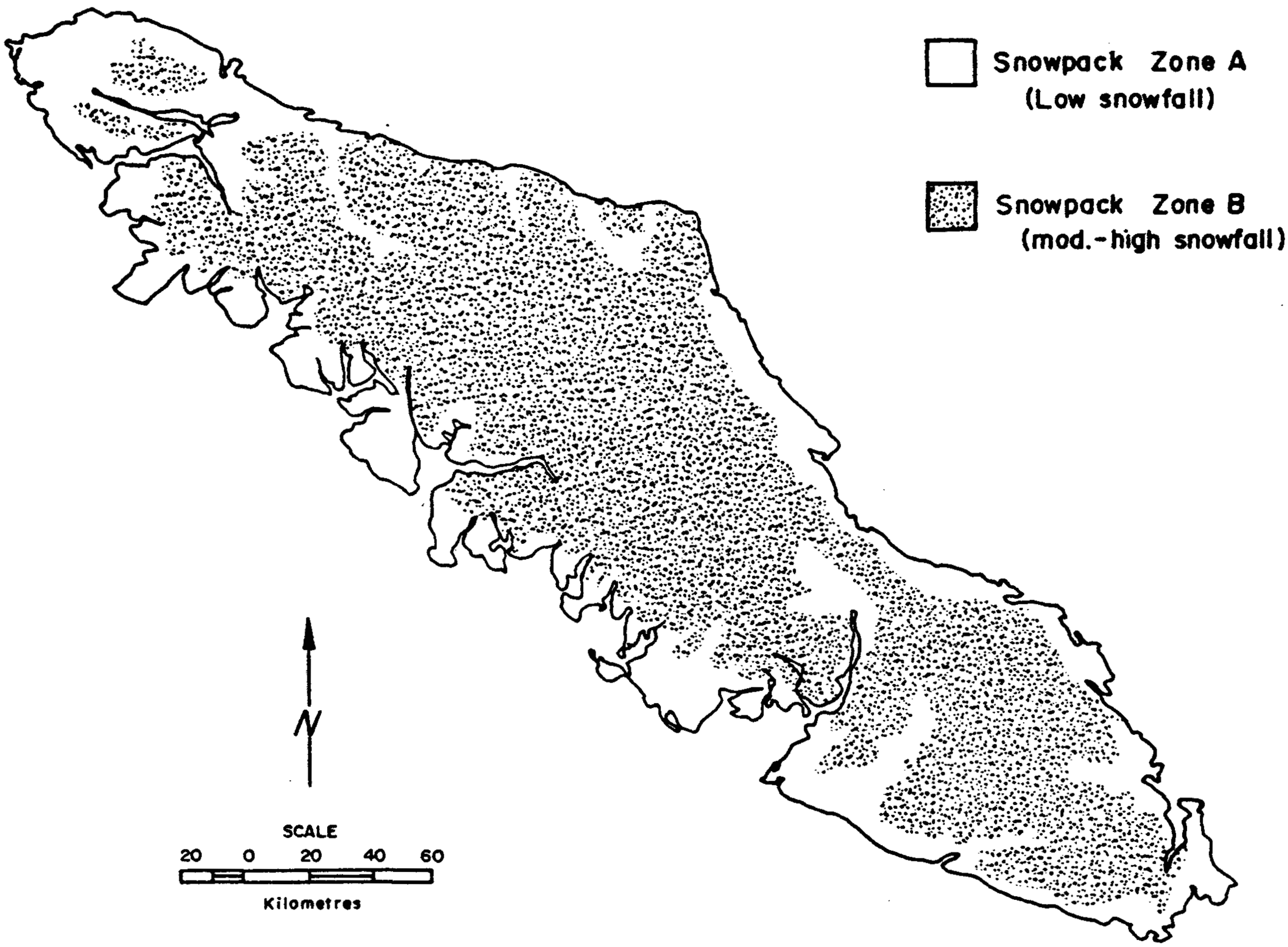

Figure 2. Snowpack Zones on Vancouver Island (modified from McNay and Doyle 1985).

Step 3. Determine habitat type boundaries within the assessment area.

Step 4. Determine stand boundaries within the assessment area.

Step 5. Calculate a stand forage value for each stand in the assessment area (habitat type potential forage value modified by stand canopy closure modifier value).

Step 6. Determine the functional type for each stand (forage, winter forage, hiding cover, or thermal cover).

Step 7. Apply a distance to cover edge modifier to each stand forage value to obtain a Stand Suitability Index (HSI_2).

Step 8. Calculate an Assessment Area Stand Suitability Index (HSI_3).

Step 9. Calculate a Seasonal Range Forage/Cover Ratio Suitability Index (HSI_4).

Step 10. Calculate an overall Seasonal Range Suitability Index (HSI_5).

MODEL APPLICATION

Step 1. Delineate the assessment area and determine the applicable model.

The selection of the assessment area is a critical step in the application of any habitat suitability model as it can strongly influence the final product of the modeling exercise. The assessment area boundary should be determined through discussions between the local forest and wildlife managers. The boundary, once determined, must not be altered between applications when using the model to estimate the impact of different habitat management scenarios. Considering elk management priorities and historical distribution of elk, wildlife managers should communicate to forest managers the relative importance of pursuing elk habitat assessments in a particular area. Incorporating elk habitat suitability index modeling into operational forestry activities is an expensive process. Limited resources of both time and money are best concentrated in areas where the anticipated benefits are the greatest. An honest, non-confrontational attitude from all parties involved is essential. Management opportunities due to land tenure and existing conditions in adjacent areas must also be considered when prioritizing areas for habitat assessments.

Due to seasonal differences in elk habitat requirements, a decision on which of the four models apply to the assessment area is necessary. Local knowledge and consulation with wildlife managers will help determine the appropriate season of actual or potential occupation of the assessment area. The general physiographic characteristics of the area can also be used to locate potential seasonal ranges (see Step 2). Elk seasonal ranges on Vancouver Island are generally 10 to 30 km^2 in size. An assessment area's boundaries should be established to encompass the entire seasonal range.

The location of the winter range determines which of the two winter models should be applied. Persistent, significant snowpacks frequently occur on the northern and inland mountainous portions of Vancouver Island. Elk wintering in this Snowpack Zone B have different habitat requirements than animals wintering in Snowpack Zone A where more mild winters usually occur.

Step 2. Determine the Seasonal Range Potential Suitability Index (HSI_1) from the general topographic and inherent vegetative characteristics of the assessment area.

Elk habitat selection at the seasonal range level appears to be for the general physiographic characteristics of an area. Vancouver Island elk seasonal ranges are consistently composed of areas of similar intrinsic characteristics. These properties cannot be produced through forest management activities but they provide a means of initially identifying an assessment area's capabilities to satisfy seasonal habitat requirements.

Based on the topographic and vegetative characteristics of the assessment area, Tables 1, 2, 3, and 4 identify the means to calculate HSI_1 as the n^{th} root of the appropriate suitability indices. We believe the geometric mean is the most representative manner in which different components combine to affect habitat suitability.

This step not only provides an initial estimate of an assessment area's potential seasonal range capabilities but is also useful to land managers in identifying where elk habitat management activities might best be undertaken.

Table 1. Relative proportions of topographic and inherent vegetative characteristics of an assessment area and the corresponding suitability indices used in calculating a Potential Seasonal Range Suitability Index (HSI_1*) for spring ranges.

Topographic/Vegetative Characteristics				
Percent of area with slope of 10-50% and aspect from 110° to 250° (a)	Percent of area in vegetated rock bluffs with slope & aspect as in (a) (b)	Percent of area in non-forested wetlands (bogs, meadows and estuaries) (c)	Percent of area in riparian habitat (50 m either side of a stream or river) (d)	Suitability Index (SI)
>50	>20	>10	>10	1.0
20-50	10-20	5-10	5-10	0.75
<20	<10	<5	<5	0.50

$$\text{*Spring range } HSI_1 = (SI_a * SI_b * SI_c * SI_d)^{\frac{1}{4}}$$

Table 2. Relative proportions of topographic and inherent vegetative characteristics of an assessment area and the corresponding suitability indices used in calculating a Potential Seasonal Range Suitability Index (HSI_1*) for summer/fall ranges.

Topographic/Vegetative Characteristics			
Percent of area in vegetated slide habitat (a)	Percent of area in non-forested wetlands (b)	Percent of area in riparian habitat (c)	Suitability Index (SI)
>10	>20	>10	1.0
5-10	5-20	5-10	0.75
<5	<5	<5	0.50

*Spring/fall range $HSI_1 = (SI_a * SI_b * SI_c)^{\frac{1}{3}}$

Table 3. Relative proportions of topographic and inherent vegetative characteristics of an assessment area and the corresponding suitability indices used in calculating a Potential Seasonal Range Suitability Index (HSI_1*) for Snowpack Zone A winter ranges.

Topographic/Vegetative Characteristics					
Elevation (m) (a)	Percent of area with slope of 10-50% & aspect from 110° to 250° (b)	Percent of area in vegetated rock bluffs with slope & aspect as in (b) (c)	Percent of area in non-forested wetlands (d)	Percent of area in riparian habitat (e)	Suitability Index (SI)
<400	>50	>10	>15	>15	1.0
400-600	10-50	5-10	5-15	5-15	0.75
>600	<10	<5	<5	<5	0.50

*Snowpack Zone A winter range $HSI_1 = (SI_a * SI_b * SI_c * SI_d * SI_e)^{\frac{1}{5}}$

Table 4. Relative proportions of topographic and inherent vegetative characteristics of an assessment area and the corresponding suitability indices used in calculating a Potential Seasonal Range Suitability Index (HSI_1*) for Snowpack Zone B winter ranges.

Topographic/Vegetative Characteristics					
Elevation (m) (a)	Percent of area with slope of 10-50% & aspect from 110° to 250° (b)	Percent of area in vegetated rock bluffs with slope & aspect as in (b) (c)	Percent of area in non-forested wetlands (d)	Percent of area in riparian habitat (e)	Suitability Index (SI)
<300	>50	>15	>10	>10	1.0
300-500	20-50	10-15	5-10	5-10	0.75
>500	<20	<10	<5	<5	0.50

*Snowpack Zone B winter range $HSI_1 = (SI_a * SI_b * SI_c * SI_d * SI_e)^{\frac{1}{5}}$

Step 3. Delineate habitat type boundaries within the assessment area.

Habitat types are vegetation units differentiated by environmental parameters which includes all the plant communities that may occur on a particular site through time. They are named after the vegetation that consistently characterizes the site. We have delineated 26 habitat types on Vancouver Island (Table 5).

Habitat type delineation allows us to assess the potential forage quality and quantity within the assessment area. Habitat types are determined by conducting a site diagnosis (Green et al. 1984) which is a procedure used to evaluate the quality of forest sites using three site elements: climate (represented by Biogeoclimatic Units[1]), soil moisture (hygrotope[2]) and soil nutrients (trophotope[3]). The vegetation present on a site is mainly the reflection of the combined influence of these three elements.

[1] Biogeoclimatic Units represent large areas of land which are under the influence of similar regional climates.

[2] Hygrotope is defined as the capacity of a soil to supply available water for plant growth. Potential hygrotope refers to the potential capacity of a soil to hold and lose or receive water based on its properties and relief, regardless of climate.

[3] Trophotope, which is defined as the capacity of a soil to supply nutrients for growth, can be inferred from soils properties.

Biogeoclimatic units for Vancouver Island have been mapped at a scale of 1:500000 (Nuzsdorfer 1984). Refinement of boundaries at a larger scale can be done using elevation and other unit characteristics described by Klinka et al. (1984).

Environmental factors influencing soil moisture and soil nutrient regimes are listed in Table 6. Characteristics of most factors can be derived from air photos and topographc, soils and terrain maps. With these characteristics a site diagnosis is carried out to determine soil moisture and soil nutrient regimes for the combined physiographic and soils polygons. With this information, and the Biogeoclimatic Unit, coniferous stand habitat types can be determined from Table 7. Non-coniferous stands and areas can be easily mapped from air photos, topographic, biogeoclimatic, and forest cover maps. Coniferous habitat type boundaries are determined using physiographic and soils polygon boundaries.

Table 5. Habitat types of Vancouver Island.

Coniferous Stands

Lichen - Salal
Lichen - Moss
Lichen - Pink mountain heather
Salal - Huckleberry
Salal - Dull Oregon grape

Huckleberry - Dull Oregon grape
Huckleberry - Moss
Moss - Dull Oregon grape
Moss
Huckleberry - Rosy twistedstalk
Rosy twistedstalk - Five-leaved bramble
Deer fern
Sword fern
Salmonberry
Sphagnum
Sphagnum - Deer fern
Sphagnum - Hardhack
Skunk cabbage

Non-Coniferous Stands and Areas

Wetlands (bogs, meadows, estuaries)
Rock outcrops
Alder/Maple stands
Garry oak/Arbutus stands
Cottonwood and other riparian deciduous stands
Mountain hemlock parkland
Alpine tundra
Vegetated apline slides

Table 6. Environmental factors influencing hygrotope and trophotope.

Hygrotope	Hygrotope and Trophotope	Trophotope
slope aspect*	slope gradient*	humus form
thickness of forest floor	slope position*	coarse fragment lithology
	slope shape	Ae horizon
	soil texture*	
	coarse fragment content*	
	soil depth*	
	presence of seepage or gleying*	
	organic matter content	
	flooding*	
	soil porosity	
	parent material*	

*Can be obtained from air photos and topographic, soils, and terrain maps.

Step 4. Determine stand boundaries within the assessment area.

Stand boundaries can be delineated from forest cover maps and air photos. If a stand polygon has two or more habitat types within it, it must be divided into more than one stand along the habitat type boundaries.

Step 5. Calculate a stand forage value for each stand in the assessment area.

From the work of the IWIFR and the B.C. Ministry of Forest Biogeoclimatic Ecosystem Classification (BEC) programs, seasonal potential forage values were assigned to each habitat type (Table 8). These values represent the maximum potential production of important seasonal forage species taking into account elk preference from seasonal use/availability information for spring, summer/fall and winter (Table 9). These values are assumed to occur under optimal light conditions for growth. The actual amount of light available in a stand for forage production is related to canopy closure. Table 10 presents forage production modifier values related to specific canopy closure classes. To derive a stand forage value, multiply the habitat type potential forage value for the stand (Table 8), by the forage production modifier value for the canopy closure of the stand (Table 10).

Habitat use research in the IWIFR program has illustrated an almost complete avoidance by elk of stands thinned at 20 to 40 years of age where the resulting debris has not been removed. In the late 1970's, a large number of stands on Vancouver Island in this age class were thinned in an attempt to catch up with a huge backlog of stands which should have ideally been thinned

Table 7. Determining habitat types from Biogeoclimatic Units and soil moisture and nutrient regimes.

Biogeo-climatic Unit[1]	SNR[2]	Soil Moisture Regime (Potential Hygrotope)[3] 0	1	2	3	4	5	6	7
CDF	A B	Lichen-Salal			Salal-Huckleberry		Moss		Sphagnum-Hardhack
	C D E				Salal-Dull Oregon grape		Sword fern	Salmon-berry	Skunk cabbage
CWHa1	A B	Lichen - Salal		Salal-Huckleberry	Huckleberry-Moss		Deer fern		Sphagnum-Hardhack
	C D E			Moss-Dull Oregon Grape			Sword fern	Salmon-berry	Skunk cabbage
CWHb1	A B	Lichen - Salal	Salal - Huckleberry		Huckleberry - Moss		Deer fern		Sphagnum-Deer Fern
	C D E				Moss		Sword fern	Salmon-berry	Skunk cabbage
CWHb3	A B	Lichen - Salal	Salal-Huckleberry		Huckleberry - Moss		Deer fern		Sphagnum-Deer Fern
	C D E		Salal-Dull Oregon grape				Sword fern	Salmon-berry	Skunk cabbage
CWHd	A	Lichen - Salal	Salal-Huckleberry			Deer fern			Sphagnum
	B C D E					Sword fern			Skunk cabbage
CWHb2	A B	Lichen - Salal	Moss	Huckleberry-Moss		Deer fern			Sphagnum-Deer fern
	C D E					Rosy twistedstalk-5-leaved bramble			Skunk cabbage
CWHb4	A B C	Lichen - Salal	Huckleberry - Moss				Deer fern		Sphagnum-Deer fern
	C D E		Huckleberry Dull Oregon grape				Rosy twistedstalk-5-leaved bramble		Skunk cabbage
MHa	A B C	Lichen-Pink mountain heather	Huckleberry-Moss				Deer fern		Sphagnum-Deer fern
	D E				Huckleberry - Rosy twistedstalk		Rosy twistedstalk-5-leaved bramble		Skunk cabbage

[1] CDF - Coastal Douglas-fir Zone
CWHa1 - Vancouver Island Drier Maritime Coastal Western Hemlock Variant
CWHb1 - Windward Submontane Maritime Wetter Coastal Western Hemlock Variant
CWHb3 - Leeward Submontane Maritime Wetter Coastal Western Hemlock Variant
CWHd - Hypermaritime Coastal Western Subzone
CWHb2 - Windward Montane Maritime Wetter Coastal Western Hemlock Variant
CWHb4 - Leeward Montane Maritime Wetter Coastal Western Hemlock Variant
MHa - Maritime Forested Mountain Hemlock Subzone

[2] Soil Nutrient Regime - Nutrient A- very poor, B- poor, C- medium, D- rich, E- very rich.

[3] Potential Hygrotope Classes - 0- very xeric, 1- xeric, 2- subxeric, 3-submesic, 4- mesic, 5- subhygric, 6- hygric, 7- subhydric.

at around 12 to 15 years of age. Virtually no wood was removed from these areas and the stems of relatively large trees which were felled have resulted in debris depths of up to 3 m. This excessive debris persists for many years making it impossible for elk to use the stand.

Fortunately, these "back-log spaced" stands are considered to be largely a thing of the past now that juvenile spacing activities have generally caught up. Any back-log spaced stand should be assigned a stand forage value of 0. Back-log spaced stands are defined as:

1. any stand thinned at greater than 20 years of age;

Table 8. Potential seasonal forage values for habitat types of Vancouver Island.

Habitat Types	Potential seasonal forage values		
	Winter	Spring	Summer/Fall
Coniferous Stands			
Lichen-Salal	.2	.3	.1
Lichen-Moss	.1	.1	.1
Lichen-Pink mountain heather	.1	.2	.2
Salal-Huckleberry	.4	.1	.2
Salal-Dull Oregon grape	.4	.1	.3
Huckleberry-Dull Oregon grape	.3	.1	.4
Huckleberry-Moss	.2	.3	.3
Moss-Dull Oregon grape	.2	.1	.3
Moss	.1	.1	.1
Huckleberry-Rosy twistedstalk	.1	.2	.1
Rosy twistedstalk-Five-leaved bramble	.3	.2	.3
Deer fern	.5	.6	.6
Sword fern	.8	.8	.7
Salmonberry	.8	.9	.8
Sphagnum	.1	.1	.1
Sphagnum-Deer fern	.2	.2	.2
Sphagnum-Hardhack	.2	.3	.2
Skunk cabbage	.8	.8	.7
Non-Coniferous Stands and Areas			
Wetlands (bogs, meadows, estuaries)	1.0	1.0	.9
Rock outcrops	.3	.4	.2
Alder/Maple stands	.8	.8	.8
Garry oak/Arbutus stands	.1	.1	.1
Cottonwood and other riparian deciduous stands	.6	.6	.5
Mountain hemlock parkland	.1	.1	.1
Alpine tundra	.1	.1	.1
Vegetated alpine slides	.5	.4	1.0

Table 9. Prioritized list (in decreasing order of preference) of forage species used for developing forage values by seasonal range.

Spring Range	Summer/Fall	Winter
Grasses	Deer fern	Grasses
Deer fern	Western redcedar	Deer fern
Sedges	Dull Oregon grape	Western hemlock
Sword fern	Red elderberry	Sedges
Skunk cabbage	Wall-lettuce	Skunk cabbage
Ninebark	Sword fern	Devil's club
Salmonberry	Bunchberry	Twinflower
Devil's club	Grasses	Red elderberry
Hardhack	Twinflower	Ninebark
Bunchberry	Sedges	Western redcedar
Western hemlock	Salmonberry	Amabilis fir
Amabilis fir	Lady fern	Douglas fir
Douglas fir	Skunk cabbage	Lady fern
	Devil's club	Dull Oregon grape
	Ninebark	Huckleberries & blueberries
	Amabilis fir	Sword fern
	Western hemlock	*Rubus* spp.
		Salal

Table 10. Stand canopy closure classes and corresponding forage production modifier values.

Canopy closure class	Modifier values
0-15	1.00
16-25	0.95
26-35	0.90
36-45	0.75
46-55	0.60
56-65	0.50
66-75	0.35
76-85	0.20
86-95	0.10
96-100	0.05

2. with a pre-spaced density greater than 2000 stems per hectare, and

3. no substantial removal of wood from timber sale or firewood collection activities after thinning.

Step 6. Determine the functional type of each stand (forage, winter forage, hiding cover, or thermal cover).

An important consideration in the assessment of elk seasonal habitat suitability is the interspersion and relative amounts of the two basic elk life requisites, food and cover. (Water is considered a superabundant resource on Vancouver Island and the availability of free water is not considered in these assessments. Elk preference for moist habitats is considered to be in response to forage quality and quantity associated with these areas and was covered in Step 5.)

Managed forests lack the heterogeneity of old-growth forests which possess the mixture of forage and cover resources which Roosevelt elk have evolved to efficiently utilize. Logging activities create relatively large, homogeneous areas which tend to function better as either forage or cover areas at different successional stages. In order to assess the interspersion and relative amounts of required seasonal forage and cover areas, the stands within the assessment area must be classified. The four functional types of stands (two each of forage and cover) used in these models are defined as follows:

1. <u>Forage Areas</u>

- coniferous dominated stands with an overstory canopy closure less than 60%;

- deciduous overstory dominated stands;

- non-forested wetlands (bogs, meadows and estuaries);

- riparian areas (50 m either side of a stream or river);

- vegetated natural slide areas; and

- vegetated rock outcrops.

2. <u>Winter Forage Areas</u> (required only on Snowpack Zone B winter ranges)

- coniferous dominated stands greater than 10 m in height with a canopy closure between 60 and 80%.

These stands provide an acceptable blend of snow interception and forage production to maximize forage availability when snowpacks are present on Zone B winter ranges.

3. Hiding Cover Areas

Thomas et al. (1979) defined appropriate hiding cover as vegetation capable of hiding 90% of a standing adult elk from the view of a human at a distance equal to or less than 61 m. Using this definition, a number of computer simulation models were developed to provide a means of assessing whether or not a stand qualifies as adequate hiding cover. Table 11 outlines a method of identifying suitable hiding cover when stand density and diameter (dbh) are known. Tree boles and the lower branches of younger stands were considered to contribute to the ability of a stand to function as hiding cover. The contributions of understory vegetation and topography are recognized for their ability to enhance a stand's capacity to function as hiding cover, but these factors must be considered on a stand-by-stand basis. This is beyond the scope of these models which are geared to planning level forest and wildlife managers and meant to be applicable without on-site data collection.

Growth and yield tables calculated by Mitchell and Cameron (1985) were used to construct Table 12 which outlines criteria for identifying adequate hiding cover when only stand height and canopy closure are known.

Additional prerequisites are that stands must be at least 3 m in height and 120 m in width to qualify as hiding cover. The minimum height requirement insures that a standing elk will be hidden from view, while the minimum stand width insures that elk will be hidden from view from all sides while in a stand surrounded by stands not qualifying as hiding cover. Adjacent stands which alone may be too narrow to qualify as cover may together qualify when their combined width is considered.

Table 11. Determining a stand's ability to function as hiding cover from stand density and diameter at breast height (dbh). (Stands must be at least 3 m in height and 120 m in width.)

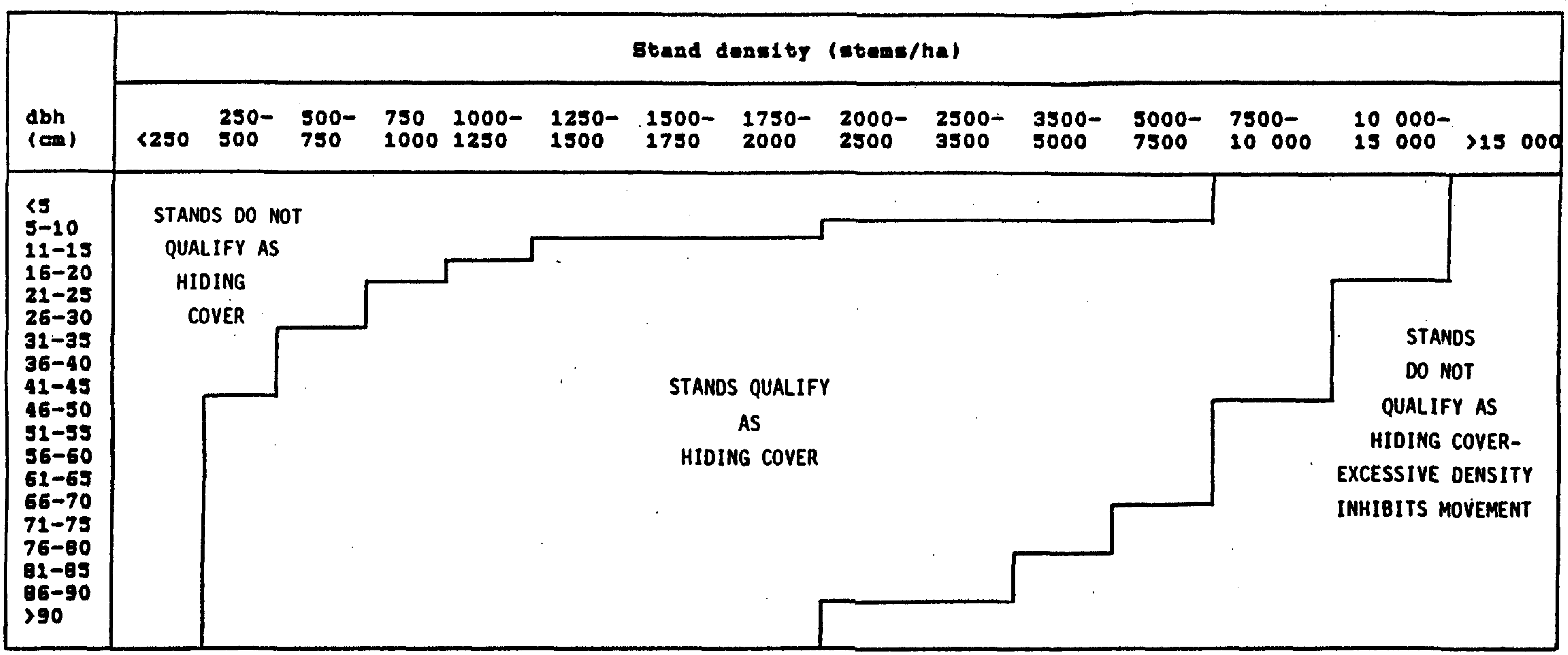

Table 12. Determining a stand's ability to function as hiding cover when only canopy closure and stand height are known. (Stands must be least 3 m in height and 120 m in width).

Stand Height (m)	Canopy Closure (%)		
	>25	25-50	>50
3-4	stands	stands	qualify
5-7	do not	as	hiding
>7	qualify hiding	as cover	cover

4. <u>Thermal Cover Areas</u> (required only on summer/fall and Snowpack Zone B winter ranges)

- coniferous dominated stands, qualifying as hiding cover, with an average height greater than 10 m and a canopy closure exceeding 80%.

Elk have an apparent tolerance of severe temperatures (Parker 1983). This makes the requirement for thermal cover questionable in Vancouver Island's relatively mild maritime climate. However, heavy use of cooler, moist, shaded areas on summer/fall ranges has been observed. Also, prolonged soaking from precipitation, especially when associated with low temperatures and wind, may create an energetic requirement for stands which ameliorate these conditions. Until further research can be conducted, thermal cover will be considered a requirement on summer/fall and Snowpack Zone B winter ranges.

Not all of the four functional types of forage and cover areas defined above are required in each seasonal range. Stands occurring on spring range or Snowpack Zone A winter range assessment areas, need only be classified as either forage or hiding cover areas. Assessments of summer/fall range areas require stands to be classified as either forage, hiding, or thermal cover. Snowpack Zone B winter ranges require stands in each of the four functional types.

It should be noted that certain stands may qualify as more than one functional type. In those instances, stands should be classified as the type which maximizes the Forage/Cover Ratio Suitability Index calculated in step 8.

Step 7. Apply a distance to cover edge modifier to each stand forage value to obtain a Stand Suitability Index (HSI_2).

Disproportionate use by elk of both forage and cover areas near their common edge has been documented on Vancouver Island (Janz 1980, Youds et al. 1985) as well as in a large number of other studies (reviewed by Skovlin 1982). Step 7 is a method of developing and applying a suitability index modifier based on the distances of relative proportions of stands to a hiding or thermal cover edge. Stands which qualify as cover (hiding or thermal) are assigned a modifier value of 1.0. Table 13 is used to develop the modifier for all other stands which is then applied to the previously calculated stand forage value (step 5) to calculate a Stand Suitability Index (HSI_2).

This step places limits on the size of forage areas (i.e., clearcuts). It is one of the most time consuming steps in the application of the HSI models presented and for that reason, only forage areas are assessed in this manner. Upper limits on cover area sizes are imposed in an indirect fashion in step 9 dealing with seasonal forage/cover ratios. Together, steps 7 and 9 handle the interspersion of food and cover more efficiently than examining distance to edge of both forage and cover stands in the assessment area.

Step 8. Calculate an Assessment Area Stand Suitability Index (HSI_3).

Forage availability and distance to cover for each stand in the assessment area were used in calculating the Stand Suitability Index (HSI_2). In order to evaluate the contribution of these variables to seasonal range habitat quality, the HSI_2 of each stand is weighted by area and summed to produce an Assessment Area Stand Suitability Index (HSI_3).

$$HSI_3 = \frac{\sum_{i=}^{n} (HSI_2 \text{ of stand } i * \text{area of stand } i)}{\text{total assessment area}}$$

Table 13. Determining the distance to cover modifier from the relative proportions of a stand within various distances to cover (hiding or thermal).

Percent of stand within the distance to cover limits	Modifier Values			
	Distance to cover limits (m)			
	0-140	141-250	251-300	>300
95-100	1.0	0.6	0.4	0.1
85-94	0.8	0.5	0.3	0.1
65-84	0.7	0.4	0.2	0.1
45-64	0.6	0.3	0.1	0.05
25-44	0.4	0.2	0.05	0.05
5-24	0.2	0.1	0.05	0.01
<5	0.1	0.05	0.01	0.01

Note:

- Stands already qualifying as cover (hiding or thermal) are assigned a modifier of 1.0.
- The distance to cover modifier is calculated as a sum of the appropriate modifier values from the above table for the various proportions of a stand within the distance to cover limits. The maximum value that can be obtained is 1.0. This modifier is calculated for all stands and applied to the previously calculated stand forage value to obtain Stand Suitability Index HSI_2.

Step 9. Calculate a Seasonal Range Forage/Cover Ratio Suitability Index (HSI_4).

Elk seasonal habitat use research has provided insights into desirable interspersion and ratios of different functional types of forage and cover areas in managed forests. Up to two types each of forage and cover areas are required, depending on the season of use and location (in the case of winter ranges) of the assessment area. Tables 14-17 are used to develop a suitability index based on the relative proportions of the various types of forage and cover stands within the area for spring, summer/fall, Zone A winter and Zone B winter ranges respectively. This Seasonal Range Forage/Cover ratio Suitability Index will be identified as HSI_4. When stands qualify as more than one functional type, they should be classified as the type which maximizes the index.

Table 14. Relative proportions of stand functional types and corresponding Seasonal Range Forage/Cover Ratio Suitability Index (HSI_4) values for spring ranges.

Percent of assessment area in forage	Percent of assessment area in cover	HSI_4
65-75	25-35	1.0
50-64 or 76-80	20-24 or 34-50	0.8
40-49 or 81-85	15-19 or 51-60	0.6
30-39 or 86-90	10-14 or 61-70	0.4
<30 or >90	<10 or >70	0.1

Step 10. Calculate an overall Seasonal Range Suitability Index (HSI_5).

The geometric mean of the three assessment area HSI values (HSI_1, HSI_3, and HSI_4) constitutes the Seasonal Range Suitability Index (HSI_5).

$$HSI_5 = (HSI_1, * HSI_3 * HSI_4)^{\frac{1}{3}}$$

Figure 3 reviews the steps in applications of the models and the information sources used to calculate the model component suitability indices and modifier values.

Table 15. Relative proportions of stand functional types and corresponding suitability indices used to calculate the Seasonal Range Forage/Cover Ratio Suitability Index (HSI_4*) on summer/fall ranges.

Percent of assessment area qualifying as:			Suitability Index (SI)
Forage (A)	Thermal Cover (B)	Hiding Cover (C)	
65-75	9-10**	15-25	1.0
50-64 or 76-80	7-8.9	12-14 or 26-50	0.8
40-49 or 81-85	6-6.9	9-11 or 51-60	0.6
30-39 or 86-90	5-5.9	6-8 or 61-70	0.4
<30 or >90	<5	<6 or >70	0.1

- *HSI_4 is calculated as the geometric mean of the suitability indices listed above for the relative proportions of the various functional types in the assessment area:

$$HSI_3 = (SI_A * SI_B * SI_C)^{\frac{1}{3}}$$

- **If >10% of the assessment area qualifies as thermal cover, classify that proportion over 10% as hiding cover.

Table 16. Relative proportions of stand functional types and corresponding Seasonal Range Forage/Cover Ratio Suitability Index (HSI_4) values for Snowpack Zone A winter ranges.

Percent of assessment area in forage	Percent of Assessment area in cover	HSI_4
55-65	35-45	1.0
40-54 or 66-75	25-34 or 46-60	0.8
35-39 or 76-80	20-24 or 61-65	0.6
30-34 or 81-85	15-19 or 66-70	0.4
<30 or >85	<15 or >70	0.1

Table 17. Relative proportions of stand functional types and corresponding suitability indices used in calculating the Seasonal Range Forage/Cover Ratio Suitability Index (HSI_4*) on Snowpack Zone B winter ranges.

Percent of assessment area qualifying as:				Suitability Index (SI)
Winter Forage (A)	Other Forage (B)	Thermal Cover (C)	Hiding Cover (D)	
20-30	30-40	9-10**	25-35	1.0
15-19 or 31-40	25-29 or 41-50	7-8.9	20-24 or 36-50	0.8
10-14 or 41-50	20-24 or 51-60	6-6.9	15-19 or 51-60	0.6
5-9 or 51-60	15-19 or 61-70	5-5.9	10-14 or 61-70	0.4
<5 or >60	<15 or >70	<5	<10 or >70	0.1

- *HSI_4 is calculated as the geometric mean of the suitability indices listed above for the relative proportions of the various functional types in the assessment area:

$$HSI_4 = (SI_A * SI_B * SI_C * SI_D)^{\frac{1}{4}}$$

- **If >10% of the assessment area qualifies as thermal cover, classify that proportion over 10% as hiding cover.

Step	Step Description	Information Sources	Output
1	Delineate assessment area and determine seasonal model applicable	-Consults between wildlife and forestry personnel -Figures 1 and 2 -Tables 1-4	
2	Determine Seasonal Range Potential Suitability Index (HSI_1)	-Air photos -Forest cover and topographic maps -Tables 1-4	HSI_1
3	Determine habitat type boundaries	-BGC subzone maps -Air photos -Topographic, soils, & terrain maps -Table 7	
4	Determine stand boundaries	-Air photos -Forest cover maps	
5	Calculate a stand forage value	-Table 8 -Table 10	Habitat type forage value x Stand canopy closure modifier ↓ Stand forage value
6	Determine the functional type of each stand	-As defined in text -Air photos & forest cover maps -Tables 11 and 12	
7	Apply a distance to cover modifier to each stand forage value to obtain a Stand Suitability Index (HSI_2)	-Distance to edge and areas from air photos & forest cover maps -Table 13	Stand forage value x Distance to cover modifier ↓ HSI_2
8	Calculate an Assessment Area Stand Suitability Index (HSI_3)	-Areas from air photos & forest cover maps	HSI_2's weighted by area ↓ HSI_3
9	Calculate a Seasonal Range Forage/Cover Ratio Suitability Index (HSI_4)	-Functional types from Step 6 -Areas from air photos & forest cover maps -Tables 14-17	HSI_4
10	Calculate an overall Seasonal Range Suitability Index (HSI_5)		$(HSI_1 * HSI_3 * HSI_4)^{\frac{1}{3}}$ ↓ HSI_5

Figure 3. The steps, information sources and suitability indices in the models.

DISCUSSION

The various HSI index values obtained as a result of model application will be useful for a number of purposes. The Seasonal Range Potential Suitability Index (HSI_1), obtained by examining the general physiographic characteristics of the assessment area, can help determine where habitat management efforts may be best concentrated by estimating an area's inherent capability to satisfy elk seasonal habitat requirements. Stand forage values and the Stand Suitability Index (HSI_2) can be used to identify how modifications of canopy closure and distance to cover (stand size and shape) can affect habitat suitability at the stand level. The Assessment Area Forage/Cover Ratio Suitability Index (HSI_3) shows how changes in the relative amounts of the required seasonal forage and cover functional types can affect an area's quality as elk habitat. Finally, the overall Seasonal Range Suitability Index (HSI_5) can be used to assess the relative impact of different forest management scenarios, or to compare seasonal range habitat quality between areas.

The relationships in the HSI models presented here were developed from elk habitat use information obtained from IWIFR studies and a number of other research programs. An inherent problem with this process is that observed preference may not clearly reflect animal requirements. Simply supplying habitat components of the type and in the proportions which appear preferred from habitat use research may not be optimizing population productivity. However, observed habitat preference does provide useful information on the integration by the animal of the many environmental variables which influence their ability to survive and reproduce successfully, and is presently our best approximation of that process. Future research is planned to examine the energetic requirements of thermal cover on Vancouver Island (Bunnell et al. 1985). This may provide insights into the problem of preference vs. requirement, but for the time being it is considered wise to assume a relationship between habitat preference and habitat requirements. The goal of providing models which relate forest conditons to wildlife outputs is not completely satisfied by the models presented here. The greatest challenge to future development of the models will be to specifically relate HSI values to elk population performance.

Continuing refinement of the models is planned for the next phase of the IWIFR elk program, including testing and evaluation in different watersheds throughout Vancouver Island. The present models are meant to be applicable to the planning level of forest and wildlife habitat management activities and the collection of field data is not required. However, site-specific data will improve the accuracy of the models and a field level version is planned which will use data collected during operational diagnoses of forest site quality. Also, the models are presently useful at developing a "snapshot" assessment of seasonal habitat suitability. Introduction of the temporal aspect in future versions will greatly improve the power of the models to evaluate habitat quality through successional changes.

Throughout the development of this and earlier versions of the models, the problem of how to "add up" the individual component relationships has repeatedly haunted us. Although we can be reasonably confident in the general relationships, the next step of considering the relative importance of these components and how they might combine with, and compensate one another, is difficult to determine. Unfortunately, simple statements on the general relationships of elk habitat ecology, while certainly more defensible, do not provide a method of quantitatively assessing the overall impact of habitat management activities. Further testing and refinements will improve the accuracy and predictive ability of the models.

Earlier versions, including a trial application, of the models outlined here were presented to a group of forest and wildlife managers from our target audience. Discussions and follow-up questionnaires indicated that although all participants agreed that the process was desirable, forest managers in particular felt that the actual application was quite time consuming and would place unreasonable demands on already busy schedules. Several possible solutions to this problem arise. Firstly, an intensive effort of follow-up presentations after delivery of the models will be required to demystify their application and prove that their implementation will help avoid the similarly time-expensive confrontations that presently arise between forest and wildlife managers. Secondly, computerization of the process could help speed model application. However, logistical problems of a common computer system aside, computerization could tend to bury the basic ecological principles used to develop the models. A "black box" spitting out HSI values can hardly be considered an educational tool. Finally, a general desire or mandate to consider integrated management of both forest and wildlife resources must be sought so that wildife habitat impact assessments are an accepted part of the forest management process. The development and refinement of accurate HSI models is only a preliminary step. Insuring their acceptance and implementation by the target audience is of paramount importance if true integrated forest and wildlife management is to occur.

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DISCUSSION

Question: It wasn't clear to me when you talked about forage, were you talking about quantity or quality, or both, and how you integrated it.

Answer: I guess we'll let the animals decide about quality because we're using food habits and use availability information. We made up a list of preferred species by season and considered the potential for production of those particular species on a seasonal range basis for each of the 26 habitat types.

Question: This is more of a comment to Kim. I am working with an eastside model which deal with cover and forage and the quality of forage and cover. Not only forest managers but biologists get models dumped on their desks -- okay go for it guys. Its been very frustrating reeducating the people you've been working with that models can be very useful tools. I appreciate you putting in that selection in a very important part -- don't just dump a model on someone and then not tell them how to use it.

Answer: I might add that in earlier versions of these models, we sort of tried it out on a target audience of forest and wildlife managers and the basic opinion that came back was, yes it's a good idea. They say "I think it's something that we need, but it's just going to take too long to implement the bloody thing because of the paperwork on our desks." That is a real problem that has to be dealt with. Computerization might reduce the amount of time that is needed to actually apply the model. We would require a common computer base and a lot of education on how to apply it. It becomes a bit of a black box where you plug in all your information and out spits an HSI. Of course, we automatically lose the major goal I mentioned about education on basic habitat ecology interactions. So, a lot of education is required and hopefully we prove to people that what we're doing is worthwhile and it should be implemented.

Question: Kim, one of the factors in Ray Scharphs's model dealt with the notion that for a certain critical time each winter, these clearcuts wouldn't be available. How does your model deal with that?

Answer: On the so-called "Zone-B" winter range areas of Vancouver Island which may experience deep snows frequently, there is a requirement for one of those forage or cover types called "winter forage areas." In the forage:cover ratio suitability index, an optimum is 10 percent of the total area in that particular type. So, we're hoping that proportion, in some of those areas which receive heavier snowpacks, will satisfy forage requirements in infrequent heavy snowfall periods. So it's a particular type that hopefully will satisfy that. That's a requirement on those winter ranges.

Question: The two previous questions about forage and then about the cover spacing models. The criterion used to develop your SI values for foraging habitats. Did you develop a preference list and then a productivity quotient to and rated the two to get your .1 through 1 value?

Answer: Right. Which is, of course the amalgamation of a huge amount of data.

Question: Okay, so it is based on field data at that level?

Answer: Yes, seasonally-collected field data too, both in use-availability plus our habitat ecologist knowing what the relative production of each of those forage species in each of those habitat types; we developed a list that way.

Questions: Okay, and what's your forage/cover ratios. You just gave one of 10 percent being optimum for the heavy snowpack zone. Was that also based on field data then?

Answer: Unfortunately, one of the main goals when we first went into this five-year research program was to document elk habitat requirements in a severe winter. So, we were all geared up. Subsequently, we had four winters that were milder than any of those on record. We've been thwarted somewhat and that particular minimum requirement has been pulled out of the literature more than anything else.

Questions: Do you have a geographical area that you're applying this model to? In other words, are you looking at all of Vancouver Island, or have you broken it into smaller segments? How do you handle that?

Answer: We're assuming applicability across Vancouver Island and also to a portion of the mainland coast where presently elk don't occur. But, there are some possible transplants in the works. I talked about the handbook that we'll be coming out with, on deer/elk and forestry interactions. So, our area of applicability is a little larger right now than elk currently occur because of the deer. It's going hand in hand with the deer section, so we wanted to include the same area of applicability which includes parts of the mainland coast where elk don't currently occur. But, it's proposed since some transplants may happen there within the next couple of years.

Chairman: Another attribute of the model which I appreciate, although I know very little about modeling, is that it's common for people to criticize a model based upon the lack of data. I think the data used to develop this model were fairly general. The model is appropriate for a planning level. It's common to criticize models because they don't have the right data upon which to be based. But, one value of the model that I've appreciated is that sometimes by organizing the model and seeing if it'll run, we frequently will come up with a good bit of insight concerning where we ought to be going with our future research. Maybe in the long run that's as much a value as the actual output of the model.

HABITAT PRODUCTION INDEX

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Abstract: The Habitat Production Index (HPI) is a method of evaluating the productivity of deer and elk habitat and is based on the concept of **maximizing energy intake** and **minimizing energy use** by deer and elk; in other words, adequate forage is available next to adequate cover. The evaluation is based on the effect of human activity (i.e. logging, recreation, etc.) on the amount of "HPI forage acres" available and forage utilized.

"HPI forage acres" are based on deductions for; access (slope, depth of slash, etc.); the size and shape of forage areas (i.e., clearcut or shelterwood units, meadows, etc.); the distance to suitable "bedding areas" in adequate cover; the acres where road traffic reduces foraging; the acres of cover removed on travelways; and additions from increasing forage quanity and/or quality through habitat improvement.

Determination "HPI forage acres" can be accomplished at three levels;

Level 1 = Recon
Level 2 = Forage and cover use
Level 3 = Forage utilization

Level 1 or recon is a field examination of each forage unit to determine forage use and bedding as affected by roads, cover, size, etc. A minimum "walk through" is used to determine "HPI forage acres."

Level 2 requires an intensive field examination (1) for pattern of forage use; (2) for bedding areas in cover blocks; and (3) to locate travelways. Data from elk telemetry monitoring can greatly assist in selecting areas to sample in these three areas.

Level 3 is an intensive sampling to determine pounds per acre utilized on "HPI Forage acres."

In R-6 U.S. Forest Service, descriptions and locations of forage areas (i.e. clearcuts, shelterwoods, meadows, commercial thinnings, etc.) can be extracted from the Total Resource Inventory data base. Landsat overlays on orthophoto quads can also be used in conjunction with harvest records.

After the field examination the data is analyzed to:

1. Compare the "HPI forage acres" with the selected forage/cover ratio which indicates the rate of harvest. For an evenflow of forage 20 percent will be in forage (or less than 6" d.b.h.), 30 percent will be in thermal shade (6" to 11" d.b.h.) and 50 percent in thermal minimum snow intercept. For

evenflow forage/cover ratio would be; forage 10 percent, thermal shade 15 percent, thermal minimum snow intercept 25 percent and optimal cover 50 percent.

2. Prescribe mitigating measures for activities such as logging. These measures would include:

   a) Road management (i.e. closing, screening) of each specific road or segment of road. In western Oregon roads are necessary for managing a forest, and it is the management of these roads that can meet deer and elk needs (i.e. security areas, increase in "HPI forage acres" and cover block use).

   b) Location, size, shape and scheduling of individual timber harvest units as they affect forage use, cover blocks, travelways and accessibility.

   c) Amount and location of forage improvement practices to increase the "HPI forage acres" to meet the selected forage component of the forage/cover ratio.

3. Level 1 data can be used to compare the actual changes in habitat acres to determine if the goals in RPA are being met. For the National Forests that are using an index to animal production in their Forest plan, Level 3 examinations are needed to make the comparision between the actual index and the goal.

There are disadvantages to this method:

1. It requires field examinations to provide reliable data on actual animal use patterns, rather than "dry lab" the effect in the office with precise research data from eastern mongolia.

2. It requires "show me" trips for the land managers to understand the system.

3. Determination of Level 3 (pounds per acre utilized) requires a well-trained professional.

4. Development of management plans require the biologist to have sound and complete data to incorporate deer and elk needs into the plans (i.e. timber harvest, geothermal, etc.).

5. It does not tell the land manager that they are bad, but how well they are meeting the wildlife goal or how they can be "HEROS" by producing all forest resources including deer and elk.

The complete details will be in the publication "Roosevelt Elk and Black-tailed Deer Guidelines" by E. Harshman and R. Jubber (in prep.).

DISCUSSION

Question: Your 80:20 forage ratio, is that based on a sustainable level of forage over time or are you optimizing with that 20 percent?

Answer: If you're on a 100 year rotation, you should be cutting 1 percent per year and the forage lasts 20 years. Then you are on a sustained forage sustained timber volume cut.

Question: How does that relate if we were optimizing for elk. If we were going to optimize for elk would it be higher, or lower, or is this just what you get?

Answer: That's what you get. The way to raise it would be to go into forage improvement and increase the quality on the units.

Question: What if we had more acres of forage, like 30 percent and 40 percent forage?

Answer: You can't sustain it over time.

If you have a 100 year rotation, cutting one percent of the area per year, and forage lasts 20 years, you're always at 20 percent. Now the 20 years applies to site 3. Twenty percent still applies to site 1, but your forage only lasts ten years and cutting two percent of the area.

Question: So you're not going to dedicate any lands for forage, you're going to rotate all forage lands across time?

Answer: That's correct. If you want to dedicate it, you go to level 5 where you want to maximize numbers. You want to farm it just like Jewell Meadows.

Question: It's interesting to note that the model I presented and the one you just did, the only difference is your stress period is 20 days and mine is 30 days. So, it turns out the same thing is what he's showing right there.

Answer: Thank you.

Question: In your experience trying to apply this model, have you gone back and field-checked actual productivity or in some fashion have you tied in to an elk response? How closely do the elk actually respond to your prediction of how they will respond?

Answer: This model was just put together about September 1983. Based on what Bob Jubber and I were seeing and all the biologists on the Willamette Forest, they should react this way. You remember the slide on good and poor, where we've gone from the poor situation, to the good situation and we've seen responses with elk numbers increasing. We need more time to go out and do HPI. I have several examples and I cite them in this publication. I'm working with Bud Adams and we have a large area where we're going to see what the other models come up with versus what this HPI comes up with.

Chairman: Thank you Ed. I have one more comment. It doesn't really relate entirely to Ed's or anyone's presentations. Again, it's this issue of forage quality and quantity. We certainly need to know more about these now. I think any of these models assume that there will be a response in forage, following logging, of some sort. It's very difficult to sort out what kind of a response we're talking about. For those of you that are not familiar with the Pacific Northwest or a coast site, it's frequently considered that forage quality is more of a problem than forage quantity. I think that biomass is quite abundant. I think that the next step on any of these models is that we need to validate, to work with the actual response of these communities, with regard to forage quality, following logging or treatment. I believe that that will yield us some benefits in a hurry.

SOME IMPORTANT ELK-FOREST HABITAT RELATIONSHIPS FOR WESTERN OREGON AND WASHINGTON

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MICHAEL WISDOM, Bureau of Land Management, Coos Bay, OR 97420

It was over 50 years ago that Aldo Leopold (1933) suggested that the management of a wildlife species must include consideration of the basics of space, water, food, cover, and interspersion. Now, in 1986, we still design our wildlife studies and management practices around those factors. Granted, we have gotten a little more sophisticated: we now use radiotelemetry, remote sensing, and rather elaborate mechanical devices to monitor and manage wildlife species and their habitats.

I would like to present some basic, yet very important, Roosevelt elk habitat relationships that we identified for the deer and elk chapter (Witmer et al., 1985) of the recent Forest Service publication, Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington (Brown, 1985). Identification of these relationships was necessary so that the needs of elk could be better integrated with forestry practices and other human activities occurring in the vast forestlands of western Oregon and Washington. It was also important to define these basic relationships so that specific elk habitat evaluation methods, elk management prescriptions, and models of elk habitat use could be developed and applied. Examples of each of these applications will be presented by other speakers in this workshop.

After a few introductory comments and precautions, I will briefly discuss each of these relationships: space and water, forage areas, cover areas, an interspersion component, and the roading/disturbance component. Perhaps only the last of these is new to the list of Leopold's basics.

One of the substantial difficulties the dozen or so of us working on the chapter faced was the variability of climate and geography of regions occupied by Roosevelt elk. Life is very different for elk living in the Olympics versus the southern Oregon Coast Range, and even for elk in the North Cascades versus South Cascades. Superimpose these differences upon the natural variability that occurs in habitat-use patterns by elk in any of those areas and you see the problem we had. But basic patterns still exist, and we wanted

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* Work funded in part by the U.S. Department of Agriculture, Forest Service, while the senior author was a research associate in the Department of Forest Science, Oregon State University.

to define them. The main precaution that I wish to express is that generalizations should not be substituted in full for site-specific information and better resolution of these relationships. Furthermore, while elk respond broadly to the landscape in which they live, the patterns of use we expect are always tempered by the presence of key areas or special habitats. These are rutting areas, calving areas, some wetland and riparian areas, and certain topographic benches. Where these areas are within the home range, elk will go out of their way to make heavy use of them during certain times of the year. Again, on-the-ground identification of these areas of heavy use should be incorporated into management practices and habitat evaluation.

SPACE AND WATER

During a given season, a herd of elk will use an area of about 1,000 to 6,000 acres. All the seasonal needs of the herd must be met in that area. For resident herds, all annual needs must be met in that area. For migratory herds, both summer and winter ranges must be managed, often differently, to provide for the well-being of the herd. Furthermore, the herd must have continued access, via traditional migration routes, to both ranges. Good management practices for elk must provide for adequately sized areas; if the management units are too large or too small, successful management of the elk herd may be impossible.

Elk require water on a daily basis. Indeed, Roosevelt elk appear particularly adapted to wet climates and habitats. Water is generally plentiful in western Oregon and Washington. July through September can be fairly warm and dry months, however, so elk often concentrate around wetlands or in riparian areas. Fortunately, these areas usually receive special treatment in management programs and regulations because of their unique value to many species and to proper ecosystem functioning.

FORAGE AREAS

Roosevelt elk spend a large amount of time feeding, both during the day and night. They meet their large energy requirement by foraging on a wide variety of plant species and plant parts; however, they are considered to be primarily grazers of grasses and forbs.

A prerequisite to abundant grass and forb cover is a relative lack of canopy cover. Once the forest canopy reaches--and then exceeds--about 60 percent, the quantity (and often quality) of understory forage begins to decline rapidly (Figure 1). Consequently, early forest successional stages--grass/forb, shrub, and open sapling/pole--provide the most forage for elk other than meadows and pastureland, which may or may not be available to a given elk herd. Additionally, areas that have received any combination of burning, fertilizing, or forage-seeding treatment provide better forage areas for elk, primarily through the improved nutritional quality of the forage. One exception to the use of open areas as primary foraging areas will be considered in the next section.

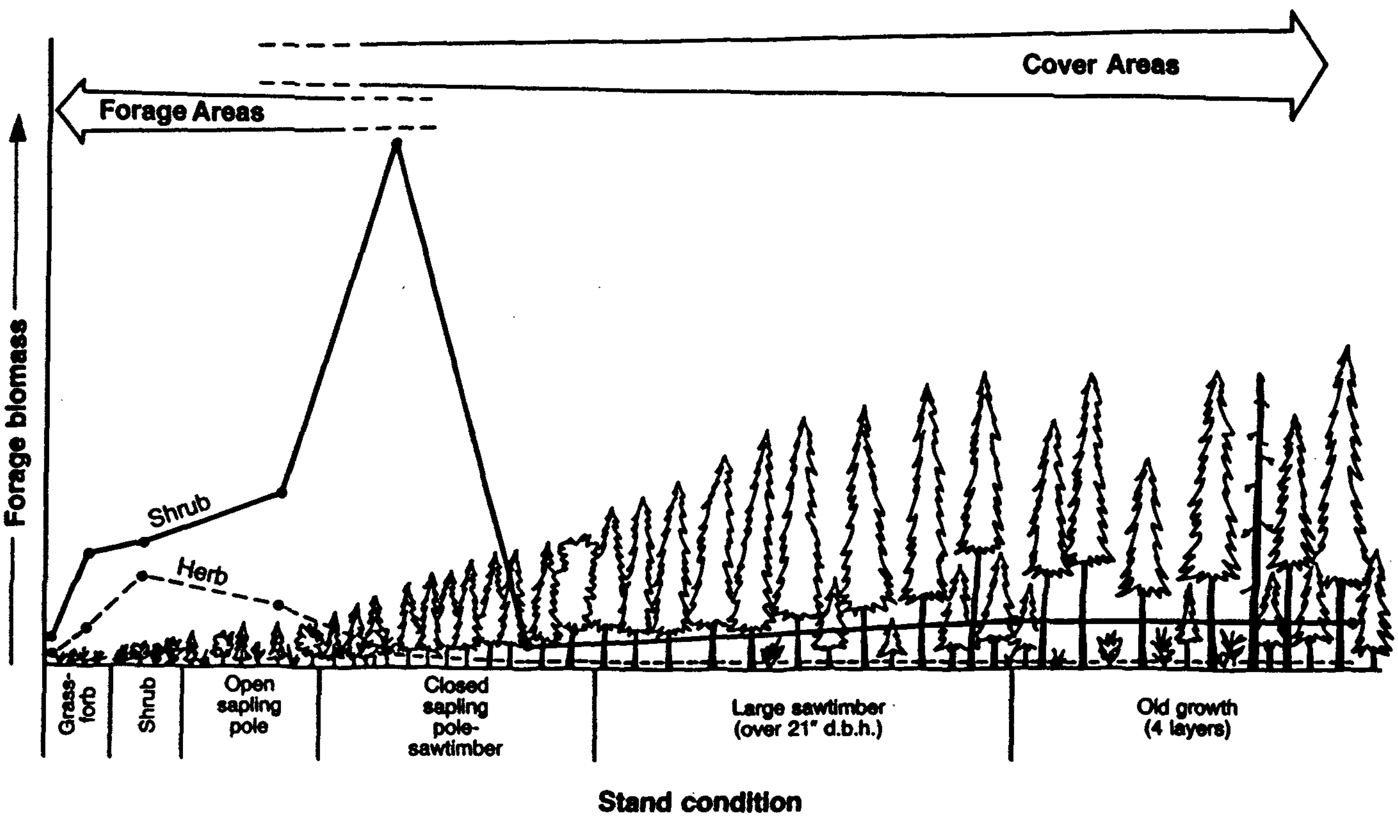

Figure 1. Relationship of forest stand condition (or seral stage) with elk forage and cover areas (from Witmer et al., 1985).

COVER AREAS

Due to site variabilities and natural or human-caused disturbances, forest stands in western Oregon and Washington exhibit wide variation in composition and structure. Our understanding of the use of cover by wildlife has increased over the years. We now know that elk use forest stands for several purposes, and not all stands provide for their needs at any given time. The use of cover allows elk to conserve energy that would otherwise be used to elude potential predators or to generate body heat to counteract inclement weather. The three main uses of cover by elk are for (1) visual screening from disturbance by humans or predators; (2) a more favorable thermal regime, both in summer and winter, than occurs in forest openings; and (3) snow interception, resulting in reduced snow depths while providing maintenance forage to sustain elk during periods of heavy snowfall. Forest successional stages that provide for each of these purposes are called hiding, thermal, and optimal cover, respectively (Figure 2). While in cover, elk loaf or bed down, ruminate, and occasionally feed on whatever forage is available. Optimal cover--provided by some large sawtimber and most old-growth stands--is truly optimal since it can provide for all the cover needs of elk. Of course, as forest management intensifies and the forest is further fragmented for various uses, the amount of optimal cover available for elk is reduced, as is the amount of supplemental forage. Elk herds are forced to make do with only hiding and thermal cover more and more each decade. In most cases, these herds are able to maintain themselves, if not thrive, until that occasional severe winter which substantially reduces the size of the herd.

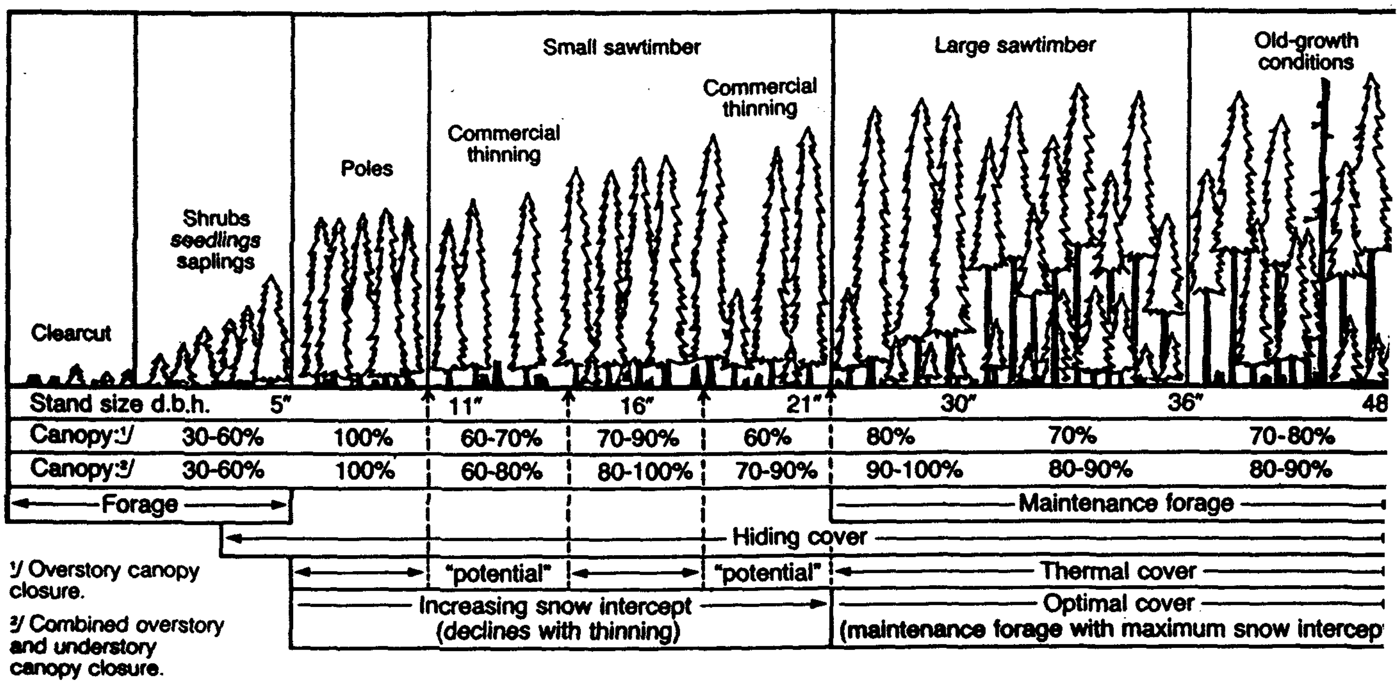

Figure 2. Elk habitat conditions illustrating the relationship of described cover types to stand size and age (from Witmer et al., 1985).

INTERSPERSION COMPONENT

I have discussed the importance of forage and cover areas to elk and have mentioned that not all forage areas nor cover areas are of equal value to elk. Because elk need to balance the acquisition of energy (from forage areas) with the use and conservation of energy (by moving and using cover areas), they tend to use edge areas more than they use areas either far from cover or far from abundant forage (Figure 3). More specifically, elk use of forage areas more than 400 feet from forest cover declines dramatically as the distance increases (Figure 4). This relationship is especially true where elk are hunted or subjected to irregular disturbance patterns. Many elk herds using protected areas or national park lands respond similarly because they spend a part of the year (often winter) outside the park, where they may be subjected to hunting, poaching, and other disturbances.

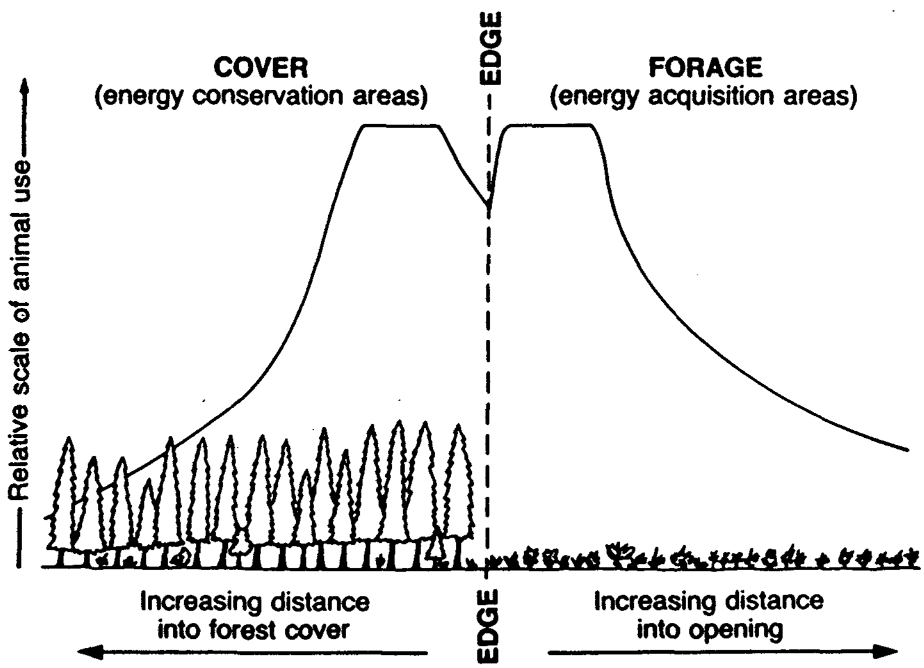

Figure 3. Generalized relationship of elk habitat use as measured from edge (from Witmer et al., 1985).

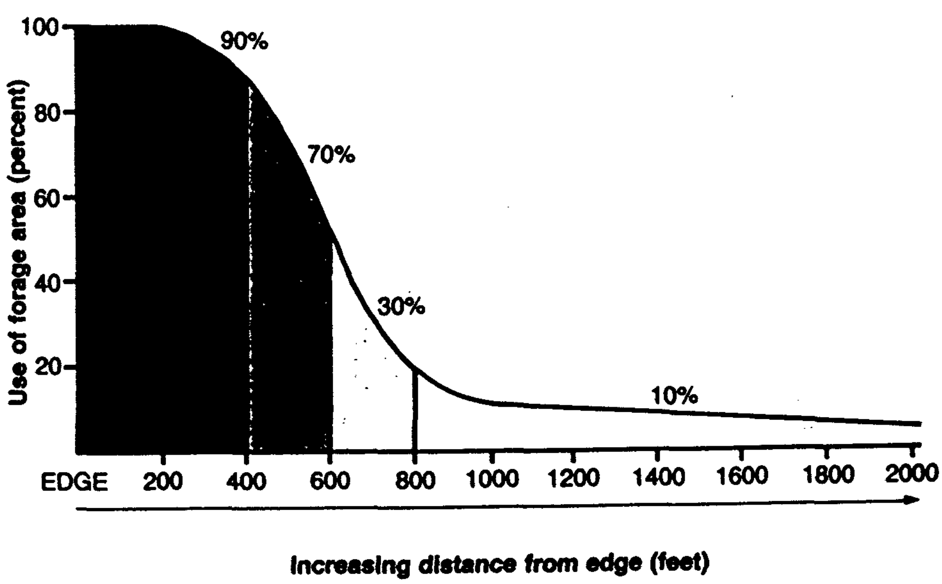

Figure 4. The generalized influence of distance to edge on elk use of forage areas (from Witmer et al., 1985).

A similar relationship holds for the use of cover areas (Figure 5). Note, however, that elk apparently have to go some distance, perhaps 400 feet or more, into the cover stand before their cover needs are met. At lesser distances into a cover stand they are, perhaps, still exposed to inclement weather or are within the visual range of potential predators. Use of cover stands drops off dramatically more than about 1,000 feet from the edge of the cover stand with a forage area. Presumably, elk do not usually go farther into cover stands because there is little to be gained and more energy would be expanded in travel between bouts of foraging and resting/ruminating.

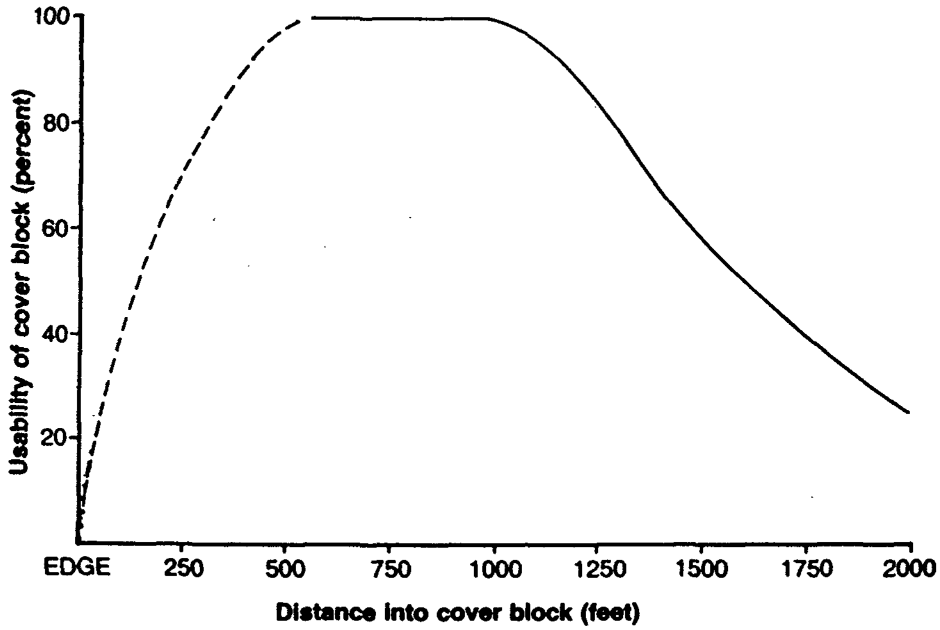

Figure 5. The influence of distance to edge on elk use of cover stands (from Witmer et al., 1985).

The management implications of these special relationships are clear and usually are incorporated into forest management practices on public lands. A pattern of small clearcuts interspersed among high-quality cover stands, with the arrangement maintained over time, is most likely to provide for the long-term needs of an elk herd.

ROADING/DISTURBANCE COMPONENT

The final relationship I want to discuss involves the influence of human disturbance on elk habitat use. Although distburbance can occur in many ways, it is often directly or indirectly associated with forest roads. Roads are necessary for the use and management of forestland. Densities of roads on intensively managed forestland often exceed three miles of road per square mile of forestland. It is the use of roads by humans, not the roads themselves, that disturbs elk. Of course, if roads are paved or gravel surfaced they preclude potential forage or cover habitat. Furthermore, where roads are closed to vehicular traffic, elk will often use them as travel routes between, for example, preferred foraging and bedding areas. Elk will often become accustomed to roads if these roads receive regular vehicular traffic but the vehicles do not stop or people do not get out.

Unfortunately, this is not often the case, so that elk respond adversely to forest roads. The pattern we have observed for Roosevelt elk (Figure 6) is very similar to the well-established pattern for Rocky Mountain elk. Because secondary forest roads are not paved, and are less travelled, elk do not respond as adversely to secondary roads as they do to primary forest roads. The pattern is, in actuality, more complicated because of varying amounts of forest cover along roads and varying topographic positions of roads.

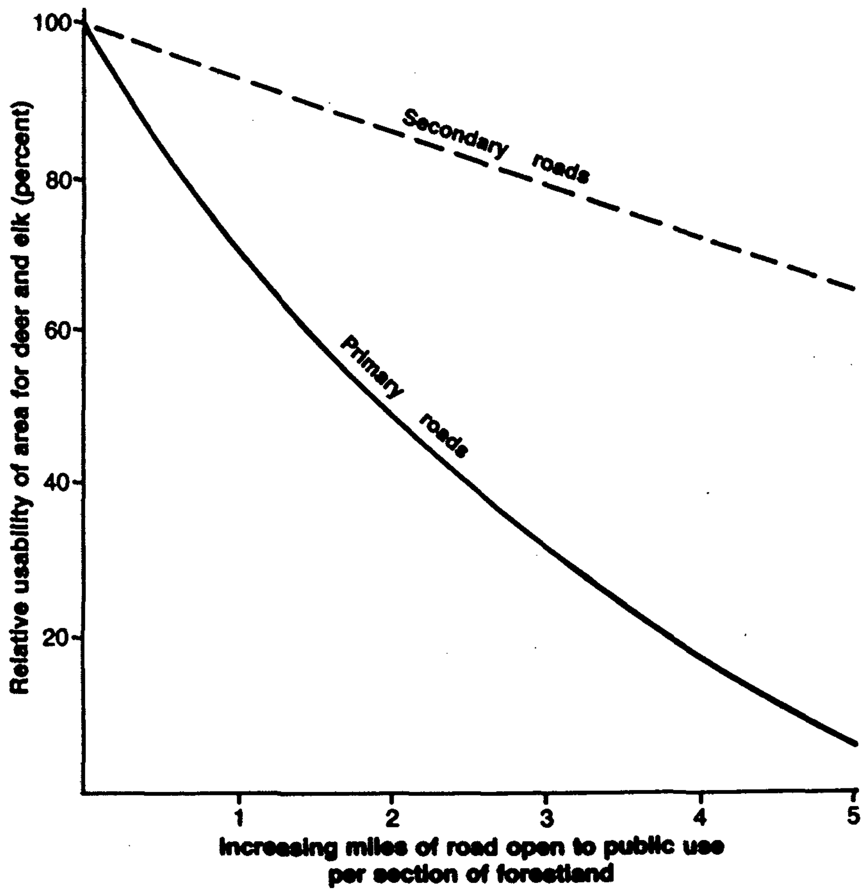

Figure 6. Generalized influence of increasing open road density on otherwise usable habitat (from Witmer et al., 1985).

Again, there are clear management implications in this relationship. If elk herds are to thrive on managed forestland, there must also be an element of people management. This can perhaps be most effectively achieved by extensive, yet flexible, road-management programs.

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DISCUSSION

Question: Again, it's in my point of view as much as a question. You said some things very well. One of the things that's happening in the Pacific Northwest these days is that there is a fancy for various groups to square off into camps with regard to old growth necessary for Roosevelt elk. Various times I've read in the newspapers that old growth is required by Roosevelt elk. I agree with the contention that Roosevelt elk are fairly early seral species and will use open areas and meadows. I'm a little confused as to how we're going to handle all this. I think we've all had experience of reading our own research and everything from an environmental statement to a newspaper article and wondering who did the work. This is a very controversial issue. You've been involved with it Gary, and I guess I would like to ask you for a brief comment on what you think about this issue in terms of the relative trade-offs and public education as much as anything?

Answer: I don't work research too much anymore other than research methodology. I find it interesting that the research I've provided in the past, I've been involved with elk in Oregon and Washington and with other species of animals too, that this research gets used in very diverse ways. I'm always kind of tickled to see how people can interpret things the way they see fit. A number of law cases since have been won and lost, apparently based on some of my research, and not necessarily by the same parties or the same sites. I guess it's kind of how you can twist and use things and make it come out in the long run. That is a very real problem. I think the variability that exists is real, and makes it difficult. I think the fact that we're trying to get a lot out of every acre of forestland makes it very difficult to apply these relationships. I'm a little bit concerned that we see a lot of models and evaluation methods being presented that seem to be keying in on different factors. Keying in on some things and ignoring others at times seems to be quite at odds with each other. Of course, this is probably because of the variability that occurs throughout the range of Roosevelt elk. So there's variability with habitat use by an elk herd in any given area. I don't think we can expect to reach a consensus on these matters. However, I think we have to continue to work in that direction. I think by unraveling pieces of the puzzle, we are heading in that direction. A lot of the models and evaluation methods vary between simple and complex, and may also vary in their objectives. As a result, I think we have to expect variability.

However, I think that it will fall together. And, as some of the research underway is completed, we can incorporate this. I think we'll see things falling into place a little more. We're definitely behind Rocky Mountain elk research and development in dealing with Roosevelt elk, although I think we're seeing a lot of similar patterns. The insight with Rocky Mountain elk studies has helped us a lot. With Roosevelt elk studies, on the other hand, we do have a different beast and different conditions. I think we have to be careful not to stretch things towards a bias that we may have. I think there is some bias towards forage:cover ratios, for example. I don't think it's as easy a matter as some of us tended to make it look or as easy of a management tool as we try to make it out. I think we do need to continue research efforts. I think we do need education in these relationships and the needs of elk so that it is more difficult to go off in different directions, and to incorporate this vitally diverse amount of variability that makes it look like the basic patterns aren't there when, in fact, they are. That's a long answer to a short question.

DEVELOPMENT OF A MODEL FOR
ROOSEVELT ELK HABITAT IN WESTERN OREGON

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Today I would like to present a model that was developed to evaluate habitat for Roosevelt elk (Cervus elaphus roosevelti) in western Oregon. This model has recently been published (Wisdom et al. 1986), and copies are available from: USDA Forest Service, Pacific Northwest Region, P.O. Box 3623, Portland OR 97208.

In this paper, I present the working framework of the model and illustrate some potential uses. The papers that follow mine (Adams 1986, Eby and Gatlin 1986) present some examples of how the model can be applied, as well as those authors' impressions of its strengths and weaknesses.

I gratefully acknowledge the modeling work in northeastern Oregon (Thomas et al. In Press), from which our group borrowed many concepts and ideas. In particular, Jack Ward Thomas, Chief Research Biologist, USDA Forest Service, LaGrande, Oregon and Donavin A. Leckenby, Research Biologist, Oregon Department of Fish and Wildlife, LaGrande, have been the "drivers" behind much of our modeling process; many of their innovations were adopted by our working group. Jim Eby, Washington Department of Game, Olympia, and Bud Adams, Oregon Department of Fish and Wildlife, Corvallis, are acknowledged for their extensive computer testing of the model.

MODEL OBJECTIVES

In developing the model, our working group (Wisdom et al. 1986) set the following objectives, written in the form of assumptions or requirements:

1. The model must reflect state-of-the-art knowledge of Roosevelt elk habitat relationships. Witmer et al. (1985) presented these relationships.

2. Model concepts, content, structure, and output must be understandable to non-biologists. Forest managers won't use a process they can't understand.

3. The model should evaluate habitat with the use of a numerical rating system. The rating system should be similar to habitat suitability index models (U.S. Fish and Wildlife Service 1981), with 1.0 being optimum habitat condition and 0.05 being minimal. This rating system is called habitat effectiveness (HE).

4. The model should be compatible with the use of automated mapping systems such as GIS (Eby and Gatlin 1986). Maps generated from satellites (Landsat Digital Imagery) can be used as the basis for automated analysis and use of the model (Adams 1986, Eby and Gatlin 1986). Intensive field evaluations are not required, but certainly would enhance the evaluation process.

5. Stand conditions of forests in western Oregon (Hall et al. 1985:26) can be identified from Landsat maps. In turn, stand conditions can be re-classified or re-mapped by computer in terms of habitat types used in our model (Adams 1986, Eby and Gatlin 1986). Witmer et al. (1985) defined habitat types for elk in western Oregon as:

   - Forage Areas: Vegetated areas with less than 60 percent overstory canopy closure. Forage areas include the grass-forb, open sapling-pole stand conditions and possibly some older stands that have been thinned.

   - Optimal Cover: Forest stands with: 1) Four vegetative layers consisting of overstory canopy, sub-canopy, shrub layer, and herbaceous strata; and 2) an overstory canopy which can intercept and hold a substantial amount of snow, yet has dispersed, small (less than 1/8 acre) openings. These criteria are generally achieved when the dominant trees average 21 inches d.b.h. or higher, have 70 percent or greater crown closure, and are in the large sawtimber or old-growth stand condition.

   - Thermal Cover: Forest stands at least 40 feet in height and with tree canopy cover of at least 70 percent; this is achieved in many closed sapling-pole stands unless the canopy cover is reduced below 70 percent.

   - Hiding Cover: Any vegetation capable of hiding 90 percent of a standing adult elk at 200 feet or less, provided such areas do not qualify as forage areas, optimal cover, or thermal cover. In western Oregon, hiding cover includes some shrub stands and all forested stand conditions with adequate tree stem density or shrub layer to hide animals.

6. Four habitat variables can dramatically affect elk use of these habitat types, and form the basis for evaluation of habitat effectiveness for any area in western Oregon. These variables are: 1) sizing and spacing of forage and cover areas; 2) density of roads open to motorized vehicles; 3) cover quality; and 4) forage quality. Each variable can be rated numerically. Then, one index of habitat effectiveness can be derived from the four ratings.

Wisdom et al. (1986) list additional assumptions and requirements of the model. Note that population density is not an output of the model, nor does the model account for the effects of local hunting regulations. We believe, however, that trends in habitat effectiveness reflect potential trends in elk densities.

By no means is our current model the last word. Just as numerous managers and biologists informally reviewed our efforts and helped mold the current product, we fully expect additional changes as validation testing continues.

MODEL VARIABLES

1. <u>Sizing and Spacing of Forage and Cover Areas</u> (HE_S)

Elk use declines with increasing distance away from the cover-forage edge, as shown in Figure 1 from Wisdom et al. (1986:14). We divided Figure 1 into 100-yard distance bands away from the edge, into both cover and forage areas, and assigned ratings of habitat effectiveness for each distance band based on the expected level of elk use (Table 1, Wisdom et al. 1986:15).

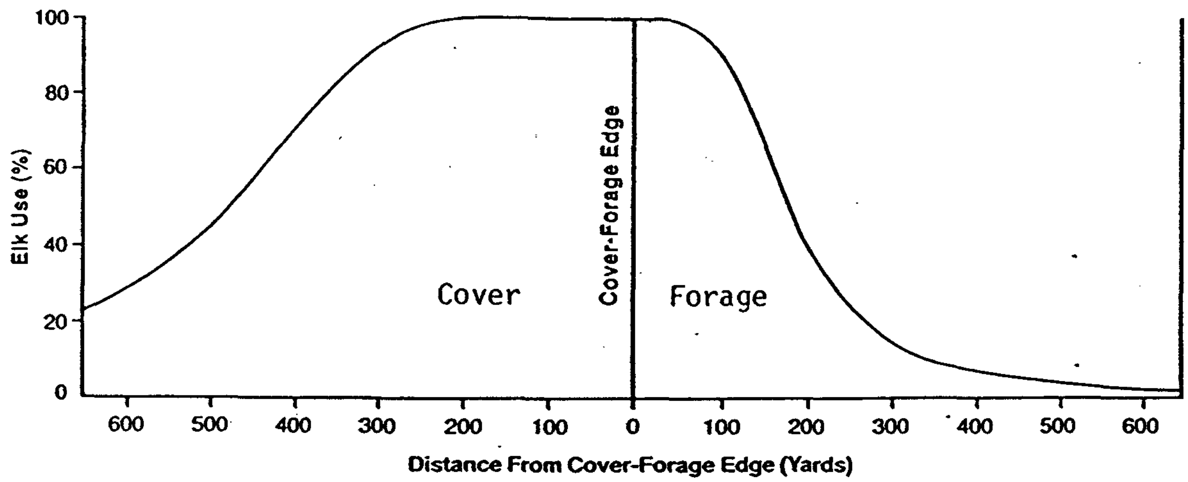

Figure 1. Relationship of elk use to distance from cover-forage edge (Wisdom et al. 1986:14).

Table 1. Ratings of habitat effectiveness by 100-yard distance bands away from the cover-forage edge, based on elk use (Figure 1).

	Distance from Cover-Forage Edge (Yards)	Percent Use from Figure 1	Rating of Habitat Effectiveness
	>400	5	0.05
	301-400	10	0.10
Forage	201-300	25	0.25
Area	101-200	70	0.70
Edge	0-100	100	1.0
	0-300	100	1.0
Cover	301-400	80	0.80
Area	401-500	60	0.60
	501-600	40	0.40
	>600	20	0.20

If a given habitat can be segregated into 100-yard distance bands away from edge (Figures 2 and 3), the proportion of area within the bands can be calculated. The proportion of area can then be weighted by the respective ratings of habitat effectiveness (Table 2). The sum of these products equals HE_S, or habitat effectiveness as influenced by sizing and spacing of forage and cover areas.

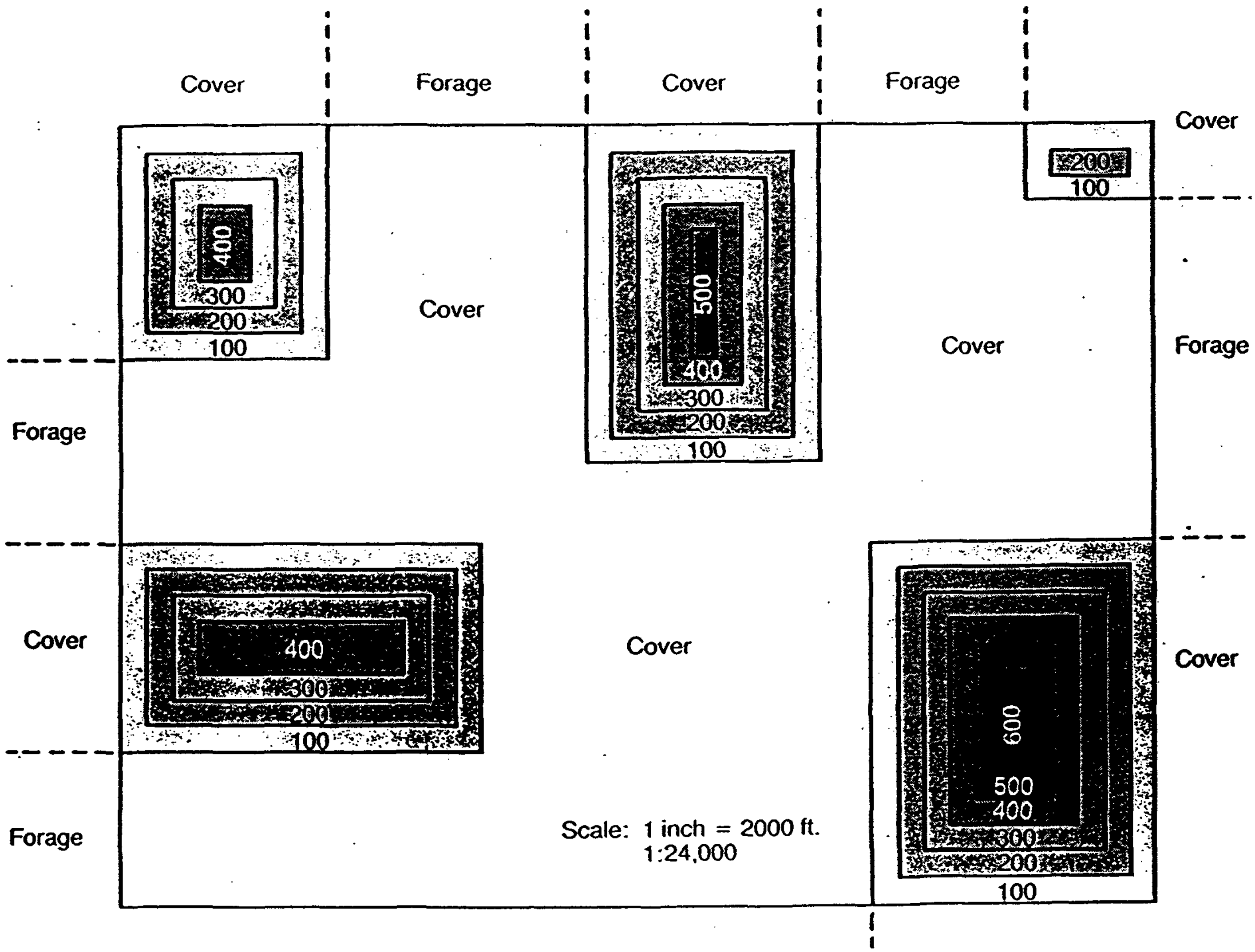

Figure 2. Delineation of forage areas into 100-yard distance bands away from the cover-forage edge to evaluate sizing and spacing for a given area. Acreage and proportion of area within the bands are shown in Table 2.

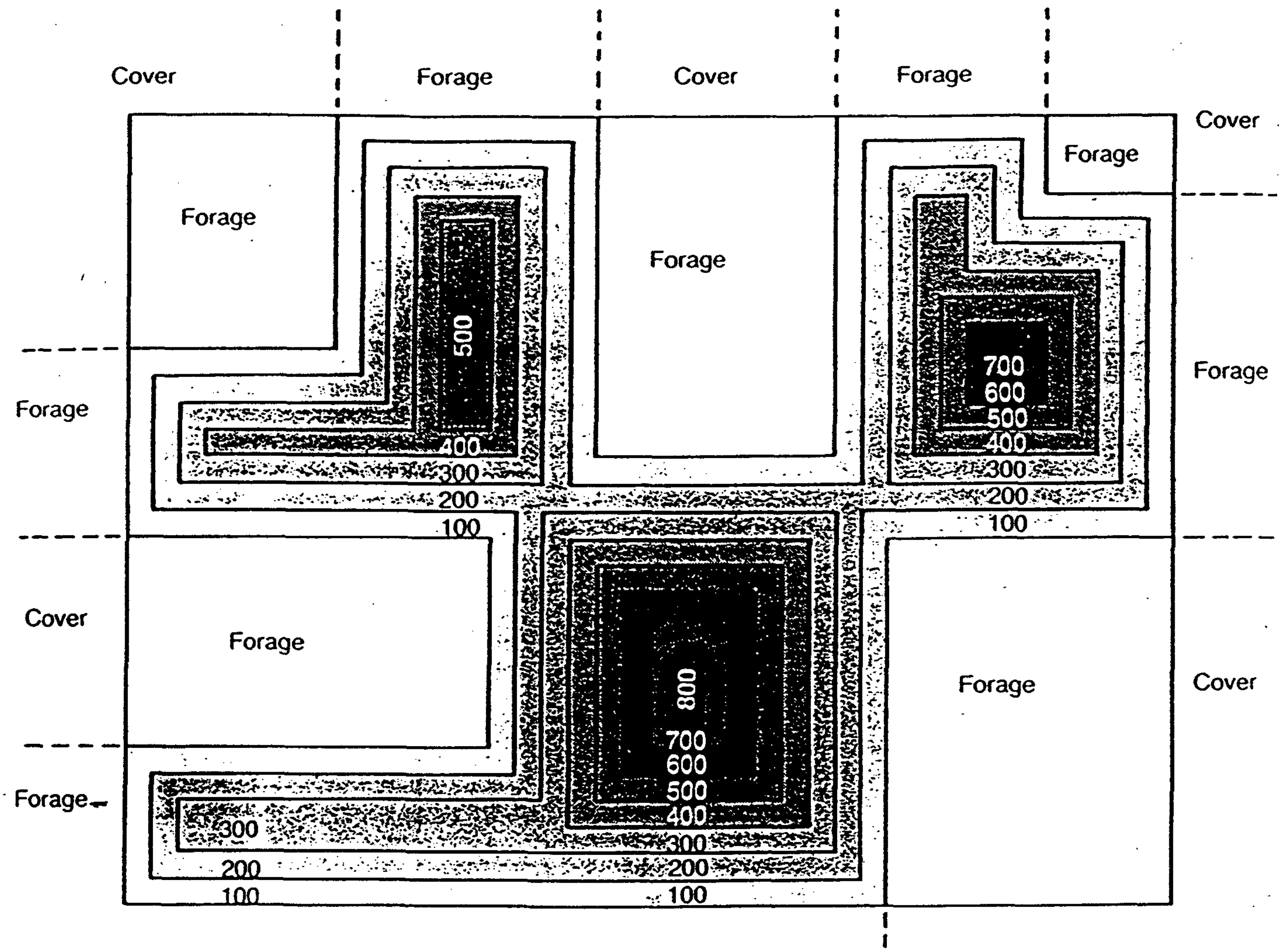

Figure 3. Delineation of cover areas into 100-yard distance bands away from the cover-forage edge to evaluate sizing and spacing for a given area. Acreage and proportion of area within the bands are shown in Table 2.

Table 2. Calculation of HE_S for the area shown in Figures 2 and 3.

Forage Areas							Cover Areas						
100-Yard Distance Bands Away from Edge	Acreage of Forage Areas	Proportion of Analysis Area	X	²Habitat Effectiveness for Distance Band	=	Weighted Effectiveness for Distance Band	100-Yard Distance Bands Away from Edge	Acreage of Cover Areas	Proportion of Analysis Area	X	²Habitat Effectiveness for Distance Band	=	Weighted Effectiveness for Distance Band
0–100	347	0.14	X	1.0	=	0.140	0–300	1092	0.44	X	1.0	=	0.440
101–200	262	0.11		0.70		0.077	301–400	202	0.08		0.8		0.064
201–300	190	0.08		0.25		0.020	401–500	124	0.05		0.6		0.030
301–400	124	0.05		0.10		0.005	501–600	58	0.02		0.4		0.008
>400	47	0.02		0.05		0.001	>600	33	0.01		0.2		0.002
SUM	970	0.4				0.243	SUM	1509	0.6				0.544

HE_S = 0.243 (Weighted Effectiveness, Forage Areas) + 0.544 (Weighted Effectiveness, Cover Areas)

= 0.79

2. Density of Roads Open to Motorized Vehicles (HE_r)

Elk use of habitat declines dramatically with increasing density of roads open to motorized vehicles. Lyon (1983) developed a general road model (Figure 4) that we used to evaluate HE_r.

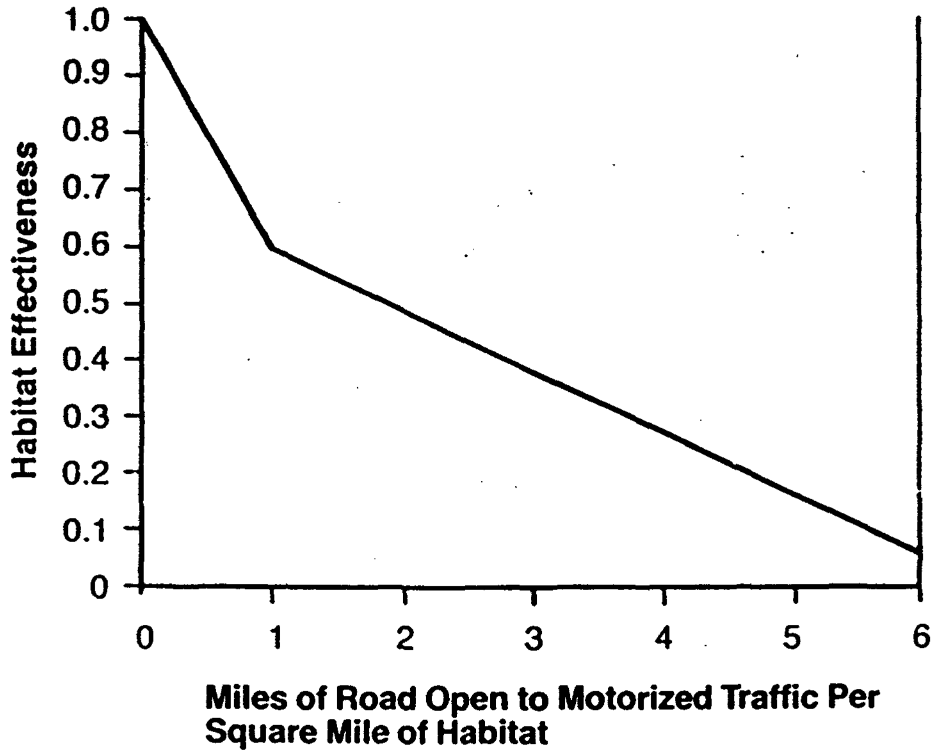

Figure 4. Relationship of habitat effectiveness to the density of roads open to motorized vehicles (Lyon 1983).

If the number of miles of roads open to vehicles can be identified for a given area (Figure 5), the density of open roads can be calculated, and referred back to Figure 4 to derive habitat effectiveness as influenced by HE_r.

For the area shown in Figure 5, 1.95 miles of roads per square mile of habitat are open to vehicles; this equates to an HE_r value of approximately 0.50 in Figure 4.

3. Cover Quality

The three cover types identified for elk in western Oregon (Witmer et al. 1985) are: 1) optimal cover; 2) thermal cover; and 3) hiding cover. These cover types are thought to differ in the functions they provide to elk in terms of energy conservation (Witmer et al. 1985, Wisdom et al. 1986).

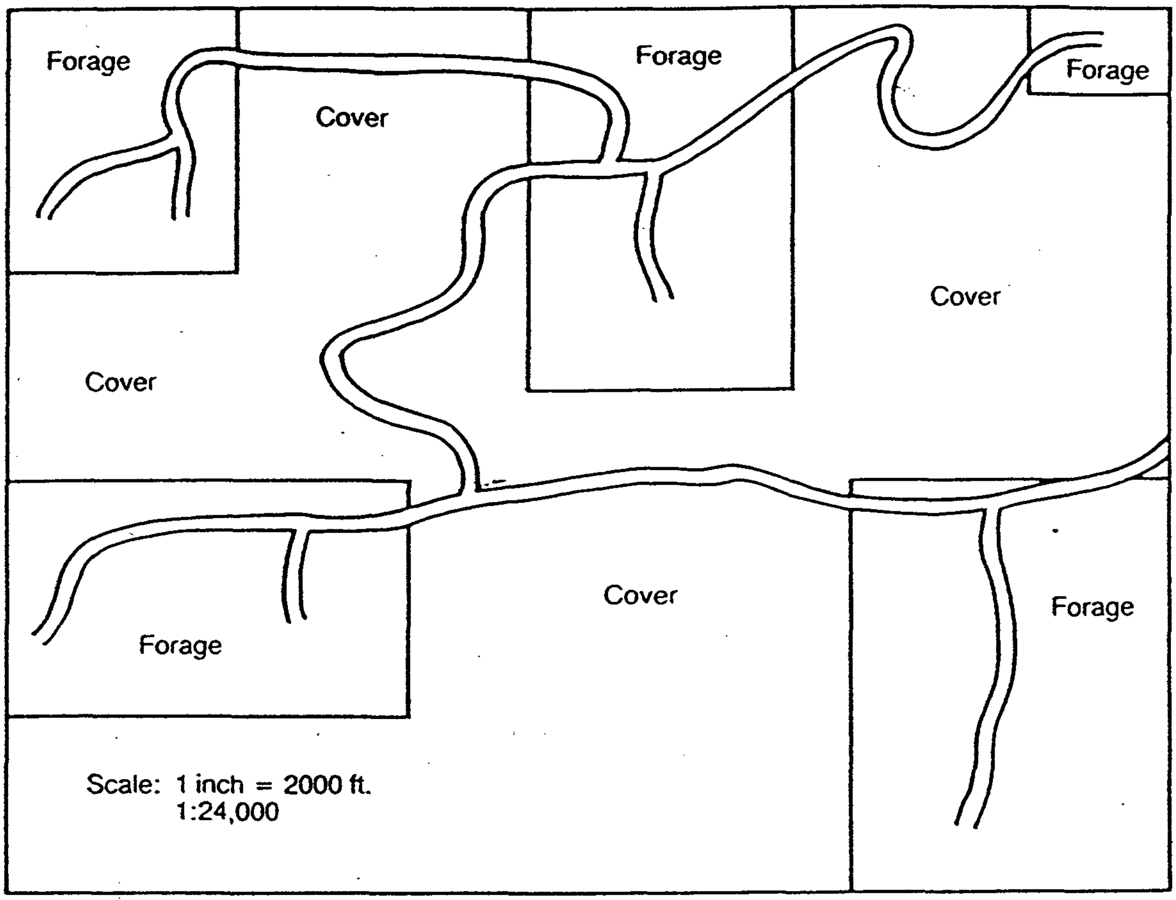

Figure 5. 7.6 miles of road are open to motorized vehicles within the 3.9 square miles of habitat.

Based on each cover type's presumed ability to conserve energy for elk, we assigned the following ratings of habitat effectiveness: optimal cover - 1.0; thermal cover - 0.5; and hiding cover - 0.1. If each of these cover types can be identified for a given area (Figure 6), their acreage and relative proportion of area can be calculated. The proportion of area occupied by each cover type can then be weighted by its respective rating of habitat effectiveness. The sum of these products equals habitat effectiveness as influenced by the quality of cover (HE_C) as shown below for Figure 6:

Cover Type	Proportion	X	Effectiveness	=	Product
Optimal	0.43	X	1.0	=	0.430
Thermal	0.33	X	0.5	=	0.165
Hiding	0.24	X	0.1	=	0.024
			HE_C	=	0.62

4. Forage Quality

This variable evaluates the quality of food available to elk within forage areas. Although some cover types, particularly optimal cover, provide forage of high quality, this contribution was considered previously during the evaluation of cover quality. See Wisdom et al. (1986) for further discussion.

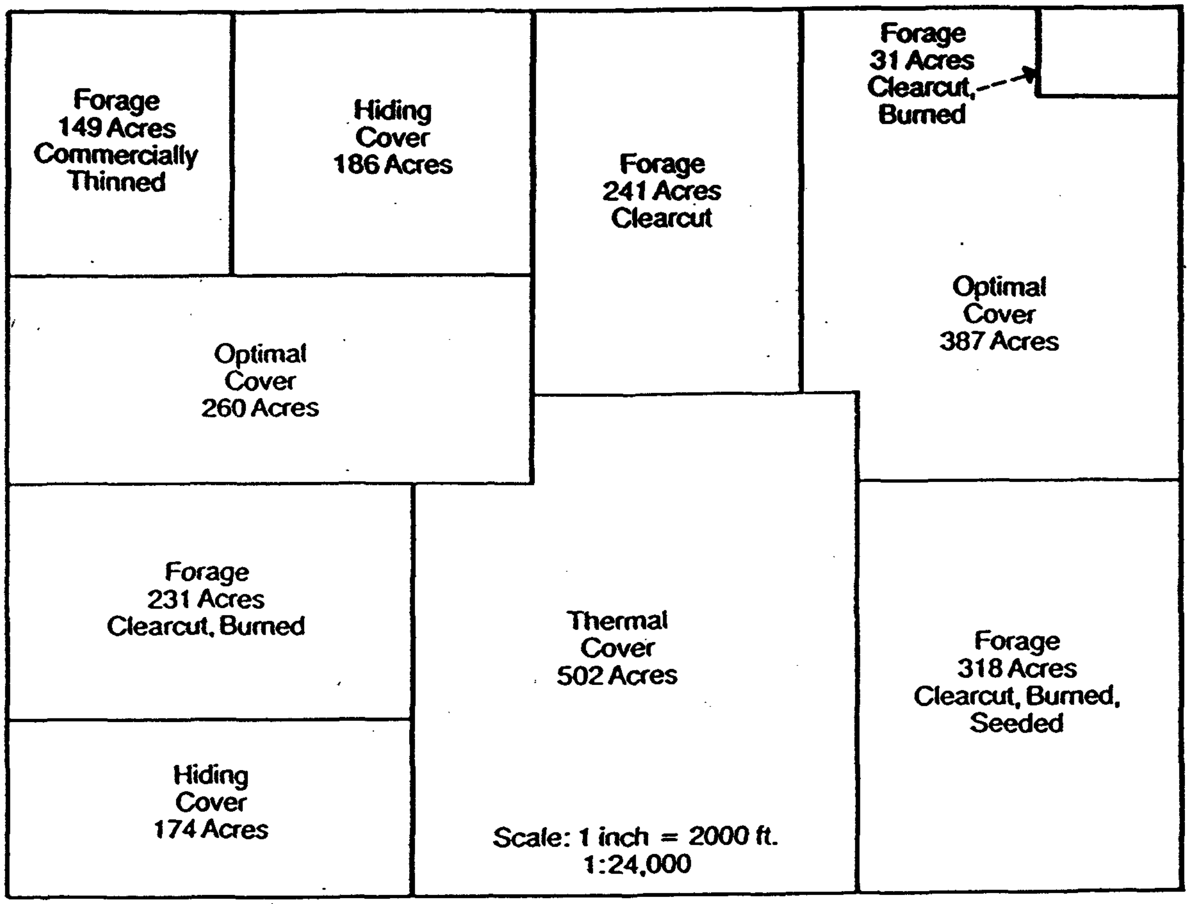

Figure 6. Identification of the forage and cover types in the area being evaluated.

For forage areas in western Oregon, we assumed that quantity of forage <u>in and of itself</u> was not limiting or restrictive to elk needs. Conversely, the quality of forage, as determined by palatability, digestibility, and nutritional content, was assumed to be a potential limiting factor to elk productivity in western Oregon (Trainer 1971, Mereszczak et al. 1981, Starkey et al. 1982, Taylor 1986).

With these broad assumptions in mind, we identified silvicultural treatments commonly applied to forage areas in western Oregon that in turn were assumed to provide beneficial effects to forage quality; these are:

-- clearcutting
-- prescribed burning
-- seeding with grasses and/or legumes
-- fertilization
-- commercial thinning
-- shelterwood cutting

We then grouped these treatments into logical categories or combinations in which they would be applied to forage areas, and assigned ratings of habitat effectiveness for each category:

Treatment Category	Habitat Effectiveness
1. Clearcutting, Burning, Seeding, and Fertilization	1.0
2. Clearcutting, Burning and Seeding	0.75
3. Clearcutting, and Burning	0.50
4. Clearcutting	0.25
5. Commercial Thinning or Shelterwood Cutting	0.10

This rating system applies to forested stands defined as cover areas before treatment application. A rating system also was developed to evaluate treatments applied to permanent or natural openings such as pastures and meadows (Wisdom et al. 1986).

How is this rating system applied to a given area? If we can identify the forage areas and the respective treatments applied to them (Figure 6), we can calculate the acreage of forage areas fitting within each treatment category. The proportion of area within each treatment category can then be weighted by the respective rating of habitat effectiveness to derive HE_f, as shown below for Figure 6:

Treatments	Proportion	X	Effectiveness	=	Product
1. CC/B/S/F	0.00	X	1.0	=	0.00
2. CC/B/S	0.33	X	0.75	=	0.248
3. CC/B	0.27	X	0.50	=	0.135
4. CC	0.25	X	0.25	=	0.063
5. CT	0.15	X	0.10	=	0.015
			HE_f	=	0.46

INTEGRATING THE VARIABLES

Our goal was to produce a model output that rated habitat in terms of one overall score of habitat effectiveness. We chose the following equation as the best representation of the interactions of the four variables:

$$HE_{srcf} = (HE_s \times HE_r \times HE_c \times HE_f)\ 1/N$$

where:

HE_{srcf} = habitat effectiveness index considering the interactions of HE_s, HE_r, HE_c, and HE_f where:

HE_s = habitat effectiveness index derived from sizing and spacing of forage and cover areas.

HE_r = habitat effectiveness index derived from the density of roads open to vehicular traffic,

HE_c = habitat effectiveness index derived from the quality of cover, and

HE_f = habitat effectiveness index derived from the quality of forage, and

$1/N$ = Nth root of the product taken to obtain the geometric mean where N = the number of habitat variables.

The scores derived in this presentation are: HE_s. = 0.79; HE_r = 0.50; HE_c = 0.62; and HE_f = .46. Thus, HE_{srcf} = (0.79 x 0.50 x 0.62 x 0.46.) 1/4, or 0.58.

This equation provides partial compensation between the scores of the four variables, with more weight given to variables having low scores. Other methods of integrating habitat variables are available (U.S. Fish and Wildlife Service 1981), but these other methods were thought too restrictive (e.g., limiting factor approach) or too lenient (e.g., arithmetic mean approach) from our perspective of the way elk respond to habitat changes.

POTENTIAL USES OF MODEL

What can managers and biologists do with our model? First, habitat deficiencies can be identified by depicting ratings of habitat effectiveness with the use of histograms (Figure 7). In the example in Figure 7, current HE_r is deficient. (It's at the 0.15 level of effectiveness.) With the implementation of a road closure plan, however, HE_r and thus HE_{srcf} are increased substantially (Figure 7). The percent change in HE_{srcf} due to the road closure represents a 39 percent increase in overall habitat effectiveness - a significant change in the capability of the habitat to produce elk.

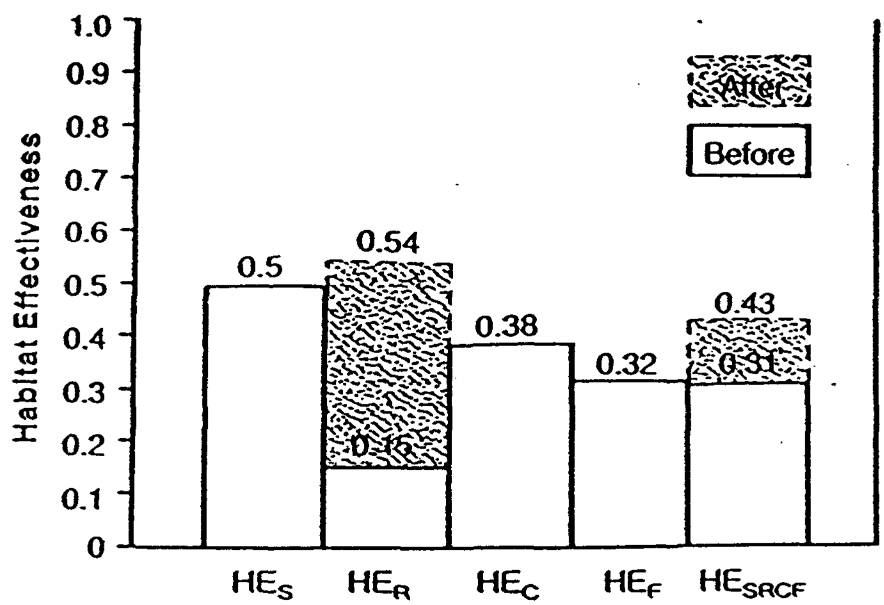

Figure 7. Changes in habitat effectiveness scores before and after implementation of a road closure plan.

This type of exercise also illustrates other potential uses of the model. A common language or dialogue can be established between biologists and managers, which in turn may lead to "brainstorming sessions" that set objectives to alleviate habitat deficiencies. Once objectives are set, biologists and managers can judge the merits of various forest practices against them.

Obviously, the model provides options for management of elk habitat. Many different forest management strategies can be designed to meet a specified level of habitat effectiveness.

SUMMARY

Our model is not a panacea for assessing and managing elk habitat. It does, however, provide a working process to identify habitat deficiencies, measure impacts, set objectives, and provide options for management.

Because the model is compatible with automated mapping systems (Adams 1986, Eby and Gatlin 1986), it can be used efficiently with minimal fieldwork. Thus, many different management scenarios can be analyzed quickly, which lends itself to forest planning.

As the model is applied and tested further by managers and researchers, more powerful tools for evaluating elk habitat will evolve. Through time, this on-going process will improve our knowledge and capability to manage elk and elk habitat.

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ELK HABITAT EFFECTIVENESS FROM LANDSAT IMAGERY FOR THREE STUDY AREAS IN THE SOUTH COAST RANGE OF OREGON

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I am excited about this afternoon session on rating elk habitats. I appreciate the work various individuals and committees working on this many-faceted problem have accomplished. We are probably raising more questions about elk management than we will answer, but I think we are getting closer to having a common base from which to approach answering those questions.

Last fall I met with several members of the committee working on the Westside model (Wisdom et al. 1986) (Doug Smithey, Bill Hines and Mike Wisdom) along with Ron Sadler and Bill Hudson of the Bureau of Land Management to discuss the feasibility of applying this model to three land units in the Coos Bay area. We felt this would serve as a good demonstration of feasibility as well as a training exercise in practical application.

We could have obtained the various factors needed to use the model manually from aerial photographs and orthophotoquads with a lot of tedious work for three fairly small (10,000 acre) study areas. We decided to use Landsat imagery and the services of the Environmental Remote Sensing Applications Laboratory at Oregon State University to do a computer based example. We were able to obtain a June, 1985 Landsat scene for our area of interest.

We selected three areas which represented three different management philosophies. We hoped to find contrasts in habitat effectiveness values and selected areas in fairly close proximity so they could be included in a field trip.

Approximately 210,000 acres were mapped for this project. This is the area for which we obtained Landsat spectral class maps from RJay Murray of the Environmental Remote Sensing Appications Laboratory at Oregon State University. The mapped area is near the center of a Landsat "scene" which covers about 115 miles on a side or 13,000 square miles.

Past experience has shown that Landsat imagery is well suited to mapping by stand condition classes. We used the stand condition descriptions as summarized by Brown (1985 Appendix 6).

Development of stand conditions is a continuum; thus, the difficulty in assigning stand condition classes to spectral classes is where to draw the line between stand conditions. This line becomes blurry where one spectral class describes two stand conditions that have similar characteristics (e.g. older open sapling-pole and young closed sapling-pole stand condition classes).

There is a gradation from mature large sawtimber into old growth that is hard to define. Two spectral classes that consistently identified old growth were called "optimal cover" in determining habitat effectiveness. Optimal cover also should have included some of the later stages of the large sawtimber class. We did not have time to field check this, but in all three study areas, the amount of optimal cover used in the habitat effectiveness scores is lower than it should have been, resulting in somewhat lowered habitat effectiveness values for cover quality.

We worked with print-outs of spectral class maps to the same scale (1:24,000) and the same size as matching orthophotoquad sheets. Each spectral class is represented on these maps by a symbol signifying that Landsat sees this particular piece of ground different from all other classes. Spectral class maps were prepared for us by RJay Murray and his staff at ERSAL through the computer center at Oregon State University. The first task was to outline homogenous blocks of individual characters representing one of fifty spectral classes.

Delineated areas containing a single symbol that represented a discrete spectral class were transferred to orthophotoquads. We tried to find at least six examples of each spectral class spread among the six different orthophotoquad size maps. Delineated spectral class areas were transferred from the orthophotoquads to larger scale (1:12,000) aerial photos for photo interpretation using stereoscopic photo pairs. Putting outlined areas on the larger scale aerial photos meant that the image was larger than on the orthophotos, which helped in transferring it accurately.

Aerial photography interpretation was done by Dave Faust and Lance Finnegan of the BLM office in Coos Bay. The use of expert photo interpreters such as Dave and Lance considerably speeded this process and resulted in quite consistent interpretation of spectral classes. Aerial photographs for this study were borrowed from the Elliott State Forest, Weyerhauser Timber Co., and the Bureau of Land Management.

Once photo interpretations were made and stand attributes such as tree height, species, dbh, crown closure, etc. were defined, each spectral class was placed in a stand condition category. Approximately 300 written descriptions of spectral classes from photo interpretation were compiled. Normally, field work would be done to do on-the-ground checking of spectral class assignments, especially of those which did not consistently describe one stand condition. In this case, time did not allow us to do that, so additional examples of troublesome spectral classes were looked at until the photo interpreters were confident that the spectral class best described one stand condition.

After assignments of spectral classes to stand condition classes were made, the remaining steps were done on the computer using software programs developed by ERSAL. Advantages of a computer based system are flexibility and speed of operations. Areas to be examined can be of any size (within the scene) or shape. Spectral classes or stand condition classes can be grouped in various ways to look at "What If" questions. Scaled maps can be printed for any combination of classes, and the acreage tables which accompany each map are used for calculating habitat effectiveness values.

We printed maps and acreage tables for each of the three study areas by spectral classes, stand conditions (Table 1), elk habitats (Table 2), cover and forage, and size and spacing (Table 3). Stand condition classes were grouped into elk habitats of optimal, thermal, or hiding cover and forage areas or pasture land. These are the descriptive habitats used in the model to determine habitat effectiveness values for cover and forage.

Table 1. Area in acres of mapping units by stand condition classes (from Landsat imagery).

STAND CONDITION CLASS	MAPPING UNIT		
	EAST	WEST	SOUTH
Old growth	226	608	33
Large sawtimber	2,172	5,329	351
Hardwoods	451	153	344
Closed sapling pole-Thermal	2,578	872	2,287
Closed sapling pole-Hiding	1,758	1,070	2,897
Open sapling pole-Hiding	600	183	671
Open sapling pole-Forage	135	215	461
Grass - forb	969	1,992	2,460
Agricultural or pasture	199	0	0
Unclassified	67	48	42
TOTAL	9,155	10,470	9,546

Table 2. Area in acres of mapping units by elk habitat classes (from Landsat imagery).

ELK HABITAT CLASS	MAPPING UNIT		
	EAST	WEST	SOUTH
Optimal cover	226	608	33
Thermal cover	5,202	6,355	2,983
Hiding cover	2,358	1,254	3,568
Forage	1,105	2,208	2,922
Agricultural or pasture	199	0	0
Unclassified	67	48	42
TOTAL	9,157	10,473	9,548

Acreages of the various cover components which enter into the calculation for habitat effectiveness for cover quality were taken from the computer print-out tables. Values were expressed as percentages of total cover and multiplied by the effectiveness rating scores (defined in the model) for the different types of cover. The sum of these products is the habitat effectiveness value for cover quality (Figure 1).

HABITAT EFFECTIVENESS FOR COVER QUALITY

Loon Lake	East Mapping Area
(Mapping Unit)	(Analysis Area)

COVER TYPE	ACRES	PROPORTION X	EFFECTIVENESS	=	PRODUCT
Optimal	226	.03	1.00	=	.030
Thermal	5,202	.67	0.50	=	.335
Hiding	2,358	.30	0.10	=	.030
TOTAL	7,786		HE_C	=	.40

Figure 1. Worksheet for determining habitat effectiveness for cover quality for the East mapping area.

All cover areas and all forage areas were grouped on the computer to produce maps and acreage tables showing just cover and forage. These maps were used to delinate forage areas for determination of treatments that would affect the habitat effectiveness ratings for forage quality. This grouping was a preliminary step for determination of size and spacing zones.

Forage areas which received any treatment such as burning, seeding, or fertilization after logging were delineated on the cover-forage maps for the three mapping units. The acreage of forage areas in each treatment category was derived from pixel counts and expressed as a proportion of all the forage areas. These proportions were multiplied by the effectiveness ratings for each treatment category (from the model) and the sum of the products was the habitat effectiveness value for forage quality (Figure 2).

HABITAT EFFECTIVENESS FOR FORAGE QUALITY

Loon Lake	East Mapping Unit
(Mapping Unit)	(Analysis Area)

LANDSAT MAPPING	SYMBOL	TOTAL ACRES	TREATMENT CATEGORY* ACRES					
			1	2	3	4	5	6
FORAGE	°	1,106	15	44	535	512		
PASTURE	A	199		199				
TOTAL		1,305	15	243	535	512		

	TREATMENT CATEGORY*	ACRES	PROPORTION	X EFFECTIVENESS	= PRODUCT
1.	CC/B/S/F & NMF or PF	15	0.01	1.00	.010
2.	CC/B/S or F & NM or P	243	.19	.75	.143
3.	CC/B or F	535	.41	.50	.205
4.	CC	512	.39	.25	.098
5.	CT or SC			.10	0
6.	MISCELLANEOUS OPENS			.05	0
	TOTAL	1,305			HE_f = .46

* LAND TREATMENT CODES:

CC = Clearcutting
B = Prescribed Burning
S = Grass or Legume Seeding
F = Fertilization
NM = Natural Meadow
P = Pasturelands
CT = Commercial Thinning
SC = Shelterwood Cutting
NO = Miscellaneous Openings consist of rock outcrops, talus, or other openings with minimal forage present.

Figure 2. Worksheet for determining habitat effectiveness for forage quality for the East mapping unit.

Computer programs were used to convert isolated cover or forage pixels (1.2 acres) to match the surrounding type, to delineate five bands in cover and five bands in forage for distances from edge as described in the model, and to summarize the acres of cover and forage in each of the distance bands. The acreages of areas in the five forage distance bands and in the five cover bands were taken from computer print-outs (Table 3). There is a separate category of effectiveness for cover areas less than 200 yards wide, these areas were hand delineated on the cover-forage maps and the acres as determined from pixel counts were subtracted from the first cover band total. RJay Murray and Don Leckenby are working on a computer software program that will do this.

Proportions of acres in distance bands into cover and forage were expressed as percentages of the total area. These proportions were then multiplied by the effectiveness ratings for each band (from the model). The sum of the products is the habitat effectiveness value for size and spacing (Figure 3).

Table 3. Area in acres of mapping units by distance from edge in distance bands.

DISTANCE FROM EDGE	MAPPING UNIT		
	EAST	WEST	SOUTH
IN FORAGE AREAS			
0-100 yards from edge	1,068	1,745	2,079
101-200 " " "	195	400	476
201-300 " " "	20	44	239
301-400 " " "	0	0	98
≥ 401 " " "	0	0	26
IN COVER AREAS			
0-300 yards from edge	4,047	5,764	5,585
301-400 " " "	997	1,047	635
401-500 " " "	1,050	775	327
501-600 " " "	596	412	42
≥ 601 " " "	1,128	243	5
	9,101	10,430	9,512

HABITAT EFFECTIVENESS FOR SIZE AND SPACING

Loon Lake	East Mapping Area
(Mapping Unit)	(Analysis Area)

FORAGE AREAS

Distance from edge	Map Symbol	Acreage	Proportion of total area	X Effectiveness	= Forage-effectiveness
0-100 Yd	1	1,068	.12	1.00	.120
101-200 "	2	195	.02	0.70	.014
201-300 "	3	20	tr	0.25	tr
301-400 "	4	0		0.10	
≥400 "	5	0		0.05	
TOTAL		1,283	.14		.134
COVER AREAS					Cover effectiveness
0-300 Yd	V	3,862	.42	1.00	.420
301-400 "	W	997	.11	0.80	.088
401-500 "	X	1,050	.12	0.60	.072
501-600 "	Y	596	.07	0.40	.028
≥600 "	Z	1,128	.12	0.20	.024
≤200 Yd Wd	HAND	185	.02	0.50	.010
TOTAL		7,818	.86		.642
Grand Total		9,101			HE_S = .78

Figure 3. Worksheet for determining habitat effectiveness for size and spacing for the East mapping unit.

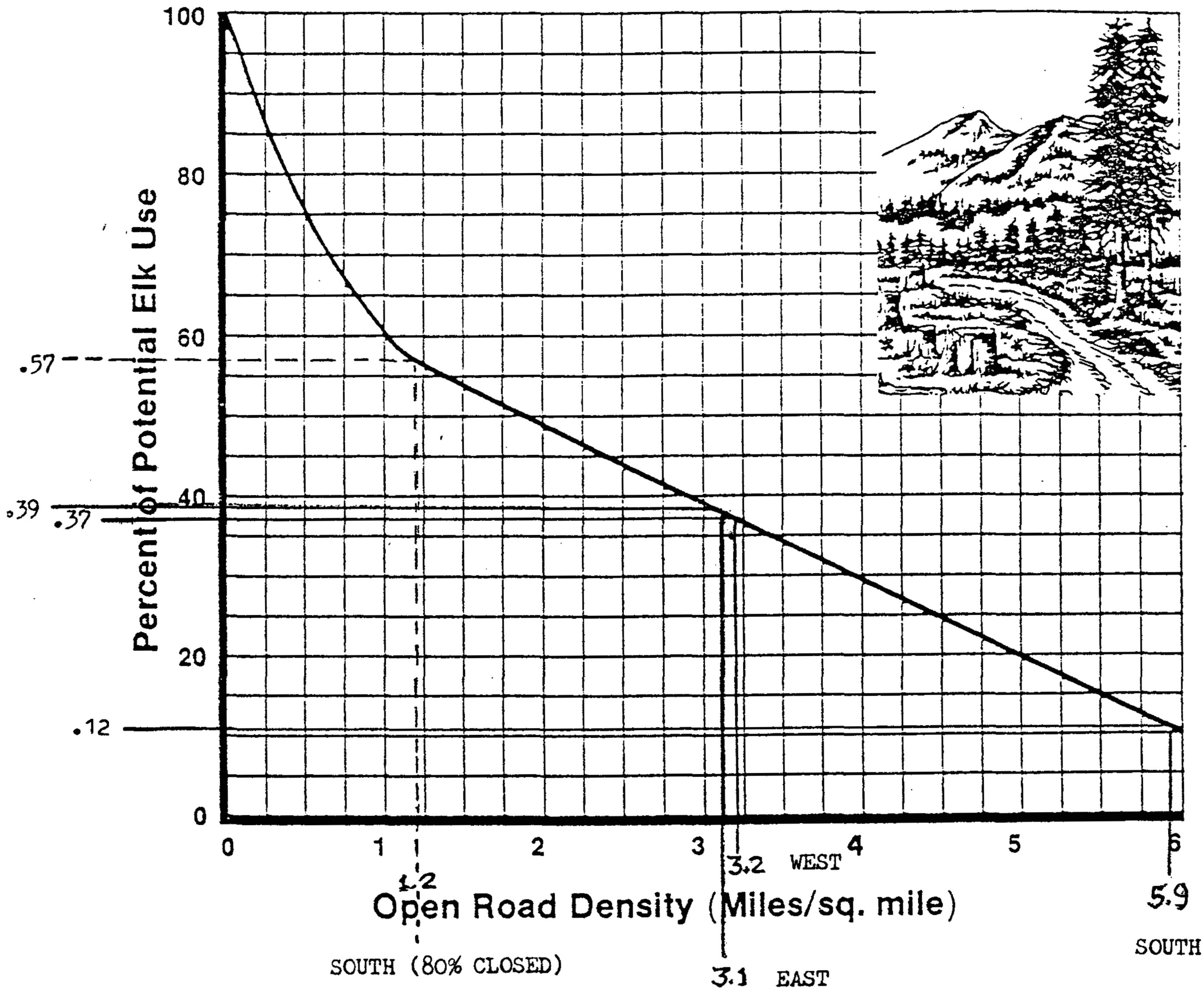
A planimeter was used to determine miles of roads on each of the study areas. The boundary of each study area was transferred to 1:12,000 scale aerial photographs. Inches of roads within the boundary for each aerial photograph were tallied on the planimeter, summarized for each study area, and converted to total road miles. The miles of road for each study were divided by the square miles of each study area (as determined from the computer print-outs of total acreages) to determine miles of road per square mile of area. Using a curve for conversions (Lyon 1983) (Leege 1984), the habitat effectiveness values for roads were determined for each study area (Figure 4).

The geometric mean of the four variables used in determining habitat effectiveness was calculated as a single measure of habitat effectiveness for each mapping unit (Table 4). Bar graphs of each mapping unit are helpful in presenting a comparison of effectiveness values for the four variables within a mapping unit as well as for comparisons between units (Figures 5, 6 and 7).

Table 4. Habitat Effectiveness Values For Three Loon Lake Mapping Areas

MAPPING AREA	COVER QUALITY	SIZE AND SPACING	FORAGE QUALITY	ROADS	HABITAT EFFECTIVENESS
EAST AREA	.40	.78	.46	.39	.49
WEST AREA	.47	.88	.34	.37	.48
SOUTH AREA	.29	.91	.26	.12	.30
" 80% Rd. Closed	.29	.91	.26	.57	.44

The values for the four habitat variables which are used to determine habitat effectiveness for any area should be valuable tools for managers to use in planning. Comparisons within the areas such as these three study areas should be valid as long as the habitat effectiveness values were determined the same way for all the study areas.



STUDY AREA	ROAD MILES	AREA (SQ. MILES)	ROADS PER SQ. MILE	H.E.$_r$.
East Mapping Unit	44.2	9,159/640 = 14.3	3.1	.39
West Mapping Unit	51.9	10,475/640 = 16.4	3.2	.37
South Mapping Unit	87.4	9,550/640 = 14.9	5.9	.12
" " (80% Closed)	17.5	14.9	1.2	.57

Figure 4. Habitat effectiveness for roads for three mapping areas.

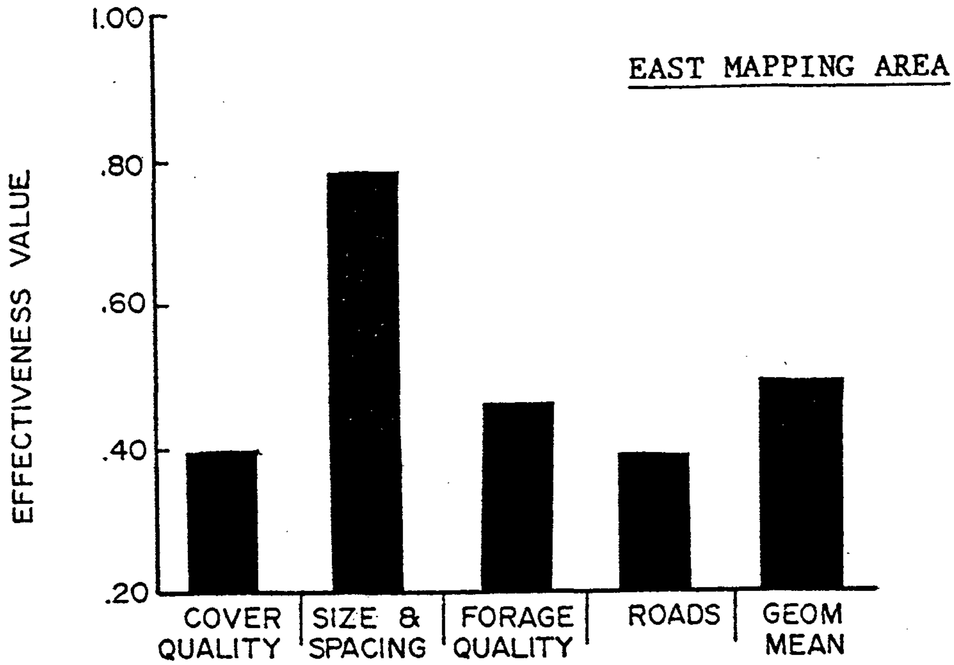


Figure 5. Habitat effectiveness values for the East mapping unit.

EAST MAPPING AREA

The cover quality habitat effectiveness value of .40 for the east mapping area was generated by a high percentage (67%) of the cover falling in the thermal cover category which receives a habitat effectiveness (HE) rating of .50. Half of the thermal cover is in the closed sapling pole stand condition and half in the large sawtimber class. The HE value for size and spacing (.78), while high, was the lowest of the three mapped areas. This value was lowered because of two large expanses of cover with 1,100+ acres more than 600 yards from a cover-forage edge. The Landsat stand condition map and the size and spacing map would be useful tools in planning where timber harvest might be done which would raise the HE score. Forage quality (HE=.46) was the highest of the three mapped areas due to a program of burning after logging, a limited amount of fertilization and seeding, and the inclusion of 200 acres of untreated pastureland in the mapped area. The HE value for roads (.39) will be slightly modified when proposed road closures go into effect. Closure of 20 percent of the roads currently open would increase the HE value for roads by 13 percent (to .44). This would increase the total habitat effectiveness score to .50, an increase of two percent.

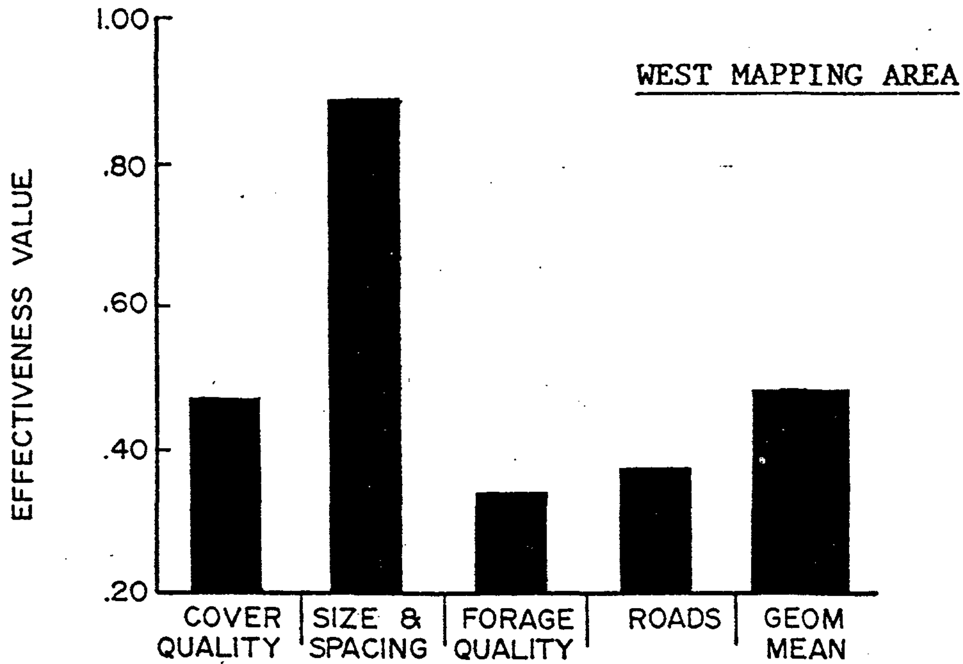


Figure 6. Habitat effectiveness values for the West mapping unit.

WEST MAPPING AREA

The HE value for cover quality on the west mapping area (.47) was the highest of the three mapped areas because this area contained higher percentages of optimal cover and thermal cover, and less hiding cover than the other areas. Most of the thermal cover (84 percent) was in the large sawtimber stand condition class. The size and spacing HE value of .88 was high because 70 percent of the mapped area was included in the first (maximum elk use) bands adjacent to a cover-forage edge. The HE value for forage quality of .34 was near marginal. Most of the older clearcuts were not burned or treated; more recently logged areas have been burned, and a limited area was burned and seeded. With 3.2 open road miles per square mile of area, the west mapping unit received an HE value for roading of .37. The mean habitat effectiveness score for the mapping unit was .48.

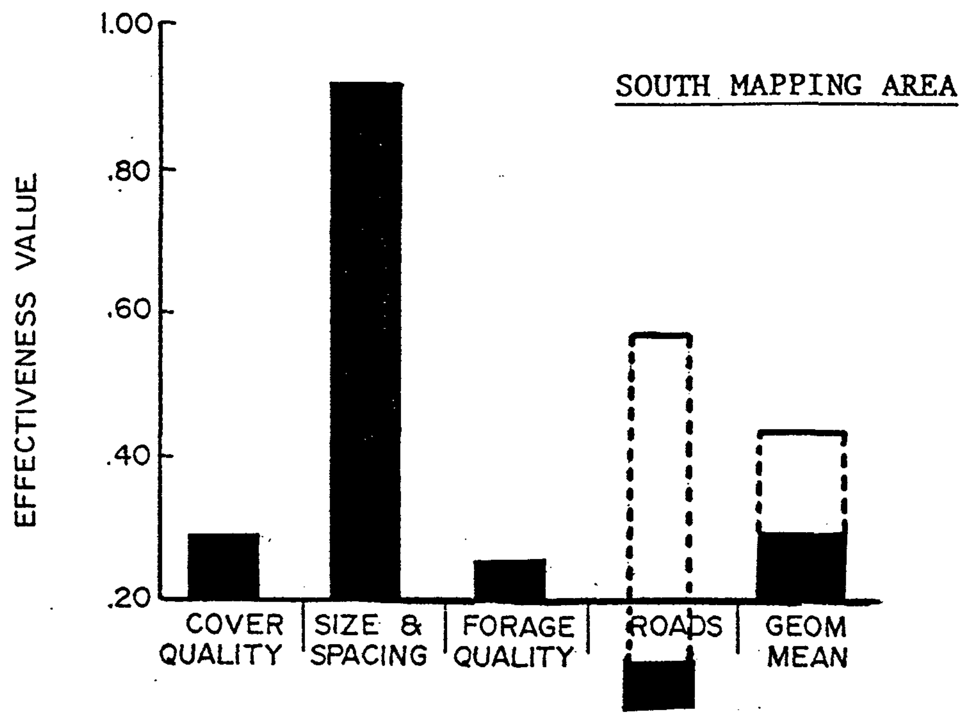


Figure 7. Habitat effectiveness values for the South mapping unit.

SOUTH MAPPING AREA

This mapping area has been intensively logged during the past 20 years. The cover quality HE value (.29) was the lowest of the three areas because 54 percent of the remaining cover was hiding cover and 45 percent was thermal cover. Seventy-seven percent of the thermal cover is in the closed sapling pole stand condition class. The high HE value for size and spacing (.91) was the result of a patchwork pattern of reforestation following logging. Differences in the timing of logging various areas, and site differences in rate of reproduction created a near optimal mixture of cover and forage. The HE value for size and spacing is expected to decrease in time as what are currently open sapling pole and forage areas grow into hiding and thermal cover classes. The forage quality HE value for the south mapping area (.26) is low because most logged areas were not burned or treated after logging. Most roads on the south mapping area are generally not open to the public and receive traffic only during logging. If the 5.9 miles of road per square mile were open, the HE value for roading would be .12 and the total HE value would be .30. With an 80 percent road closure, the HE value for roads is increased 375 percent to .57 and the total HE score is increased by 47 percent to .44.

In conclusion, I would like to express a few ideas and concerns about using computer based Landsat imagery to determine elk habitat effectiveness. One of the criticisms of using satellite imagery is that by the time it gets to the biologist's hands, it is history. This exercise demonstrated that with ample and willing manpower, this need not be. These analyses were based on imagery taken in June, 1985. Acquisition and processing of data took approximately four months.

I also used the habitat effectiveness evaluation method to look at six elk herd ranges on the north coast of Oregon. I think we are getting unrealistically high values for size and spacing generated mainly by using a first band into cover that is 300 yards wide and which receives a utilization rating of 1.0. We need to look more closely at this rationale.

I think we need to define a minimum size for cover and forage areas when doing size and spacing. We currently remove isolated pixels of 1.2 acres, but areas of a few acres not only count as high use areas, but also are core areas generating size and spacing zones around them. I also think we need to consider not using hiding cover as "Cover" when doing size and spacing analysis.

I like this method and think it is a good tool for elk management. It will need some tuning as we get more familiar with it and get more examples. I am confident that changes will be made as we get more experience and relate habitat values to biologist's knowledge of tested areas.

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ELK HABITAT EFFECTIVENESS MODELING IN THE SOLEDUCK REGION OF THE OLYMPIC PENINSULA

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Roosevelt elk (Cervus elaphus) are a key big game species for recreation and resource management considerations on the National Forests in Washington. Wildlife and public land managers have managed their respective resources without the ability to relate a wildlife species to its habitat in terms of habitat needs and management actions. The Washington Department of Game is responsible for wildlife species management and agencies such as the U.S. Forest Service, Washington Department of Natural Resources and private landowners impact the habitat base over large land areas through timber and grazing practices. A long history of conflict developed as timber and livestock management impacted wildlife habitat, especially that of big game species. As the demand for forest products increased, the conflict level rose. The need to quantify the impacts to elk habitat from habitat changes caused by logging is a high priority. Such information is needed to evaluate timber sale layout alternatives and in planning long term strategies for elk habitat and timber management. The habitat effectiveness model developed by Wisdom et al. (1986) provides a framework to address this information need. The digital analysis procedure described in this paper provides the analysis method to supply managers with habitat evaluations based on the model.

The specific habitat functions of thermal cover and forage areas, and the relationships of the elk to these habitats has been researched and published in studies such as Thomas et al. (1979) and Brown et al. (1985). In addition, studies by Perry and Overly (1977) and Lyon (1983) evaluated the impacts of forest roads on elk use of available habitat. The habitat effectiveness model draws on these sources and also recent studies of elk behavior to develop the effectiveness rating method. The overall habitat effectiveness index is a composite expression of habitat quality from a set of variables. The interspersion of the thermal cover and forage areas (known as size and spacing) is one effectiveness variable. Effectiveness variables are developed for thermal cover based on quality, and for forage areas based on harvest type and post-harvest treatment. The final effectiveness variable is the road density in lineal measure per square unit of habitat. The overall effectiveness index is computed by mathematically considering the effectiveness ratings of size and spacing, thermal cover quality, forage quality, and roading for any prescribed study area.

STUDY AREA

The study area is located on the northwest corner of the Olympic Peninsula, Washington, and comprised about 87,900 hectares (217,200 acres). The Soleduck River and tributaries dominate the area along with some minor streams draining to the Strait of Juan DeFuca. Federal ownership (Olympic National Forest) accounts for 56 percent of the land. State holdings, managed by the Department of Natural Resources are 23 percent of the area and private lands the remaining 21 percent. The major private timber land manager in the area is ITT Rayonier. The study area did not include any parts of Olympic National Park.

This area was of particular interest and suitability because it has several owners with differing land management objectives. It is one of the few remaining Forest Service districts with substantial old growth stands, which are scheduled to be cut. The adjacent private and state lands has been subjected to very intensive forest management and may result in a sharp contrast in habitat effectiveness.

OBJECTIVES

Overall, the objective was to use digital processing techniques to apply the habitat effectiveness model. We will not attempt to describe the model in detail except as necessary to explain how it was applied and adapted for this project.

As developed by the authors, the effectiveness model is designed to derive an overall index number (one value) for an entire study area. This could be done manually by drawing the habitat types on a map and following the prescribed procedures. In this project, Landsat data and other digital data were used to develop information on a cell by cell (the Landsat pixel) basis rather than area wide. It becomes attractive to automate the procedure for large study areas, and for reasons of data consistency, repeatability, update capability, and capacity for experimenting with alternative management scenarios. The ability to map the elk habitat types of cover and forage with digital analysis of Landsat data has been proven (Bright, 1981; Adams and Carey, 1984) and provides the initial step to automate the habitat effectiveness model. The task is to adapt the remaining procedures from the effectiveness model to digital image processing. Precedents for this type of elk habitat analysis in the Northwest are found in Colwell et al. (1982), and Eby and Bright (1986).

More specific objectives were:

1. To compare habitat effectiveness values over time.
2. To compare habitat effectiveness values by ownership.
3. To develop habitat effectiveness values for sub-areas of special concern.
4. To compare habitat effectiveness for winter and summer range areas.

Planned products included habitat effectiveness value tables and computer generated maps showing habitat effectiveness distribution and some components such as size and spacing of cover and forage.

DATA DEVELOPMENT

Cover and forage data were mapped based on Landsat data. The Landsat data obtained from the National Park Service, Denver Service Center, was for a 1976 base year and was used to develop the habitat effectiveness value for that year. Landsat photographic products were purchased for 1983 and 1984 and were used to update the cover and forage situation.

Cover quality was mapped based on Landsat data. The model uses three cover types, optimal thermal, thermal, and hiding. The Landsat data was field checked to correlate Landsat classes to cover types. In order to improve the cover type mapping the Landsat data was combined with digital terrain data to remove the effects of shading caused by steep slopes.

Forage areas were mapped using Landsat data. Information was added to the basic Landsat data to develop forage and treatment data. The habitat effectiveness model assigns forage values based on the treatments following forest overstory removal such as burning, fertilizing, and forage seeding. This information was obtained from interviews with land managers and from U.S. Forest Service computer files listing treatment history.

The Landsat data classified by cover and forage was subjected to a digital filtering process to create the data layer containing size and spacing information. This is similar to an averaging filter process except it is done on a binary image. Each filtering pass adds a new distance band to the image where the filter size determines the width of the band. The filter is rounded at the corners to compensate for the larger diagonal dimension of the pixel. The exact distance specified in the effectiveness index model may not be achieved on a pixel by pixel basis due to pixel dimension limitations. The filter can be selected so that the average width for any distance band over the study area is very close to the desired value. The habitat effectiveness model uses five distance categories for forage areas and six categories for cover areas.

The road information was acquired in map form and digitized to create the road data layer. For the road density effectiveness value, it would be possible to simply measure total miles for the study area and assign a constant effectiveness value over the entire area. In order to develop a more precise method, the road data was overlaid with a randomly placed 1.6-square kilometer (one-square-mile) grid. The number of road pixels in each square-mile cell can be used to assign the proper effectiveness value to the cell. The technique allowed road location as well as density to be evaluated.

The 0 to 1.0 scale used by the model was converted to a 0 to 100 scale in using digital processing to calculate the overall effectiveness index. The digital pixel by pixel application of the model used only three layers since cover and forage quality were combined into one layer. That meant that the overall effectiveness index on a pixel by pixel basis was the third root of the product of the three layers. In actual processing, the third root of each layer was taken and the layers were then multiplied. VICAR allows this to be done in floating point calculation with a Fortran-like expression. The final output was rounded to integer values and stored in image form so that normal display, summary, and manipulation could occur.

A winter/summer range mask was developed using digital terrain data. Two categories of winter range were identified, Type 1 was below 1,500 feet elevation (460 m.) with slopes of 0-30 percent, and Type 2 was below 1,500 feet with slopes of 30-60 percent. Summer range areas were defined as above 1,500 feet with slopes of less than 60 percent. The mask was used to summarize habitat effectiveness.

An ownership overlay was also digitized so that effectiveness could be calculated by land owner classes. This was based on a slightly generalized map of federal, state, and private lands. This overlay also identified some sub-areas of special interest for habitat effectiveness calculation.

RESULTS

Habitat effectiveness values were calculated for the study area for 1976 and 1984 federal, state, and private ownerships. The individual effectiveness parameter values and the overall values are shown in Table 1.

Habitat effectiveness for 1984 was calculated for winter and summer ranges and for some special interest areas. These special interest areas were (1) state lands south of Clallam Bay in the Clallam River drainage, (2) state lands east of Forks between the Calawah and Bogachiel Rivers, (3) private lands in the Pysht River drainage and (4) U.S.F.S. lands along the south side of the Sitkum River. Overall winter and summer range results are shown in Table 2, and results for special interest areas in Table 3. The state and private areas are mostly winter range while the Forest Service area has both winter and summer range, as Table 3 shows.

At this date, maps to be produced are in the planning stages and will depend on agency needs. Figure 1 shows a sample cover and forage map of the type which will be used in the project. Printer symbols represent habitat types and maps are produced at 1:24,000 scale. In addition to cover and forage maps, size and spacing maps and road effectiveness maps can be produced. The symbols on size and spacing maps would depict the different distance bands from the cover/forage edge as specified in the habitat effectiveness model. An example of a digitized road network is shown in Figure 2 overlaid with the one-square-mile grid cells (1.6 sq.km.).

USES AND MANAGEMENT IMPLICATIONS

Timber production is maximized on state and private land surrounding the Olympic National Forest in the study area. This even aged stand management greatly affects many wildlife species. Timber production is also the primary land management strategy on the ONF. As the results indicate, there is a higher overall habitat effectiveness on ONF lands. The tables show that ONF lands rate higher especially for cover quality, due to much higher percentage of cover in the optimal category.

However, unless specific ratios of cover/forage and size and location of cut units are targeted on a sub-drainage scale, ungulates, such as deer and elk could be greatly reduced or even eliminated as the ONF continues to liquidate the valuable optimal cover stands. The USFS does attempt to manage for deer and elk by optimizing conditions on a much smaller land base. The overall

Table 1. Habitat Effectiveness, 1976 vs. 1984

Effectiveness for Component and Overall Geometric Mean by Ownership Categories.

	1976			1984		
	PVT	DNR	USFS	PVT	DNR	USFS
Cover	38.0	43.2	58.6	41.3	45.7	57.4
Forage	51.5	50.0	49.4	51.9	47.8	49.7
Size and Spacing	85.9	75.7	81.0	80.4	75.1	81.9
Roads	54.0	57.0	52.0	53.0	56.0	52.0
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Overall HE	54.9	55.3	59.1	55.0	55.1	59.0

Table 2. Habitat Effectiveness, Summer/Winter Range, 1984 Effectiveness for Component and Overall Geometric Mean by Ownership Categories.

	Winter Type 1			Winter Type 2			Summer		
	PVT.	DNR	USFS	PVT.	DNR	USFS	PVT.	DNR	USFS
Cover	23.7	29.5	39.7	26.9	31.0	44.4	40.0	45.6	62.9
Forage	53.3	47.7	50.1	50.4	47.8	49.9	50.0	47.8	49.5
Size and Spacing	79.8	73.1	77.4	79.3	75.1	81.0	86.4	87.7	84.7
Roads	51.8	55.0	50.1	57.6	58.7	57.7	52.8	63.1	49.0
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Overall HE	47.8	48.8	52.7	49.9	50.6	56.7	55.0	58.9	60.0

Winter Type 1 - less than 1,500 feet el., 0-30 percent slope
Winter Type 2 - less than 1,500 feet el., 30-60 percent slope

Table 3. Habitat Effectiveness, Special Interest Areas, 1984 Effectiveness for Component and Overall Geometric Mean by Summer/Winter Ranges.

	DNR-Clallam River		DNR-Forks		Private-Pysht River		USFS-Sitkum River		
	Winter 1	Winter 2	Winter 1	Winter 2	Winter 1	Winter 2	Winter 1	Winter 2	Summer
Cover	25.2	25.1	39.5	40.7	22.6	29.9	51.0	59.0	82.8
Forage	47.8	47.7	47.7	47.7	50.0	50.0	48.6	47.9	41.8
Size and Spacing	79.5	78.9	81.7	80.9	67.1	66.3	90.6	89.1	41.9
Roads	53.5	54.8	54.0	54.6	53.4	55.5	44.7	56.9	91.9
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Overall HE	47.6	47.7	53.7	54.1	44.8	48.4	56.3	61.5	60.4

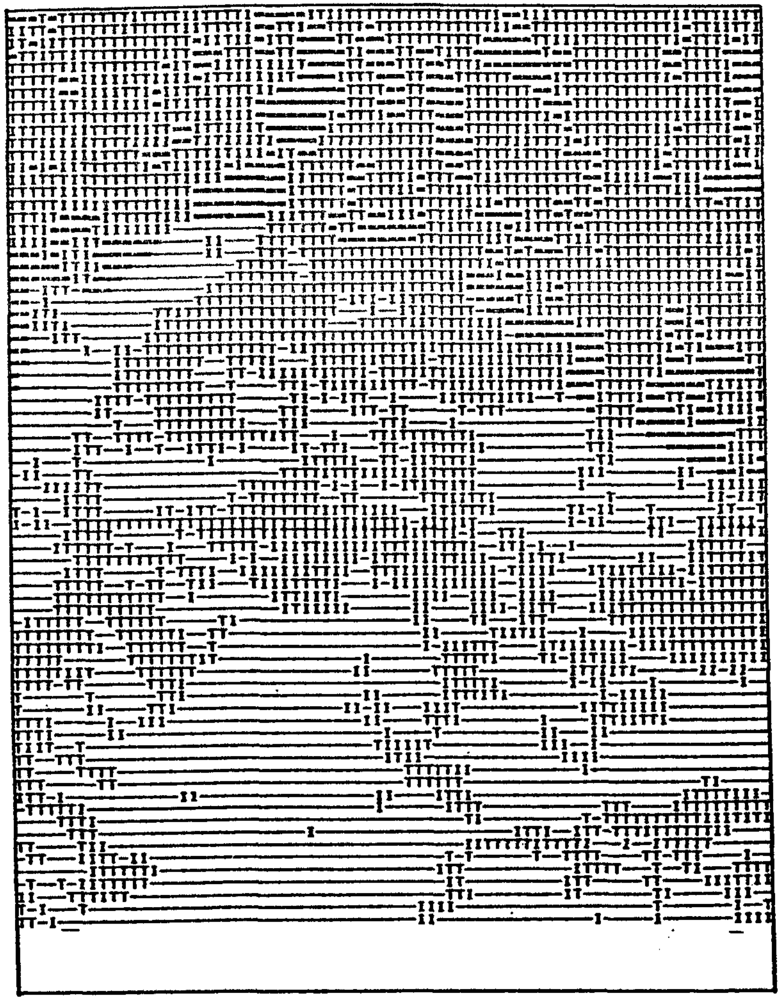

Figure 1. Elk Habitat Type Mapping

Optimal Cover T
Thermal Cover I
Hiding Cover =
Forage -

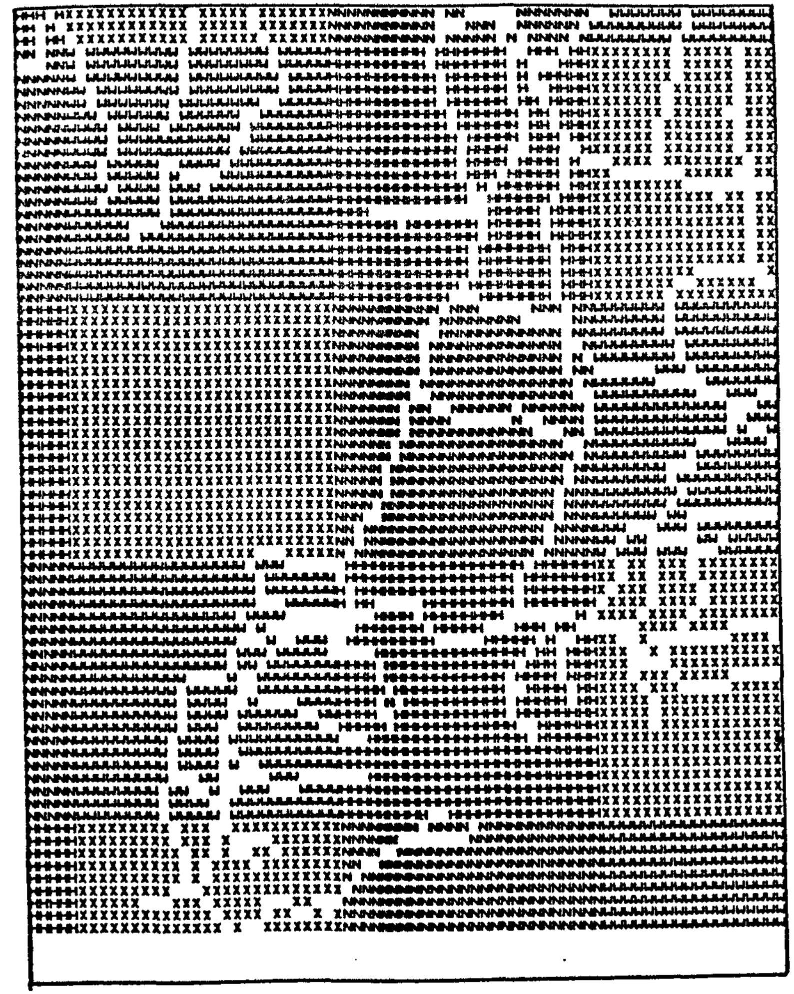

Figure 2. Roads on One-Square-Mile (1.6 KM) Grid Cell.

decline in population could not be made up for by increasing densities greatly in these small areas. Small, specially managed areas, can be extremely important (i.e. critical winter ranges etc.), but they cannot compensate for the overall loss of suitable habitat.

Winter range is the limiting factor for deer and elk populations on the Olympic Peninsula. This relationship is not surprising, in fact it is considered fundamental for most temperate zone ungulate populations. This being the case it follows that any habitat manipulation which occurs on sites utilized by elk as winter range can profoundly affect populations which utilize a much larger area during the remainder of the year. Land management, both positive and negative, are greatly magnified if they occur on winter range. Without an appropriate habitat matrix of forage and cover on winter ranges, big game populations will suffer. Inspection of Table 2 shows that winter range values are lower than summer ranges, especially for the prime type 1 winter range. Cover quality ratings are especially low for winter range, due to a lack of optimal cover in those areas. Wisdom et al. (1986) states that ratings below 40 are considered to be marginal.

These results can have a direct bearing on the current Olympic National Forest Planning process. The planning process involves multiple use of the resource, as it should, since the forest is a dynamic ecosystem with many competing users. However, the big game resource has already been subjected to some compromise. The actual animal optimum forage/cover ratio would probably include 30 percent forage and 70 percent old growth on critical winter range, where the forage areas were managed solely as forage areas in perpetuity as would be the old growth cover stands, with virtually no wood fiber harvest. The managed forest optimum forage/cover ratio on CWR now being considered for the ONF is a 20/30/50 (forage/hiding cover/thermal cover at 21" dbh or greater) which would effectively reduce true potential habitat carrying capacity by 40-50 percent as compared to the animal optimum baseline above. This is due to the low rating for hiding cover in the model. A good portion of actual CWR has already been logged or has been programmed for harvest. It appears that some districts on the ONF are aiming towards an 80 year conversion/rotation on CWR which will only provide about 10 percent of the area in cover blocks averaging 21" dbh or larger on a sustained basis. To compound the problem, optimal thermal cover is non-existent on surrounding state and private land and the distribution of existing cover blocks on CWR is already marginal in some areas of the ONF. Too many "compromises" are already part of the system, which signifies the importance of developing habitat effectiveness models and subsequent output for consideration by land managers.

There is a continuing deterioration of the relationship between suitable cover types and useable foraging areas at the expense of native big game populations. There are two main reasons for this, 1) modern reforestation practices seek to establish a stand immediately after logging which tends to curtail the most productive forage years and 2) old growth conversion is occurring at a time when second growth cannot yet substitute as optimal cover for old growth that is removed. This type of modeling is a step to a more systematic approach which addresses long term forage/cover relationships on a sustained basis over time within individual drainages.

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AN INDEX TO EVALUATE FORAGE QUANTITY AND QUALITY INTERACTIONS:[1] ONE OF FOUR VARIABLES PROPOSED FOR MODELING ELK HABITAT EFFECTIVENESS ON WINTER RANGES IN THE BLUE MOUNTAINS OF OREGON AND WASHINGTON

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Abstract: New research and current land-use planning requirements make it clear that a model of habitat effectiveness (HE) for winter ranges of Rocky Mountain elk is needed with which managers may assess likely effects of and results from proposed or executed alternative actions. In this article we examine the forage variable of a four-variable HE model developed for the Blue Mountain province of Oregon and Washington. Derivation and calculation of the forage variable are emphasized, and some range treatments to improve forage are compared from the point-of-view on which this variable is founded. Interaction of quantity and quality is indexed by relationships derived from data specific to decreaser forages, Idaho fescue and bluebunch wheatgrass, that are key elk foods and common dominants in plant communities on winter ranges throughout the northwest.

National Forest land managers in the Blue Mountains of Oregon and Washington have been using a habitat suitability index model (or modifications of that model) developed by Black et al. (1976) and Thomas et al. (1979) for Rocky Mountain elk (*Cervus elaphus nelsoni*) summer ranges. The original model specifically stated that:

> The cover requirements of...elk on winter range must be considered more carefully than for summer range. Animals distributed over thousands of square kilometers at high elevation in spring, summer and fall are forced by increasing snow depths to travel downslope as winter sets in. They move down through spring-fall ranges and by mid-winter are concentrated into smaller, more restricted areas at lower elevation. Consequently, the number of animals per unit area is much greater than on summer and spring-fall ranges...

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> Most of the winter ranges in the Blue Mountains are at lower elevations where forested areas are interwoven with openings. In such cases forest cover may be less than optimum, and existing cover is frequently the key to determining how animals will use the area...
>
> Winter ranges are more sensitive to land management decisions than are summer and spring-fall ranges because of their scarcity and higher intensity of use. It is inappropriate to provide...detailed criteria for managing...winter ranges because the consequences of error could be greatly magnified. Each winter range is different in its vegetative mosaic and the way it is used by the animals. The managers should study winter ranges carefully before deciding to alter cover--particularly thermal cover (Thomas et al. 1979:114-115).

We concur with those observations. However, the situation has changed since 1979. There are new research data on elk use of habitat on both summer and winter ranges in the Blue Mountains (Leckenby 1984). Current land-use planning requirements make it clear that a model applicable to evaluation of elk winter range habitat effectiveness is needed to assess management alternatives.

The purpose of this article is to examine the forage quantity-quality interaction variable from a proposed model (our working hypothesis) of relationships among four variables affecting elk habitat. The size and spacing of cover and forage stands, the density of roads open to traffic, the quality of thermal cover, and lastly, the quantity and quality of available forage, singularly and their interactions, may influence the effectiveness of habitat for promoting the welfare of elk more than any other factor or combination of factors. We chose to emphasize the derivation and give an example of applying the forage variable here because other participants in this workshop have already discussed those other variables, how they are computed, and how they may by applied (Wisdom, Adams, Eby, and others in this conference). Our index of the forage variable, however relies on some challenging concepts that may require us to make a paradigm shift in our interpretation of what is optimum forage on winter range. We also compare some range treatment methods for improving forage quantity and quality in the light of that shift in point of view.

INTERACTION OF AVAILABLE FORAGE QUANTITY AND QUALITY

The interaction between the quality (nutrient composition associated with growth stages of plants) and quantity (available biomass) of elk forages present in natural openings (i.e., grasslands) is suggested as an index to the effectiveness of forage for elk on winter ranges in the Blue Mountains. It is assumed that the elk forage biomass in such grasslands will usually be some predictable multiple of that present in forested areas and in transitional rangelands, both of these being intermixed with the grasslands. Grassland communities dominated by either Idaho fescue or bluebunch wheatgrass or both are used as examples here for two reasons. These bunchgrass communities are very common and comprise many acres of winter ranges in the northwest (Daubenmire 1970, Hall 1973, Hopkins and Kovalchik 1983, Johnson and Simon 1985). Also, those two grass species constitute common and preferred forage for Rocky Mountain elk throughout much of their native range (Nelson and Leege 1982).

The model produced by Thomas et al. (1979) to evaluate elk habitat effectiveness on summer and spring-fall elk ranges did not include consideration of forage availability *per se*. It was assumed that either forage availability was not a problem on such ranges or that the evaluation of forage-cover area ratios would encompass such considerations. In the model designed to evaluate elk habitat effectiveness of winter ranges, it seemed appropriate to specifically evaluate the quantity and quality of known key elk-forage species because: (1) elk are concentrated on winter ranges and their ability to shift to other areas is limited; (2) forage of adequate quantity and quality is often not available during winter; (3) livestock graze winter ranges before elk migrate to them in the fall -- i.e., the degree of grazing by livestock influences the quantity and quality of the forage available to elk; and (4) snow accumulation and duration of snow cover influences forage availability as well as the nutrient requirements of elk.

Assumptions adopted for indexing the interation of forage quantity and quality

The forage quantity-quality habitat effectiveness index (HEF) is construed from known forage and animal relationships that are expressed in the following 10 assumptions:

(1) Some level of sustainable yield of livestock and big game can be produced from managed forests and rangelands. Whatever that level of production is, it should result from management that attains a positive balance between seasonally changing plant requirements and animal needs (Thomas et. al. 1979, Lyon 1980, Austin et. al. 1983, Svejcar and Vavra 1985).

(2) Interations between grazing animals can be coordinated with plant physiology in order to optimally schedule range management actions (eg. grazing systems or prescribed burning).

(3) Recent studies demonstrate that grazing by livestock and other treatments can be scheduled to favorably manipulate forage quality and thereby increase availability of nutritious food for the consumption of big game (Willms et al. 1980, Willms et al. 1981, Gates and Hudson 1981a, 1981b, Austin and Urness 1983, Austin et al. 1983, Urness et al. 1983, Gavin et al. 1984, Hobbs and Swift 1985).

(4) Dual use of range by livestock and big game is more flexible than the either-or situation that some land management planning allocations suggest. That is, estimates of competition levels based strictly on diet similarities (preferred forage species) are probably inaccurate. Animal-unit forage equivalencies are likely more complicated functions

than only the ratios of forage weights required to satisfy either a maintenance or production demand. Such equivalencies are really simple ratios of livestock body weights to those of elk (or deer *Odocoileus hemionus* and *O. virginianus*). The weight ratios are accurate equivalencies only when the animals are required to consume the same food, because food intake then is proportional to body weight.

(5) Quantity alone is not a sufficient index to judge the role of forage in modifying habitat effectiveness. The interaction of forage quality with quantity is also important -- at least equal with quantity.

(6) The quality of fall forage consumed by big game influences the level of maximum possible fat reserves attained before winter commences.

(7) Thermal cover in the winter range management unit is adequate and thereby effectively provides operable temperatures that prevent total depletion of reserves of body fat before quality forage is again available in spring (Gates and Hudson 1981b, Parker and Robbins 1984, Moen 1985).

(8) Spring forage is sufficiently nutritious and available to satisfy gestation requirements and at the same time to build reserves that will be utilized by big game during their spring migration back to summer range (Holl et al. 1979, Gates and Hudson 1981b, Moen 1985).

(9) Habitat effectiveness is directly correlated with elk and deer use of habitat, the physical condition of the animals, and herd productivity levels.

(10) Habitat effectiveness is poorly related to, and therefore not a good predictor of, densities of big game animals *per se*.

How Forage Quantity and Quality Interact

The influence of forage availability on habitat effectiveness is judged in our model by considering the interaction of the quantity and quality (Hobbs and Swift 1985) of the above ground biomass remaining on key forage species as of October 1. The appropriate relationships are shown in Figures 1, 2, and 3. The forage variable, HEF (a function of the HEF scores, derived from the curves in Figures 1 and 3) suggested here is a first approximation of the interaction of forage quantity and quality with elk preference and carrying capacity in the Blue Mountains of northeast Oregon. Calculation of the forage variable is detailed after examination of the relationships involved. In essence, a manager estimates the percent of herbaceous plant cover that is comprised of decreasers in the analysis area. Idaho fescue and bluebunch wheatgrass being decreasers in the sense that their abundance decreases as range condition moves away from ecological climax through seral stages of plant succession toward a dominance of a site by non-vegetation (eg. bare ground, gravel, stones etc.). From that foliar coverage of decreasers, the manager determines a score for the forage quantity HEF from the relationship depicted in Figure 1 (data adapted from Hopkins and Kovalchik 1983, and

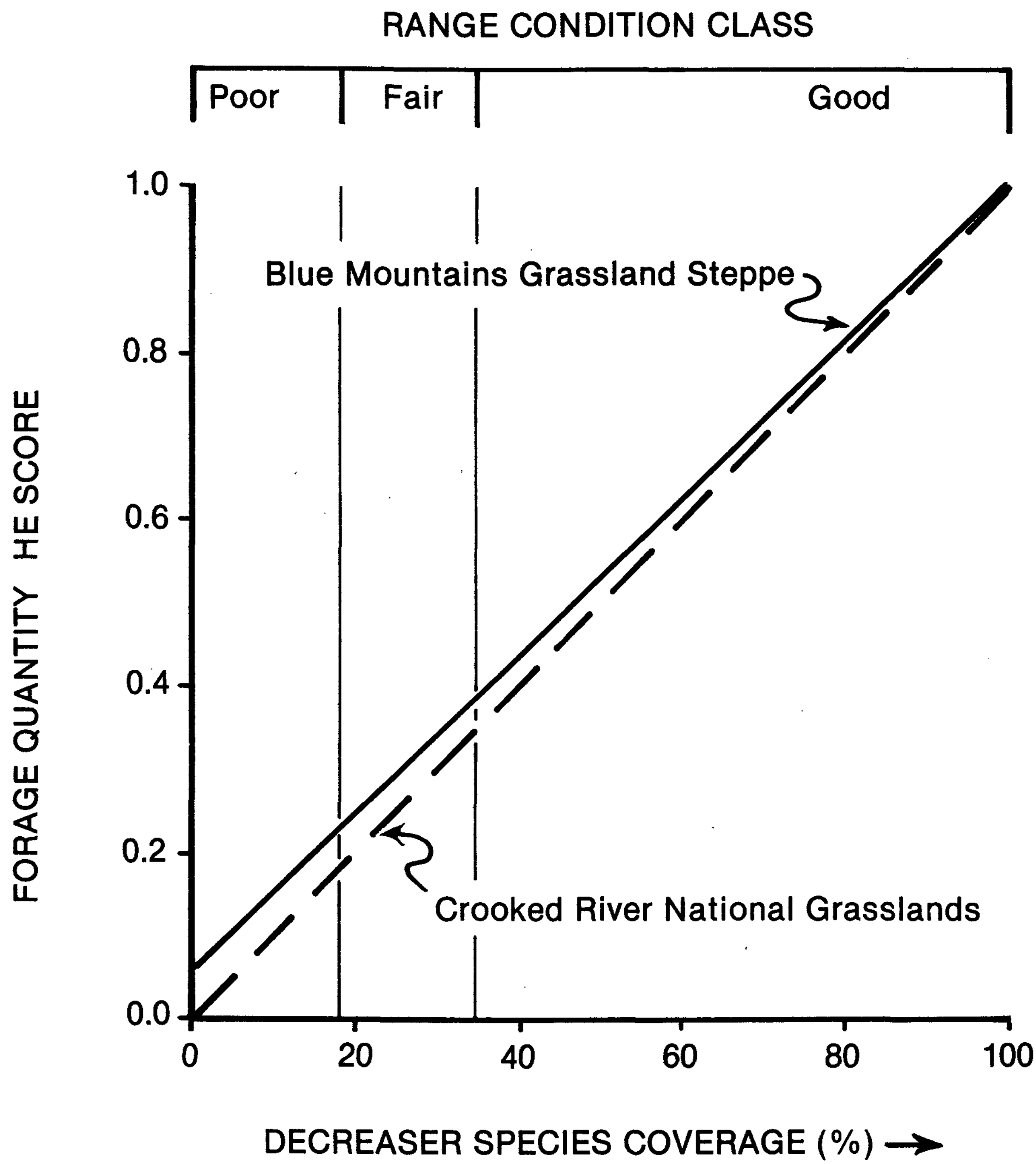

Figure 1. An estimate of total plant cover (% foliar coverage) comprised of decreaser species (eg. Idaho fescue and bluebunch wheatgrass) is used to determine the forage-quantity HE score (data adapted from Hopkins and Kovalchik 1983, Johnson and Simon 1985).

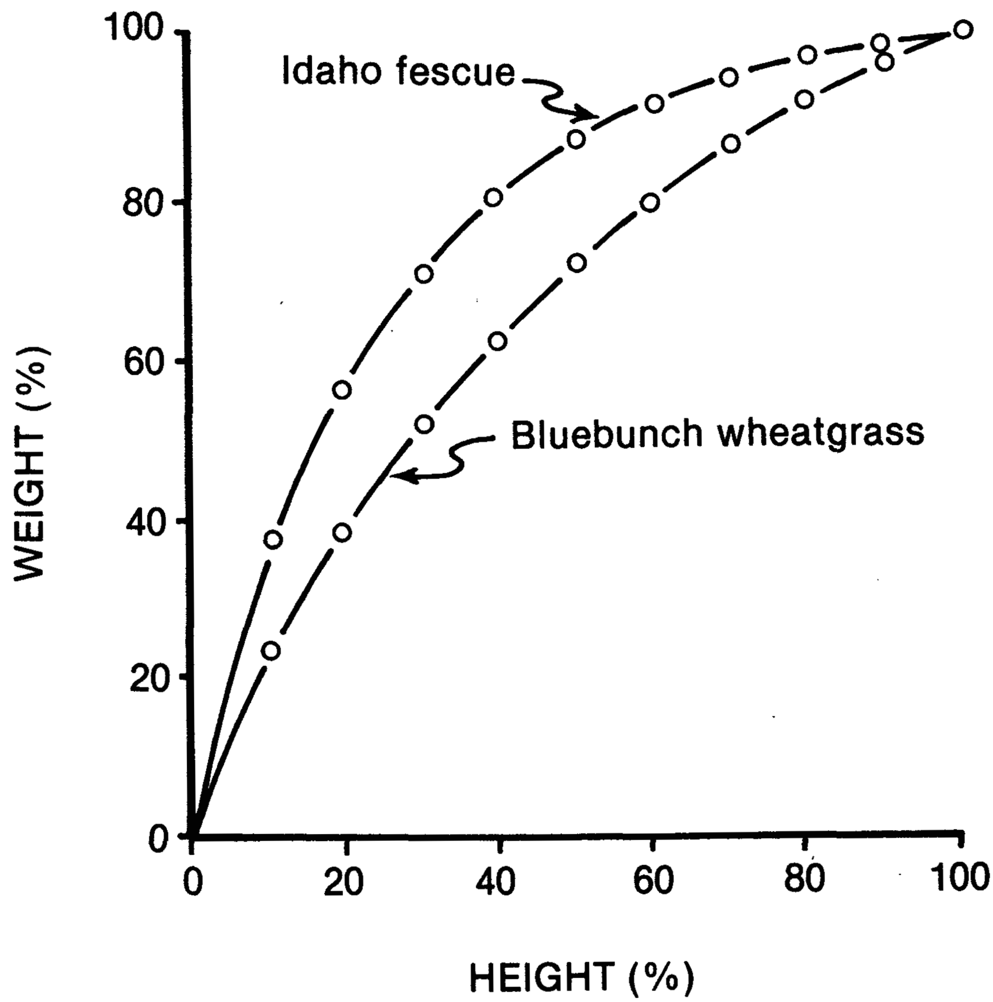

Figure 2. An estimate of grass height remaining on October 1 after grazing by livestock is used to estimate the weight of forage available to elk (data courtesy of F.C. Hall 1985, personal communication).

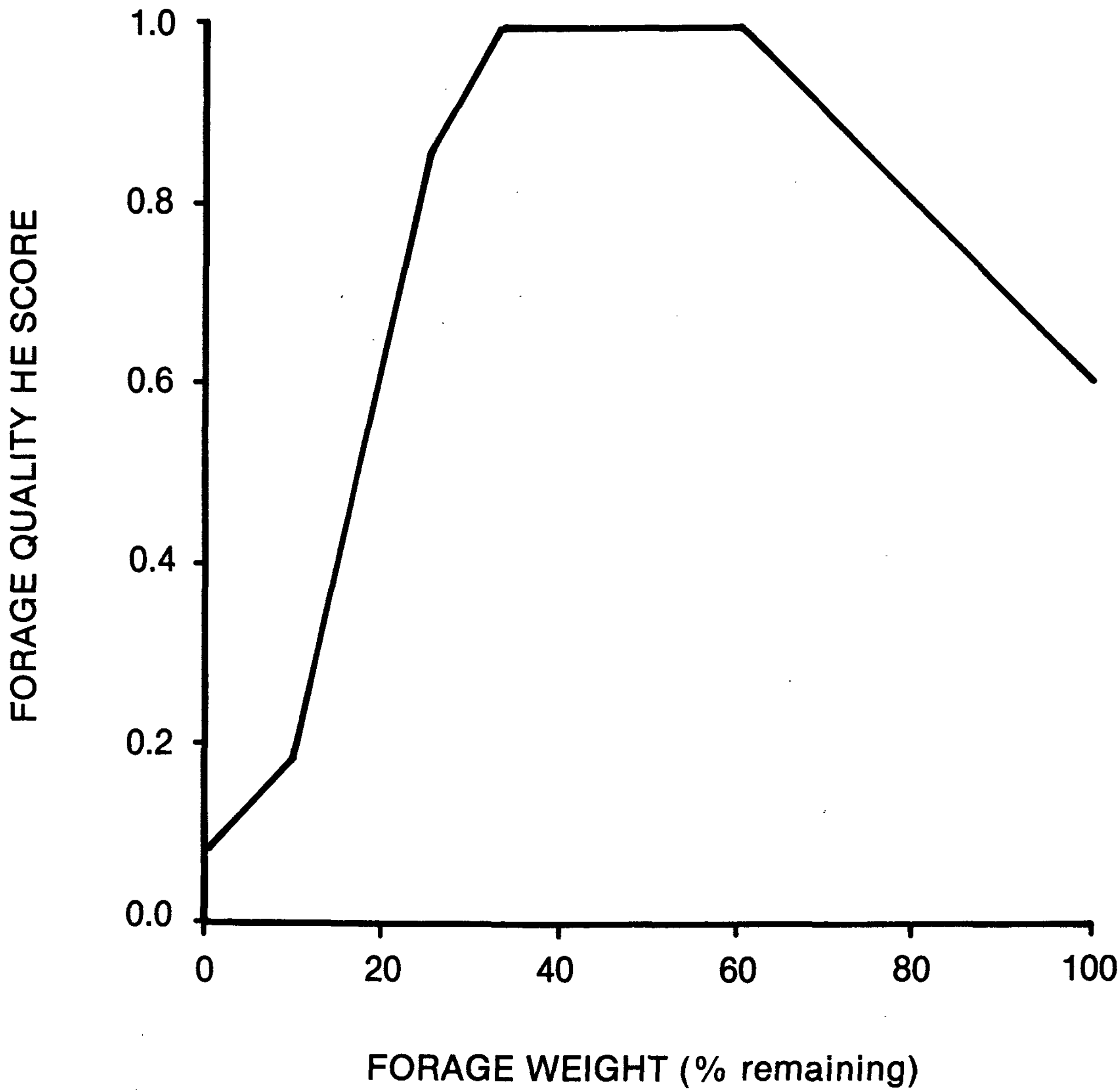

Figure 3. An estimate of the weight of forage remaining is used to determine the forage-quality HE score (data adapted from Hobbs et. al. 1982, Hobbs and Swift 1985).

Johnson and Simon 1985). The manager then estimates the percent of plant height remaining after livestock grazing on either Idaho fescue or bluebunch wheatgrass. From another relationship (Fig. 2, data courtesy of F.C. Hall by personal communication 1985), that estimate is converted to the percent of forage weight remaining. The forage quality HE score is then derived from the relationship between weight remaining and habitat effectiveness (Fig. 3, data adapted from Hobbs and Swift 1985). Finally the two scores, one representative of forage quantity and one of forage quality, are combined in a manner consistent with their compensatory interaction (U.S. Fish and Wildlife Service 1981:14) to derive the HE_f (forage-index variable) which then can be applied in the multi-variable habitat effectiveness model.

This index is based on the demonstration by Hobbs and Swift (1985) that "...only at intermediate or low dietary nutrient concentrations..." were estimates of carrying capacity from available biomass greater than those derived from the interaction of both the quality and the quantity of the forage [underlining not in original quoted text]. They reported analyses of herbivore ecosystems demonstrated that the "...nutritional quality of herbage is inversely related to its abundance..." An earlier model of similar form (Hobbs et al. 1982) was recently used to estimate carrying capacity levels for cattle, levels of beef production, and to predict forage improvements resulting from vegetation treatments in the Blue Mountains (Svejcar and Vavra 1985).

Given these new research interpretations, it seems best to derive weights for the forage HE variable from carrying capacity relationships proposed by Hobbs and Swift (1985) because their new models resolved a paradox in carrying capacities among elk habitats (Hobbs et al. 1982, Hobbs and Swift 1985). Their model reliably predicts the maximum quality of diets obtainable by a specified number of animals -- eg. that number perhaps being the current management objectives for wintering elk in the Blue Mountains.

There could be significant and practical solutions to some current problems facing land and wildlife managers. Those answers may logically result from application of the paradigm shift required in adopting Hobbs and Swift's (1985) reasoning. Concerns and conflicts among resource interests may become less on winter ranges where managers intentionally manipulate forage quantity and quality to expressly maintain fewer elk in better condition. Improved distribution of quality forage could permit elk to express higher rates of recruitment than previously existed. A greater rate of recruitment could sustain desired levels of harvest in spite of there being fewer breeding elk maintained on that winter range. The improved forage quantity and quality, necessary to produce the better animal condition, could be established by treatments such as prescribed burning and specific grazing systems for livestock -- both kinds of treatments being selected specifically for each site.

It seems advantageous to have a diverse pattern of quantity-forage swards mixed with quality-forage swards within the cover-forage mosaic of optimally-sized and distributed stands. Utilization of those swards will be optimal where no portions are more than 1,200 feet (400 yards) from the nearest cover-forage edge. This mix can be created by various treatments (livestock grazing, prescribed burning, tree thinnings, etc.). Such diversity of forage quantity and quality provides big game the opportunity to optimize the quality of their diet and adjust that hourly and daily as dictated by changing weather conditions (Gates and Hudson 1981a, Austin and Urness 1983, Gavin et. al. 1984, Hofmann 1985, Medcraft and Clark 1986). The forage-quantity and forage-quality diversity should allow big game to minimize nutrient debits sustained during deep snow cover. They would do this by using high-quantity but low-quality forage, sticking out of the snow or that found on wind-swept aspects, during the period while their forage intake rate is naturally (physiologically) depressed (Moen 1973, Robinette et. al. 1973, Gates and Hudson 1981b, Robbins 1983, Moen 1985). To put this in a banking analogy, loans (deposited as body fat) to be used to pay for those periods of forage debt would be secured in the fall and spent over the winter. The used up capital of the loans would be repaid with interest in spring when the currency of green, high quality forage is sufficiently available to not only repay the debts but to provide a surplus above the animal's needs -- when their appetite is naturally increasing.

Computation of HE_f. Habitat effectiveness resulting from the interaction of forage quantity and quality (HE_f) requires on-the-ground inspection to determine:

(1) The percent of herbaceous cover that is made up of decreaser species and the percent of the ungrazed-height of key elk forages that is remaining on October 1 (figures 1 and 2); the manager does not have to clip and weigh samples!!

(2) If bluebunch wheatgrass makes up 50 percent of the herbaceous cover, that corresponds to a HE_f quantity score of about 0.5 (from Figure 1).

(3) If 20 percent of the height of bluebunch wheatgrass is remaining, it can be determined that this corresponds to 37 percent of the above ground biomass (from Figure 2).

(4) The weight remaining (i.e. 37%) is used to determine the forage-quality portion of the HE_f score from the relationship depicted in Figure 3; in this example that score is 1.0.

(5) Then the interaction of the two scores (i.e., forage quantity at 0.5 and forage quality at 1.0) is computed from the geometric mean of their product -- that is $[(HE_f \text{ quantity}) (HE_f \text{ quality})]^{1/n}$; in this example it is $[(0.5) (1.0)]^{1/2}$ which is 0.71.

At this point it seems appropriate to interject the example HE_f score into the elk habitat effectiveness model for winter range to illustrate its effect on the index that results from the interaction of scores from the other three variables -- all four indicies being calculated within the fixed boundaries of the land management which is being evaluated.

Overall habitat effectiveness (HE_{sfrc}) versions reviewed earlier in the program of this conference consider the interaction of: (1) sizing and spacing of cover and forage areas (HE_s); (2) density of roads open to vehicular traffic (HE_r); (3) forage quantity and quality (HE_f); and (4) the quality of thermal cover (HE_c) (Thomas et. al. 1986, in press).

Computation of HE $_{srfc}$. Elk habitat effectiveness is computed (using hypothetical scores determined earlier for each variable to illustrate the procedure) as follows:

$$
\begin{aligned}
HE_{srfc} &= (HE_s \times HE_r \times HE_f \times HE_c)^{1/n} \\
&= (.61 \times .42 \times .71 \times .80)^{1/4} \\
&= (.15)^{1/4} \\
&= .62
\end{aligned}
$$

It may be useful for managers to compute habitat effectiveness (as illustrated) and use the resulting HE_{srfc} values to either help decide whether some action is needed to meet program objectives or to monitor results of past actions. Then they still must choose among treatment techniques that are known to often result in highly variable responses of forage plants -- in terms of the quantity and quality of elk forage produced. Are there generally-appropriate tips that might help managers anticipate likely results from given treatments in specific situations?

Improving Forage Quantity And Quality On Winter Range

Prescribed burning

Historically, fire was the most important factor affecting plant succession and species on most sites (Gruell 1980, Dell 1980, Houston 1982). Gruell (1980) suggested that "a reduction in acres burned has allowed vegetation to reach advance succession at the expense of herbaceous plants and deciduous shrubs and trees. With advancing succession, the carrying capacity for elk and other wildlife has declined."

Results from prescribed fires, designed to improve forage on winter range, are as diverse as the habitats upon which they were conducted. Skovlin et al. (1983) concluded that fall burning on a foothill rangeland in the northern Blue Mountains did not increase elk use during winter. Burning was conducted after fall rains had begun; this may have influenced forage production on the treatment plots.

In mixed conifer/pinegrass communities studied by Hall (1977), prevention of underburning decreased elk forage (pinegrass and elk sedge -- the most palatable plants) and increased tree cover. Forage production was only 50 to 100 pounds per acre. In the same community type where periodic underburning had occurred, tree canopy averaged 50 percent and forage production was 500-600 pounds per acre. A portion of the increase in forage production on burned plots may have been attributable to the decreased canopy closure of the trees (McConnell and Smith 1970); thus, not all the additional forage was probably a result from the effects of fire *per se*.

Hobbs and Spowart (1984) warned that inferences on the benefits to ungulates from prescribed fires may severely underestimate the values of burning to the nutrition of big game if those inferences are based only on changes in forages and not on dietary changes. They observed that prescribed burning greatly improved the quality of winter diets of mountain sheep and mule deer in two plant communities while only small changes in quality of individual forages was noted. More green grass was observed on burned plots than unburned plots during winter, primarily due to removal of standing dead herbage and warmer soil temperatures; the latter being enhanced by greater absorption of sunlight due to blackened soil surfaces. Ungulates were able to select more weight of highly-nutritious green grasses from burned plots and consequently significantly alter the quality of their diet. Later in the spring, diet quality from control plots exceeded that of burn plots. They suggested spring forages on control plots were phenologically younger than on burned plots in the later samples. Therefore, the plants in the control were higher in quality than in the burn at the later date because growth had started earlier in the spring on the burned plots. They stated "differences between burn and control plots in initiation of plant growth benefit ungulates by offering two temporally, distinct flushes of nutritious plant tissue, early on the burn and late on the control." This prolongs the time when nutritious forage is available to ungulates. Such results emphasize the importance of diversity of habitats and treatment conditions in providing forage choices for ungulates to match with prevailing weather conditions. This is also the basis for the two parts of the HE_f variable (Figure 1 and Figure 3).

The following are some of the factors that can influence whether a prescribed burn will meet desired objectives for forage enhancement (Wallowa-Whitman winter range paper, undated, unpublished, typewritten):

(1) The heat tolerance of the forage species.
The morphology of a plant has a direct influence on its tolerance to heat. For example, bunchgrasses have low tolerance because their densely clustered culms can burn for several hours after fire has passed. Wheatgrasses are more heat tolerant because their coarse stems burn out quickly following fire passage.

(2) Fire resistance of the forage species.
Resistance of a plant to burning is related to the carbohydrate reserve present in the plant. Reserves are generally lowest during the active growing season and burning during this time can be damaging to some species.

(3) Time of year.
This relates to No. 2. Spring burning of Idaho fescue can cause damage or mortality to the plant while fall burning during dormancy will cause little damage.

Prescribed burning as a technique to improve forage quality for ungulates has shown a variety of results. The response of elk to prescribed burning on winter range must be closely evaluated to assess whether specific objectives are being achieved.

Fertilizing with chemicals

Information concerning use of fertilizers to improve forage quality and quantity for elk on winter range is scarce. Skovlin et al. (1983) observed that fertilizing winter range in the northern Blue Mountains in fall increased elk use in the winter by 49 percent the first winter following application. No carry-over effects were observed in succeeding years in terms of elk response. The authors felt the application was not cost-effective but may have practical application in certain special situations. Bayoumi and Smith (1976) observed an increase in forage quantity and quality following fertilization of a sagebrush-grass type winter range and related this response to potential improvement of forage for big game. They suggested that fertilization may not prove cost-effective in terms of increasing elk use where sufficient forage is available to meet normal winter requirements.

As with prescribed burning, fertilization of rangelands to improve quantity and quality of forages has revealed varied results. Skovlin et al. (1983) recommended that land managers contemplating fertilization develop a simple field trial to determine feasibility under varying range conditions.

Grazing by domestic livestock

Utilizing livestock to improve forage conditions on big game winter range is currently the subject of considerable debate. In separate grazing studies conducted on elk winter ranges in northeastern Oregon, opposite conclusions concerning the effects on elk use were presented. Anderson and Scherzinger (1975) suggested that light grazing by cattle in spring and early summer stimulates regrowth which is higher in nutrients than ungrazed range. Such an improved forage condition was one change that may have attracted additional elk to the study area from surrounding winter ranges. Conversely, Skovlin et al. (1983) observed that spring grazing by cattle on winter range significantly reduced elk use (measured by counts of pellet groups) during the second winter of a 3-year study in northeastern Oregon.

After observing distributions and behavior of white-tailed deer, O.v.leucurus, Gavin et. al. (1984:37) concluded, "Manipulation of grassy fields by haying or cattle grazing was necessary to maintain feeding areas for deer, but pastures grazed by cattle were preferred." Leckenby (1983) reviewed publications showing positive as well as negative results from studies on how on deer distributions and forage quantity and quality interactions were affected by grazing of ranges with livestock.

Svejcar and Vavra (1985) predicted lower carrying capacity and beef production could result from vegetation treatments that did produce more forage biomass on some sites in the Blue Mountains; the greater quantity being associated with lesser quality of forages.

The apparent contradiction among studies might be explained by results of research along related lines. Collins and Urness (1979) reported that "distribution of elk pellet groups did not give accurate representation of relative habitat segment use." Elk defecated at a greater rate when active, such as walking from one area to another. Other work by Collins (1977), not seen but cited in Boyce and Hayden-Wing (1979), indicated elk move about less in more productive habitat -- the most preferred for grazing. Pellet group counts underestimate elk use in these foreage-rich areas because elk travel less when feeding there and they defecate less when less active.

Hobbs and Spowart (1984) observed that improvement in diet quality for ungulates following fire was related to the presence of green grass on burned plots. Green grass on unburned sites was obscured by standing dead herbage and litter on the ground; Austin et. al. (1983) observed this with mule deer also. Hobbs and Swift (1985) noted burns contained more forage with high nutrient concentrations but less forage overall. They also noted that forage quality is inversely related to its abundance in many ecosystems.

These observations can be related to the data collected by Skovlin et al. (1983). The grazed plots were structurally similar to the burn plots of Hobbs and Spowart (1984), i.e., dead herbage was removed and green forage was more available. The elk use data of Skovlin et al. (1983) may have been misinterpreted in light of the work by Collins and Urness (1979). In other words, we would expect less pellet groups on grazed plots because more highly nutritious green forage would be available to elk. This is further supported by the observation on page 187 of Skovlin et al. (1983), related to the reduction in elk use (pellet counts) during the second winter - "The winter with the least snow and heaviest elk use." The details of this observation are unknown. In any case, if elk concentrations were high and green forage was more available on grazed plots, we would expect fewer pellet groups on these plots.

Anderson and Scherzinger (1975) developed a livestock grazing system based on the morphological and physiological characteristics of forage plants. The objectives were to remove dead herbage to prevent formation of wolf plants and improve quality of forage species regrowth by manipulating the physiology of forage plants through livestock grazing. This concept has been strengthened through the recent work of Hobbs et al. (1982) and Urness et al. (1983). That paradigm also supports observed distributions of elk and deer on many winter ranges.

In another study of northeastern Oregon rangelands, Miller and Vavra (1982) observed south exposures and wind-swept ridges provided a major portion of winter forage consumed by deer and elk. These areas continued to be important into early spring because they provided a new source of abundant green forage. They suggested these areas had the greatest potential for competition for forage between livestock, elk, and deer; Gruell (1973) and Houston (1982) came to similar conclusions about ranges in and near Yellowstone Park.

Forage in cover stands

Forage inside cover stands is extremely important to elk in summer and winter, especially during clear and hot days and during deep snow periods when forage is essentially unavailable in open areas (Marcum 1976, Gates and Hudson 1981a, Leckenby 1984, Parker and Robbins 1984, Wickstrom et al. 1984, Zahn 1985). On winter range, interception of snowfall by the canopy reduces snow depth inside cover stands, making forage more available (Beall 1976, Leckenby 1984, Parker et al. 1984). Leckenby (1984) also observed elk frequently eating lichens (Alectoria sp.) in all seasons. This forage was abundant inside thermal cover stands. Samples, of this rich and often underrated elk food, contained 1.99-2.24 M cal of digestible energy per kilogram of dry matter and 6-7 percent crude protein.

A diversity of crown closures in both cover and forage areas on winter range will provide elk a variety of foraging opportunities to match with day-to-day conditions. This in turn will enhance survival and optimize productivity (Moen 1973, Beall 1976, Leckenby 1984, Parker et. al. 1984, Wickstrom et. al. 1984).

Tips on Managing For Diversity Of Forage Quantity And Quality

- Provide a diversity of forage stand conditions (in terms of forage structure, i.e., grazed, burned, forage inside cover, ungrazed) that will match variation in day-to-day opportunities for elk.
- Implement livestock grazing systems keyed to the physiology and morphology of the forage species in the plant community on each specific site to improve forage quality on winter range types.
- Apply prescribed burning techniques to improve forage quality on winter range -- based on specific objectives for forage diversity -- and on probabilities of successful response in each plant community treated.
- Avoid using fertilizers to improve forage quality on winter range because that is not cost-effective in most instances.

CONCLUSION

Forage quantity and quality interactions are variables that could be indexed to help managers define goals in plans for winter ranges of Rocky Mountain elk. Changes in the indicies could help evaluate whether projects are producing results that meet specific program objectives. Those two steps could provide a basis for monitoring progress toward a successful execution of the plan. However, a forage index is only one variable of importance in evaluating habitat effectiveness for elk on winter range. It seems likely that probable interactions of forage quantity, forage quality, thermal cover quantity, thermal cover quality, size and spacing of both forage areas and thermal cover, and the influence of disturbance are all important for modeling habitat effectiveness.

We have presented details addressing the forage quantity and forage quality interaction index here -- have emphasised those -- because other presentations in this conference have explored the total habitat effectiveness index, how it is computed, how that is automated and tied to Landsat MSS data classifications, and how it applies to areas other than the Blue Mountains. Those papers and others soon to be published cover the total HE concept. Our purposes in this report were to (1) examine a proposed index to the effectiveness of forage for elk, (2) to redefine a few concepts about elk and deer forage relative to carrying capacity and habitat effectiveness, and (3) to compare some techniques for improving elk forage on winter range, given those redefinitions. Some traditional concepts about forage should perhaps be modified because of new knowledge about animal physiology and plant physiology. The newer data and interpretations suggest that livestock grazing has been and could continue to be applied as a useful tool to accomplish planned objectives for management of elk (and deer) winter range forages.

Habitat effectiveness is defined as an index used to account for elk habitat conditions on managed forests. The index (HE_{srfc}) relating levels of elk use of habitats, elk productivity, and suitability of habitats for elk is a biologically based index. This index reflects elk habitat effectiveness during that period when elk are not hunted. Habitat management to enhance the hunting experience, to reduce the number of elk killed or the rate of elk killed during hunting season, or to benefit other wildlife are altogether different issues and are not addressed here.

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FIELD TRIP DEBRIEFING NOTES

Question: Out there on the field trip today, there was no mention of any livestock interaction or grazing.

Answer: A lot of the country you see on the south coast is nearly vertical. We didn't see so much vertical today, but I don't honestly believe that there's much of a grazing industry in much of the Coast Range of the type that we saw today. There's been quite a little bit of new work that's being started with sheep grazing on clearcuts and it is a developing thing. I want somebody else with BLM, anybody willing to field this question as far as locally on the handling of livestock grazing?

Answer: I'm Wayne Logan from BLM in Salem. There wasn't any mention of livestock grazing out there and, incidentally, we have a little bit of grazing but it's normally trespass. In fact, we don't feel it's worth the time to go after it. Alsea Ranger District did some extensive studies with some grazing and found that it worked pretty well if you had real good control. You've got to remember, we're foresters over here and we're not rangecons. One of the problems that you come up with considering areas like Nevada and Idaho, is that you have ranchers that trail their sheep around in various areas. We don't have that type of sheep operation over here on the westside. I think they even had to pay to get a herder to bring a band of sheep over into the westside to do their study. The sheep that are grazed in the Willamette Valley are normally pastured in an area. I don't think they're set up for that type of operation. It just seems to me that it's going to be a lot more complicated than just doing a study and foreseeing sheep or cattle out in an area. It takes a lot more control than that.

If we were going to bring someone in we'd probably have to bring someone from eastern Oregon. In fact, we'd be trucking them over here and trucking them back. So there's a whole lot of problems with that aspect of grazing. It sounds really easy when you have a whole bunch of grass out there, more grass in one of these clearcuts than the whole state of Nevada has. Yet you feel like you can't use it. There's a lot of problems with the type and amount of grazing that you really need out there, so it's not very easy.

Question: A question for Bert Cleary from that first stop we made. He mentioned that when he originally started his forage seeding he used legumes. Now after he's been into it for a few years, he's more into a grass forage mix. We started out just the opposite. We started out with mostly a grass mix and now we're going more towards a legume mix. I talked to Bert a little bit but we didn't get into it. I was wondering why he had made the change.

Answer: The reason was because the forest industry has had a lot of problems with grass competition in their fir plantations. When we first started the project they were very reluctant to allow us to introduce grasses when they'd already had this history of grass-tree problems. They didn't seem to feel that concerned about legumes. That was kind of the foot-in-the-door. I started with legumes because that's what they'd let me use and gradually switched over and added grasses to that mix.

Question: The reason we went back to a greater legume mix was we were looking for a more palatable, higher quality forage. We're using probably 60 percent legume, 10-15 percent forb, and then the rest grasses (alta fescue and orchardgrass). We're hoping that the legumes will start out for the first 5 years or so and then the grasses will keep on going til they get crowded out from competition from the trees. Do you feel that your mix is giving them a high quality forage by having more grasses instead of the legumes?

Answer: We've done several evaluations on forage quality. Keep in mind, first of all, we're looking at winter production. The area, the time of year that we consider to be critical is from the first of November through April. In all of our evaluations we've looked at forage during that time of year. Generally speaking, on both the clearcuts and our improved pasture program, we've found that these improved pastures exceed minimal requirements in digestible energy by about three times, and about twice the minimum requirement for digestible protein. Where we compared these with unseeded clearcuts and also unmanaged pastures, we found those situations never meet minimum requirements.

Question: I accept the fact that a clearcut without being seeded is on the lower end of what I want. I was looking more at the legume mix as compared to a more dominant grass mix. I don't have a lot of data to tell me that the legume is the more quality forage. I have the heavy, wet snows which knock everything down, so I can't grow anything through the snow for the winter. But for early spring browsing is what I'm looking at mostly.

Answer: I think when the legumes are actually growing that's a much higher quality. But, during our months of January and February, sub clover is a fairly active winter legume. Some winters we get active sub clover growth all through the winter. But year in and year out the ryegrass is the most active winter growing plant that we've found. That's the one that carries them through that January-February period, the grasses. When things start to improve in the spring and the legumes start to come on, then yes, I agree, they are much higher volume.

Answer: I might point out that the publication that we gave you, those that registered anyway, the "ecology" publication has a chapter in there that was put together by Bert. It discusses a lot of what you were talking about and gets down to some of those data that he couldn't find his notes on.

Question: I heard, yesterday, that elk differentially use habitat according to the degree of slope. All of the habitat effectiveness models I heard about yesterday seem to pretty much consider all the land the same. Today I saw 20 percent slopes and I saw 70 percent slopes. It seems to me that the elk aren't going to use, possibly, a 70 percent slope, regardless of what's going on that. How does all of this tie into the habitat effectiveness models I heard about? Shouldn't topography come into this somehow?

Answer: I'll try to answer the rest of the question. In the first place, I think it's a really good point and what I feel it is is a refinement beyond where we are going right now with the four-step method of looking at habitat effectiveness. I think this is something that we can refine and add as we get the capability. A second point that I can think of, I don't know if you heard Jim Eagan's program yesterday afternoon using geographical information system and the LANDSAT imagery, this is one of the steps that he had in his computer program. Slope and aspect can be done with the computer programs. We have maps printed out that show this. We can do elevation levels, we can do aspects. We haven't really looked at it yet in terms of how do we want to work it into a model. I think it's important and I think it's something that we can do. This is an additional step beyond where we are right now.

Question: While you're up there, one of the things that seemed to impress me in the modeling, and it was eluded to, was the taking of one of the components by itself, the forage component. It was said somewhere that this might be a limiting factor. If the component became too low, even though you might have an overall habitat effectiveness valued fairly high, you wouldn't have an effective habitat. Can you see any way to rectify that or make the model shake that out? It would seem that you could only provide an effective habitat with so little forage and we saw quite a variation in those areas on the field trip.

Answer: I think this could get to be a problem where you had, even with the model, a very limited amount of forage, although your size and spacing probably would show up poor. If the small amount of forage area that you had was treated, for example, it could show up as a high forage quality and still the area as whole would, from the broad look at it, seem kind of low. I think we're going to need to look at more areas and get experience.

It is written in the model that if any of the three variables, cover quality, forage quality, or size and spacing falls below .20 level of habitat effectiveness, it really raises a red flag and says, "hey, before you worry about anything else you have to look at this." In other words, you're flat out on the line there at .20. Even if the other values are high enough to bring this up on a final point on the scale, it'll raise the flag. I can think of a place where you have a limited amount of area in forage and some of this westside is going to be that way in the future, but if that forage area had all been treated, the model would show a high value for forage quality.

Answer:

Let's not confuse these models with the biological models. As the man from the BLM said yesterday, those models were developed for a land administrator to make decisions and rate different kinds of treatments on the same piece of ground. We can make biological models but don't confuse these with that kind of a system. This is just a means of rating treatments, alternatives if you will.

END

BREEDING SEASON OF ELK IN OREGON

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Abstract: Conception dates were estimated from embryos recovered from uteri of Rocky Mountain elk (*Cervus elaphus nelsoni*) and Roosevelt elk (*C. e. roosevelti*) cows harvested during November-January hunting seasons in Oregon, 1983-85. Differences in time of breeding were evident between cows from some areas. Median dates of conception by area varied from 25 September to 13 October. There was no indication that disturbance from hunting seasons interrupted the rutting period. No clear relationship was apparent between post season bull ratios and conception dates. Other factors possibly influencing the timing of breeding are discussed.

In 1979 the Oregon Department of Fish and Wildlife initiated annual collections of reproductive tracts, udders and mandibles from cow elk harvested during antlerless elk seasons in Oregon. Data on reproductive rates, age structures and breeding seasons obtained from the collections have been part of the information base used for management of elk.

From the standpoint of productivity, the time of breeding has attracted attention for several years. In the 1950's Altmann (1956) speculated that hunting might interfere with breeding in elk in such a way as to decrease reproductive success. With sharp increases in hunting and other recreational uses in recent years, this concern has continued to be expressed in Oregon as well as in probably several other western states. A parallel consideration has been, that with declines in bull ratios because of intensive hunting pressure particularly since the 1960's, the breeding season would be delayed due to shortages in mature bulls. If the period during which conceptions occur was sufficiently prolonged, then later parturition dates would be expected that would probably ultimately lower survival of calves (see Hines and Lemos 1979, Hines et al. 1985).

The purpose of this paper is to present data on breeding seasons of elk from various areas in Oregon during the fall seasons of 1983-85. From this summary the period of breeding will be described, and some factors affecting the timing of conceptions discussed.

Much credit for the data presented in this paper is extended to O.D.F.W. biologists, volunteers and hunters who gave of their time in collecting specimens. Appreciation is extended to John Gendron and John Toman who assisted with laboratory examinations of 1985 samples.

METHODS

To obtain specimens, hunters drawing permits for certain controlled elk seasons where antlerless animals could be taken were required to save the incisor teeth, uterus and udder from any cow harvested. Approximately two weeks before the opening day of a hunt, each hunter was mailed a "kit" containing a (1) plastic bag (15" x 20"--labeled with the hunt number for identification), (2) instructions for collecting the specimens, and (3) a map showing locations of barrels for depositing the specimens obtained. The samples were removed from the collection barrels periodically during the season and were frozen until examination.

The teeth, uteri and udders were thawed and examined in a laboratory. Calves, yearlings and many 2-year-old animals were identified on the basis of replacement of incisor teeth; for specimens with fully erupted incisors, one primary incisor (I_1) was removed, cleaned and sent to a commercial microtechnique service for age determination from counts of cementum annuli. Udders were cut open and checked for "wet" (lactating) or "dry" condition depending on the presence or absence of milk.

Uteri were placed in a tray, opened and checked for pregnancy. For pregnant specimens, chorionic vesicles were removed and embryos larger than about 10 mm were freed from the membranes. Two measurements of length were taken depending on the size of the embryo. For specimens less than 65 mm, the crown-rump length (CR) or the distance from the anterior-most to the posterior-most point of the embryo, was measured with calipers while the embryo was submerged in water. Conceptuses less than about 10 mm were measured without being removed from the membranes. Specimens 65 mm or larger were placed with their back along a straight edge and their body straightened so that the long axis of their head was at right angles to the long axis of their body; the measurement taken was the forehead-rump length (FR), which is the distance from the anterior-most point of the crown to the tuberosity of the ischium (Morrison et al. 1959). For the purpose of simplicity in this paper, specimens of all developmental stages will be referred to as embryos.

The age of each embryo recovered was estimated by comparing its CR or FR length with measurements on a growth curve for known age elk embryos (Morrison et al. 1959). Once the age of the embryo was determined, the date of breeding was calculated by subtracting the embryo age in days from the date of collection. Because actual dates of collection (harvest) for cows were unknown in most hunts, the second day of the season was assigned as the date of collection for specimens taken during 7 to 9 day seasons. For longer seasons, the collection date was estimated based on dates that specimens were picked up from collection barrels.

RESULTS AND DISCUSSION

Description of Samples

Dates of conception were estimated for 140 Roosevelt elk collected from three areas of western Oregon and 744 Rocky Mountain elk from eight areas of northeast Oregon (Fig. 1). Except in the North Beulah area, where specimens were obtained starting on November 9, all samples were collected from cows killed between November 19 and January 31. The age of embryos examined ranged from approximately 22 to 128 days; most however, were less than 100 days of age.

Although the outside period that data were collected is the three years 1983-85, specimens were not obtained from all areas each year. The Tioga, Desolation and Minam areas were sampled only in 1983 and 1984; the South Cascades, only in 1984 and 1985, although most of the specimens were taken in 1985. Samples were collected from the remaining seven areas throughout all years of study.

The data presented are mostly summarized by median, earliest and latest conception dates. The median was used as a measure of central tendency to facilitate descriptions of distributions in percentiles. To allow for comparisons with data from other studies, however, mean values are included in the tables. Of the two parameters, the mean conception date was usually 1 to 2 days later than the median.

Within each area there was good agreement among timing of conceptions each year, which allowed for combining data by area. To further simplify discussion, data from some areas were pooled on the basis of similar medians or to increase sample sizes.

Conception Dates by Area

Differences in time of breeding were evident between cows from various areas (Table 1). Median conception dates varied from September 25 in the Coast Range to October 8 in Heppner for a spread of 13 days. In northeast Oregon, median conception dates could be grouped into two classes according to time of breeding. Cows from Wenaha-Snake River and North Beulah, with medians of 26, and September 27 bred earliest, whereas cows from Starkey-Desolation, Chesnimnus and Heppner with medians of 3, 4 and October 8 respectively, bred from 6 to 12 days later. (Table 1, Figs. 2-4). The timing of breeding was more uniform in western Oregon, with median conception dates of September 25 and 29 for elk in the Coast Range and South Cascades, respectively (Fig. 5).

Based on conception dates for the total 884 cows examined during 1983-85 (Table 1), breeding took place over a 70-day period with the earliest and latest conceptions indicated on August 29 and November 7, respectively. The median conception date was September 30, with the peak of conceptions occurring between the last week in September and about the first 10 days of October.

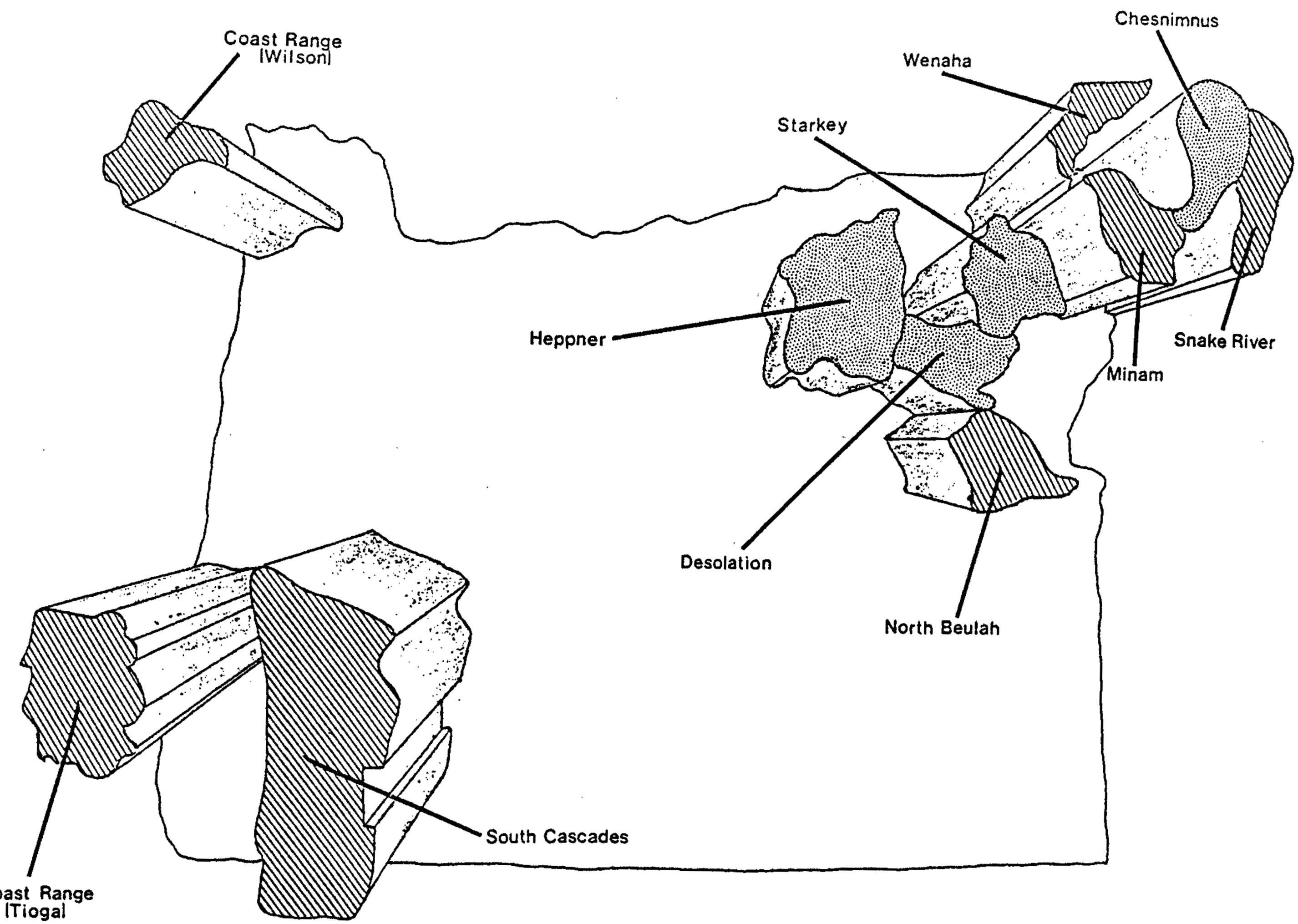

Fig. 1. Areas of elk reproduction collections in Oregon, 1983–85.

Table 1. Estimated conception dates of elk collected in Oregon during November-January periods 1983-85.

Area	n	Mean ±SE[a]	Cumulative Percentile of Conceptions			Earliest	Latest	Spread in days[c]
			25	50[b]	75			
Wenaha-Snake River	195[d]	27 Sept.±0.8	20 Sept.	26 Sept.	3 Oct.	5 Sept.	1 Nov.	57
North Beulah	83	28 Sept.±1.1	23 Sept.	27 Sept.	1 Oct.	4 Sept.	20 Oct.	46
Chesnimnus	50	5 Oct. ±1.7	25 Sept.	4 Oct.	12 Oct.	12 Sept.	28 Oct.	46
Starkey-Desolation	322	4 Oct. ±0.7	25 Sept.	3 Oct.	11 Oct.	8 Sept.	3 Nov.	56
Heppner	94	9 Oct. ±1.2	30 Sept.	8 Oct.	16 Oct.	17 Sept	1 Nov.	45
Northeastern Oregon Total	744	2 Oct. ±0.4	23 Sept.	1 Oct.	10 Oct.	4 Sept.	3 Nov.	60
South Cascades	90	1 Oct. ±1.5	22 Sept.	29 Sept.	10 Oct.	29 Aug.	7 Nov.	70
Coast Range	50	28 Sept.±1.6	19 Sept	25 Sept.	6 Oct.	7 Sept.	24 Oct.	47
Western Oregon Total	140	30 Sept.±1.1	21 Sept.	28 Sept.	7 Oct.	29 Aug.	7 Nov.	70
TOTAL	884	2 Oct. ±0.4	23 Sept.	30 Sept.	9 Oct.	29 Aug	7 Nov.	70

[a] Standard error in days.

[b] The 50th percentile is the median date, that is, 50% of the conceptions occured before and after this date respectively.

[c] Number of days between earliest and latest conception dates.

[d] Includes 20 conception dates from elk collected in the Minam unit, 1983 and 1984.

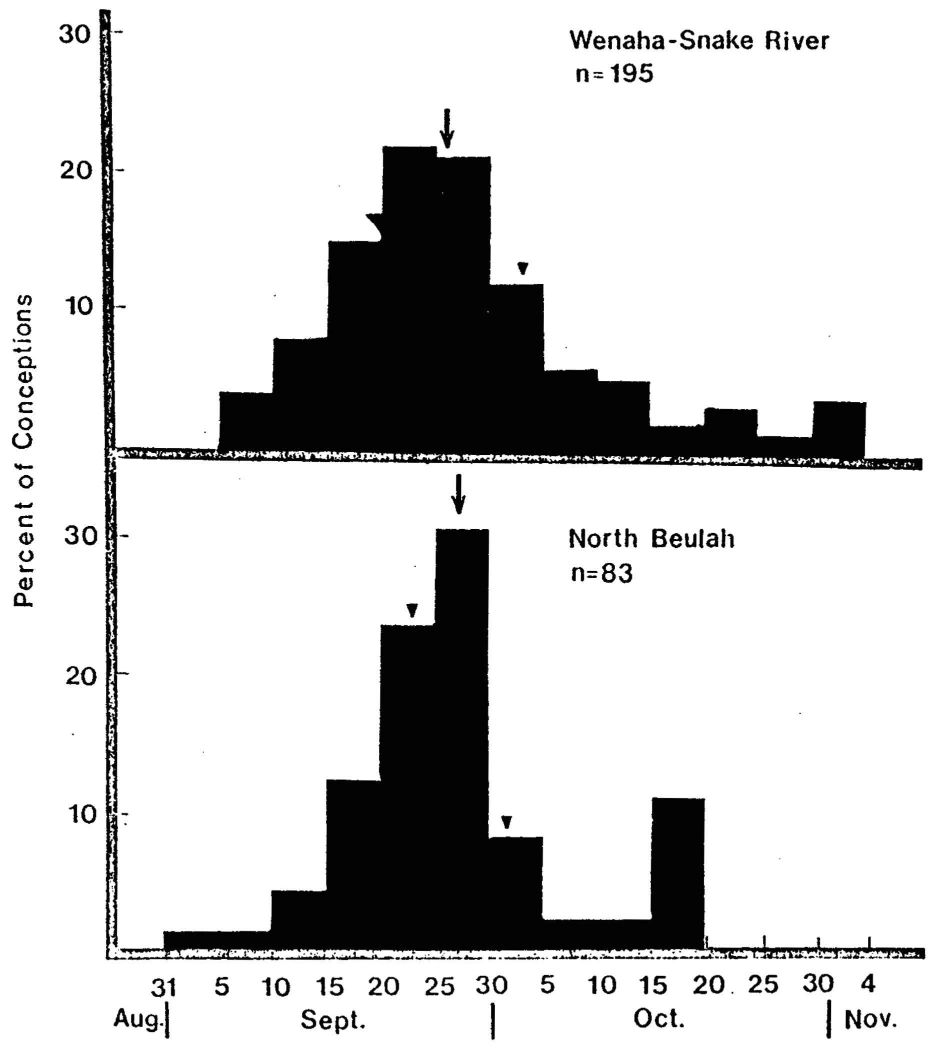

Fig. 2. Estimated conception dates of elk collected from two northeastern Oregon areas. 1983-85.

- median: ↓
- 25 and 75 percentiles: ▾

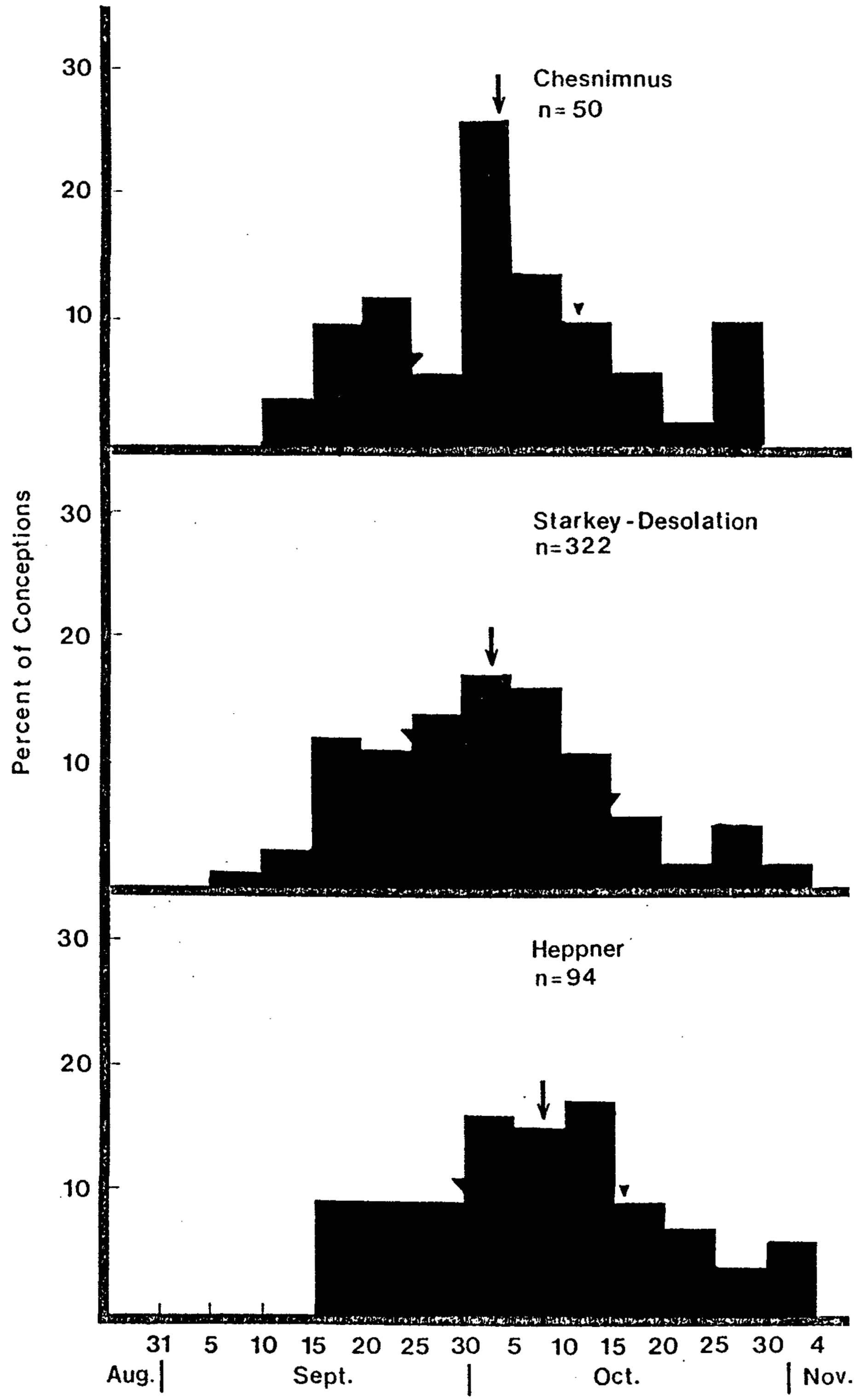

Fig. 3. Estimated conception dates of elk collected from three northeastern Oregon areas, 1983-85.

- median: ↓
- 25 and 75 percentiles: ▾

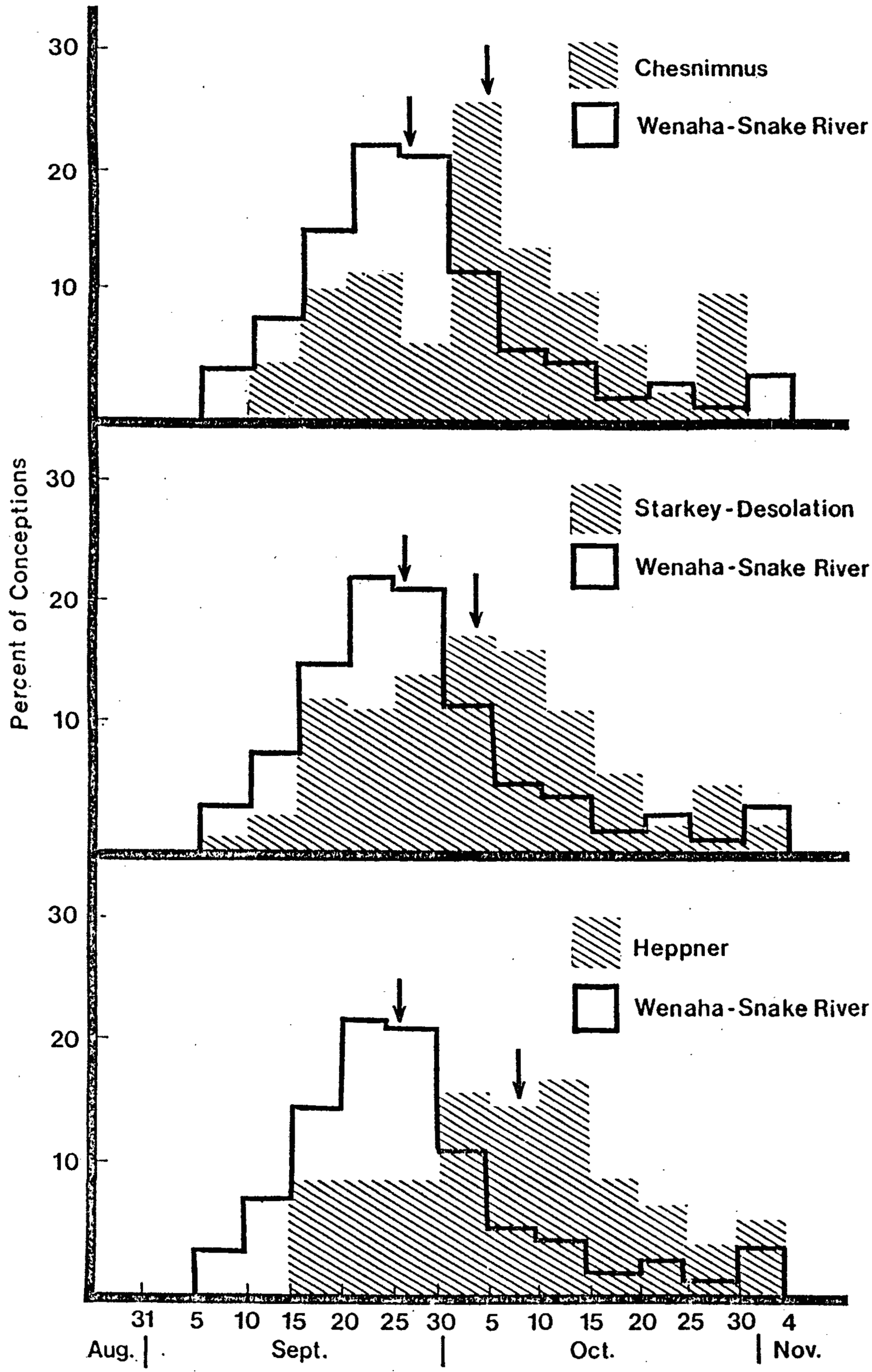

Fig. 4. Comparison of estimated conception dates of elk from four northeastern Oregon areas, 1983-85.

• median: ↓

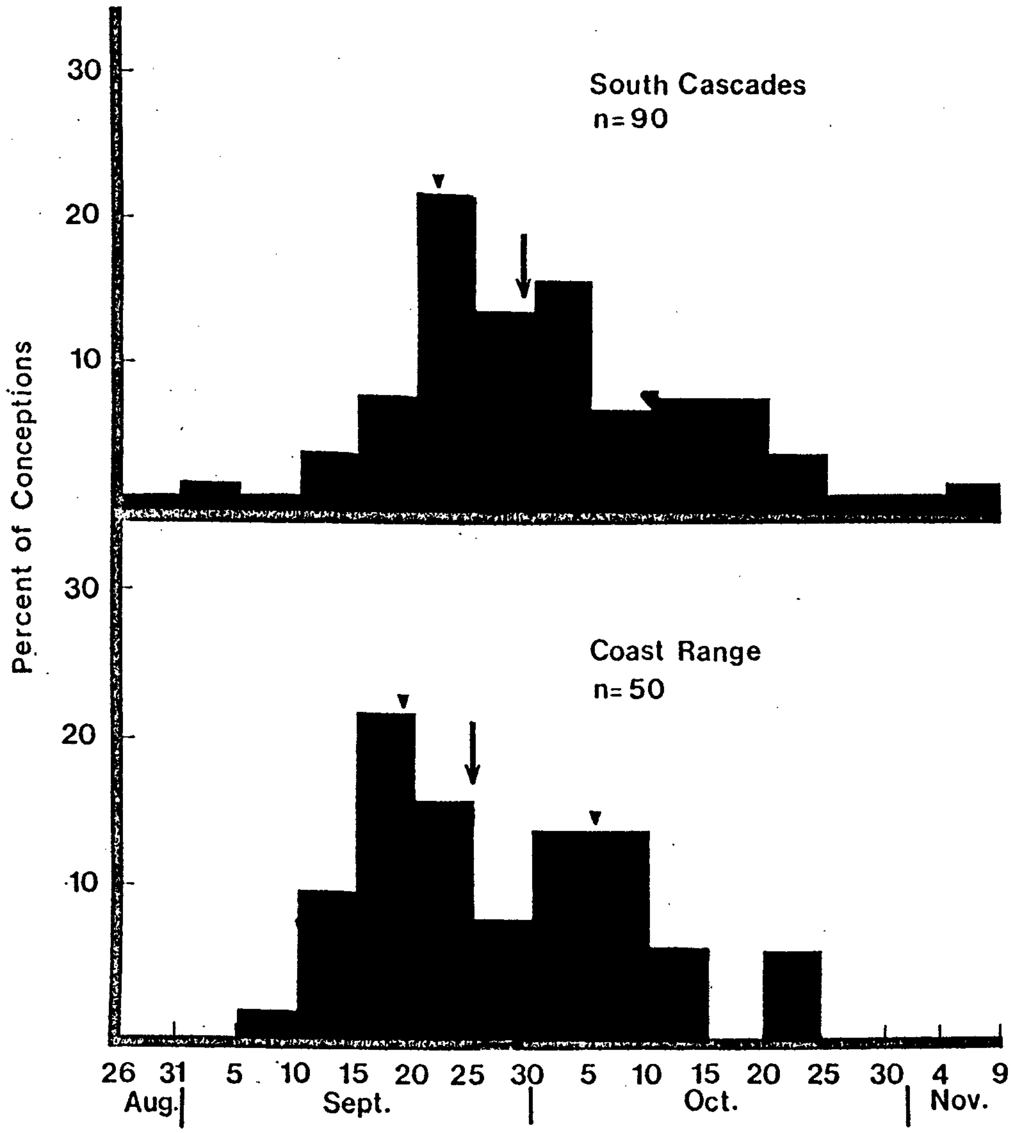

Fig. 5. Estimated conception dates of elk collected from two western Oregon areas, 1983-85.

- median: ↓
- 25 and 75 percentiles: ▾

Factors Influencing Timing of Conceptions

Photoperiod is considered the principal factor in setting the sexual cycle in deer. Rutting in most ruminants in temperate regions is stimulated by decreasing day length (see McCulloch 1969, Mitchell and Lincoln 1973). There are, however, several factors unrelated to day length that can also influence the time of breeding. Some of these factors will be discussed relative to the conception dates observed in the elk studied.

Age of Cows

To determine the effect that age of the cow might have on timing of conceptions, the breeding dates of 338 cows collected during 1983 and 1984[1] were tabulated by age (Table 2). There was an indication of later breeding among the small sample of yearlings, which had a median conception date of October 18, contrasted with medians ranging from September 28 to October 2 for older age classes of females. Among adults, there was a tendency for earlier conception dates in cows 4 years of age and older as compared to 2 and 3 year olds, but the differences were not great. Considering that only a small number of yearlings were examined, and because over one-half were from the Wenaha-Snake River and North Beulah areas where conception dates were early, the variations in breeding dates observed among areas were not attributed to differences in age structure among samples.

Table 2. Estimated conception dates among different age classes of elk collected in Oregon, 1983 and 1984 (n = 338).

Age (years)	n	Mean ± SE[a]	Median	Earliest	Latest	Spread in days[b]
1	12	14 Oct. ± 2.7	18 Oct.	29 Sept.	26 Oct.	27
2	57	1 Oct. ± 1.6	1 Oct.	8 Sept.	31 Oct.	53
3	40	3 Oct. ± 1.7	2 Oct.	12 Sept.	31 Oct.	49
4-10	181	1 Oct. ± 0.9	29 Sept.	5 Sept.	3 Nov.	59
11+	48	29 Sept. ± 1.8	28 Sept.	7 Sept.	7 Nov.	61

a Standard error in days.
b Number of days between earliest and latest conception dates.

Disturbance from Hunting

In a recent study in Utah, intensive hunting pressure was implicated as having interfered with the normal breeding season in elk. Conception dates of the cows in that study were distributed bimodally, with a 30-to-35-day period between peak frequencies that coincided with the regular elk and mule deer seasons (Squibb et al. 1986).

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[1] The ages of cows collected in 1985 had not been determined at the time this paper was prepared.

Two major hunting seasons in Oregon overlapped at least part of the rut. The archery season extended from late August to about September 25 and the general deer season occurred from about September 29 to October 10 in northeast areas and later in western Oregon. The distributions of conceptions for the elk studied in 1983-85 are basically unimodal with no major troughs or gaps in breeding dates that would indicate disruption of rutting activity during periods of hunting (Figs. 2, 3 and 5).

In Heppner area, no conceptions were recorded before September 17 (Table 1, Fig 3). Hunter numbers were heavy in this area during archery and general deer seasons (Glen Ward, Personal Communication 1986). Because the archery season continued through late September, the possibility that disturbance from hunting had the effect of delaying the start of breeding in this area cannot be ruled out. Although, from the distribution of conception dates (Fig. 3) it was apparent that hunting activity during the general deer season (September 29-October 10) interfered little with the rut, once it was underway, as conceptions were at near peak levels in Heppner as well as in most other areas during this time.

Male Service

Earlier studies of Roosevelt elk in the Tioga Unit on the South Coast Range showed that the breeding season was delayed when mature or branched antlered bulls were in short supply (Hines and Lemos 1979, Hines et al. 1985). In these investigations, later than normal conceptions and subsequently late births occurred because of a shortage in breeding bulls, which probably resulted in many cows not being serviced on their earliest estrus.

The relationship between bull ratios and conception dates observed in cows during the 1983-85 period is unclear. Using post season herd composition counts, which provide the only measurement of bull numbers available, ratios of bulls per 100 cows in northeast Oregon averaged 26:100 in North Beulah, 11:100 in the Snake River part of Wenaha-Snake River area, 6:100 in Starkey-Desolation and Heppner, and 4:100 in Chesnimnus and the Wenaha part of Wenaha-Snake River areas. The earlier conception dates in North Beulah and Snake River units do coincide with a higher proportion of bulls seen in these areas. But the reverse was the case for the Wenaha part of Wenaha-Snake River area, where conception dates were early (median of September 26), however, the ratio of bulls was only 4:100 cows, which is as low or lower than the areas with much later breeding dates (Fig. 6).

Similarly, the association between bull numbers and conception dates is poorly defined in western Oregon. Bull ratios post season averaged 4:100 cows in the South Cascades despite a median conception date of September 29 which is not considered late relative to other median dates for Oregon. On the Coast

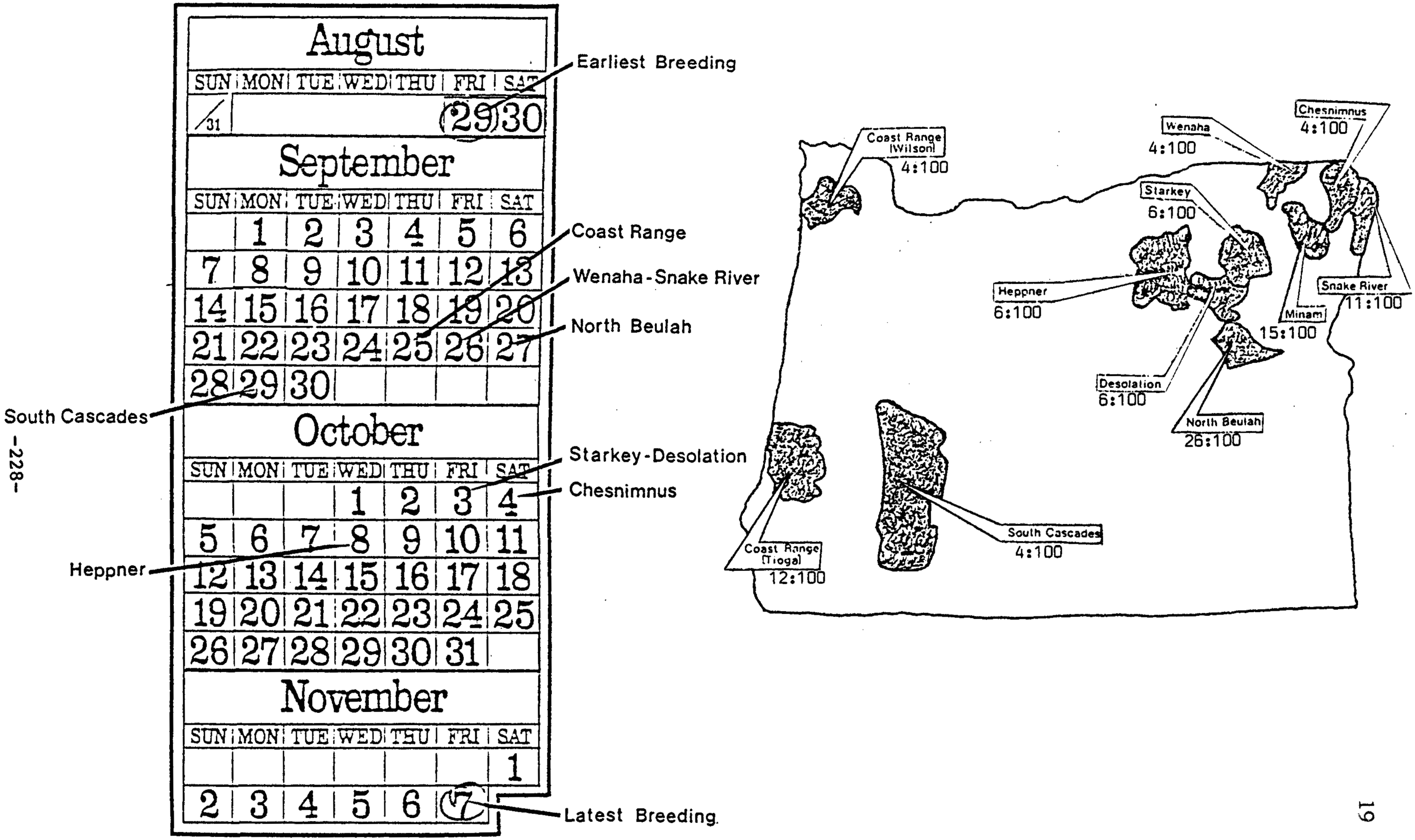

Fig. 6. Range and median conception dates of elk in Oregon, 1983-85. (Bull ratios per 100 cows postseason are listed for each area on map.)

Range, bull ratios averaged 4:100 in the north portion and 12:100 in the south portion; yet, despite the difference in bull ratios, the cows (one-half of the sample of cows were from north and south parts, respectively) conceived early with a median date of September 25 (Fig. 6).

From review of the above findings, it is apparent that there was no clear pattern to link post season bull ratios with conception dates of cows during 1983-85. It is pointed out, however, that such a relationship is difficult to test using post season bull inventories. For example, recent radiotelemetry work has shown that bulls frequently spend the rut in areas other than where they were observed during late winter herd composition counts (Leonard Erickson, Personal Communication 1986).

Geographic Location

There was no relationship between time of breeding and north-south location of areas where cows were collected. Using Rocky Mountain elk areas as an example, median conception dates varied from early to late among the most northerly as well as the most southerly areas (Fig. 6). Conceptions in Roosevelt elk cows of western Oregon occurred on the average about two to three days earlier than for Rocky Mountain elk cows in northeast Oregon (Table 1). Whether or not this small difference was related to genetic variation or to different environmental conditions is unknown.

Physical Condition

Findings from several studies show that nutrition can affect the time of breeding in cervids. McCulloch (1969) reported that Tule elk (*C. e. nannodes*) bred earlier during years of abundant forage as contrasted to years of poor food production. Haagenrud and Markgren (1974) found that variations in physical condition of female moose (*Alces alces*), which apparently resulted from different winter snow conditions, influenced the time of estrus during the subsequent fall. Mitchell and Lincoln (1973) working with red deer (*C. elaphus*) in Scotland showed that hinds in good body condition tended to conceive earlier that those in poor condition. A similar relationship was evident for Roosevelt elk cows examined in a 1968 study in Oregon (Fig. 7).

Unfortunately, no information on physical condition is available to compare with the different dates of conception apparent in northeast Oregon areas during 1983-85. But considering data available from other investigations, the level of body condition may well have exerted a strong influence in determining the breeding dates observed.

Conception Dates of Elk--Other Studies

Except for earlier breeding dates in cow elk from Alberta province Canada, there was close agreement between mean dates of conception in the current study and dates published for elk in other states (Table 3). The average breeding dates of cows collected during 1967-68 and 1983-85 periods in Oregon were very similar within the respective northeast and western areas.

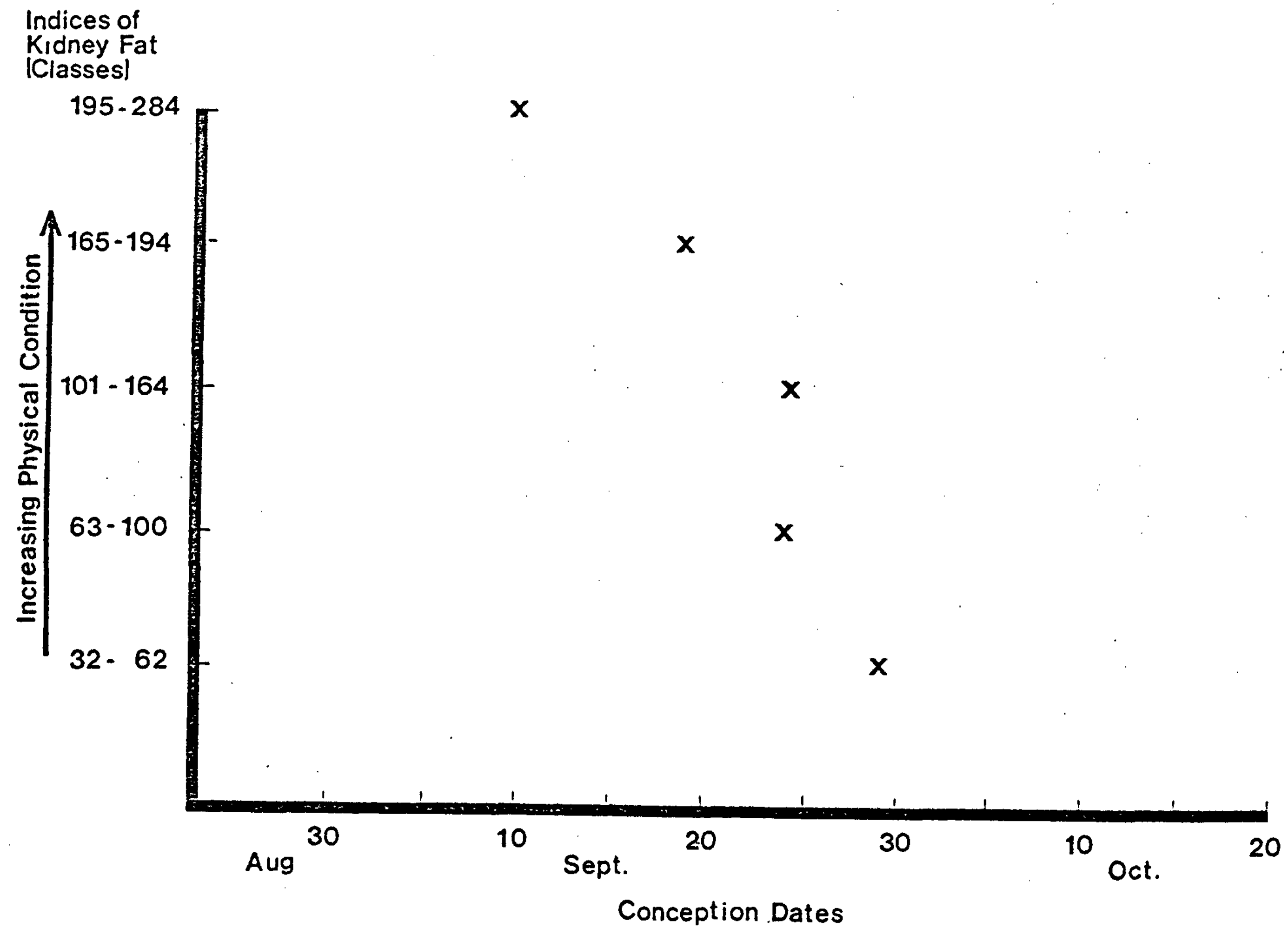

Fig. 7. Comparison of physical condition and conception dates for 25 Roosevelt Elk, 3-10 years old, collected November 1968, Millicoma area, Oregon (Trainer 1971). Values shown are means.

Table 3. Estimated conception dates of elk as reported from western states and provinces.[a]

Location	Years collected[b]	n	Mean	Earliest	Latest	Source
Nat'l Bison Range, MT	1954-56	18	3 Oct.	17 Sept.	31 Oct.	Morrison et al. 1959
North Yellowstone Park, MT	1948	22	6 Oct.	24 Sept.	25 Oct.	" " "
San Juan Basin, CO	1965-66	98	2 Oct.	11 Sept.	24 Oct	Boyd and Ryland 1971
Jasper Park, Alberta	1966	105	19 Sept.	1-5 Sept.	11-15 Oct.	Flook 1970
Banff Park, Alberta	1966	30	11 Sept.	1-5 Sept.	21-25 Sept.	" "
Willapa Hills, WA[c]	1973-74	62	28 Sept.	10 Sept.	22 Nov.	Kuttel 1975
Northeastern Oregon	1967-68	75	2 Oct.	10 Sept.	8 Nov.	Trainer 1971
	1983-85	744	1 Oct.	4 Sept.	3 Nov.	This study
Western Oregon[c]	1967-68	73	28 Sept.	19 Aug.	17 Nov.	Trainer 1971
	1983-85	140	30 Sept.	29 Aug.	7 Nov.	This study

[a] Dates determined from growth curve of known-age embryos.

[b] Year of breeding season.

[c] Roosevelt Elk.

CONCLUSIONS

From the conception dates studied, it was evident that cows from Chesnimnus, Starkey-Desolation and Heppner bred later than in other areas sampled. Applying a gestation period of 255 days (i.e., the mid-point of the 247 to 262 days listed for elk in Morrison et al. 1959) to the median conception dates in these areas, the median dates of parturition would be about June 15 for Chesnimnus and Starkey-Desolation and June 20 for Heppner. Such estimates suggest late calving dates in these areas, as Murie (1951) reported that elk calves were generally born between mid-May and mid-June. Similarly, Johnson (1951) gave May 21 to June 12 as the birth season for elk that he studied in Montana. The impact that the relatively late breeding dates in the current study might ultimately have on calf crops is unknown. But it would be expected that offspring born later than normal might have reduced chances for survival as compared to those born earlier in the season.

Hunting activity at levels experienced during 1983-85 did not interupt the rut. From data available, it could not be determined if disturbance from the archery season had any influence on the relatively late initiation of conceptions in Heppner area.

There was not a consistent correlation between post season bull ratios and conception dates. But such a relationship is difficult to identify without information on ratios of bulls just prior to the rut.

Interference from hunting and also inadequate male service have frequently been mentioned as factors that can disrupt the time of breeding in elk. There is some data from other studies to support these views. Nevertheless, there is also evidence that body condition of cows affects timing of conceptions. The extent that varying levels of physical condition of females figured in the differences in conception dates observed in northeast Oregon areas was not determined, since no measurements of fat reserves were taken from the cows examined. But it may well be that nutrition, as modified by density of animals or habitat condition, played a major role in regulating the timing of conceptions in the cows studied.

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DISCUSSION

Question: For conceptions what sort of sample sizes were there.

Answer: There's a sample of 25 animals there. They were collected in November and this was in the 1967-68 collections from the Millicoma Tree Farm. It's in a thesis. I might point out that in that type of data, it's very important to collect it as soon as possible after the breeding season. If you go later, you don't see much of a relationship and I think this is because condition may change. In other words, a cow that was in good condition during the rut, may not be in good condition later on relative to others.

Question: Chuck, your last statement about animal density and probable effects on body condition. I'm sure you're aware that Buechner had some data published in the North American Transactions about '53 or '55 where we did some intensive harvests in northeast Oregon, particularly in Mill Creek watershed in the Walla Walla. He had conception rates in yearlings and he had increases in conception rates in all classes of females. Are you aware of that?

Answer: Yes.

Question: Did you see any relationship between previous years' lactation at all?

Answer: For cows in southwestern Oregon here, those that are in the best physical condition, are the cows that are dry. The ones that are in the poorest physical condition are those that are wet. That is probably due to the stress of lactation. This is a common factor that's working in red deer, particularly in Scotland in harsh habitats there. It's the very same thing. I would expect a lactating cow from this area as being at the lower level of physical condition. That's what you'd expect. Conversely, a dry cow would be in much better physical condition.

Question: Chuck, I don't think Bill Hines has made it back yet. He was on the broken down bus and he was going to address the Matson Creek-Fall Creek study in this area. Only about two-thirds of these people received that study in their packets. Would you speak briefly to the results of that study as far as bull ratios and how that judgement was made?

Answer: We went through one of the areas today. This is his free-ranging elk herd. He had hunts in two areas. In one area they closed the season on bulls for one year. There was no bull hunting in there. As a result, in the second year, when they made collections of reproductive tracts of both areas, what you had in one area was, for Oregon standards, a rather high ratio of branch-antlered bulls. In the other area it was very low. I think the preseason ratio of branch-antlered bulls was something like less than 1 or 2 per 100 cows and he saw a great difference in conception dates as a result of this. In the Matson Creek area where you had the higher bull ratios, he had conception rates in adult animals that were running something like 15 to 20 percent higher than in the Fall Creek area where bull ratios were low. He also saw a difference in timing of conceptions as a result of a very low bull ratio in Fall Creek. Conception dates were, I think, about a week later, maybe longer in Fall Creek as compared to Matson Creek. And the cows in Matson Creek were in much better physical condition. So, that's kind of the essence of the study.

Question: This is going to sound more like a statement. Maybe you'll have some comment on it in order to get the message across for managers here. The results of that, as best I can recall, was that a judgement was made that somewhere in the range of 2-10 older-age class bulls per 100 cows in the rut was what we should have. The reason for the range was dependent on cow physical condition and demand. With that data, we made a management decision for all of western Oregon that we would have, at least as a target, no less than 7 bulls per 100 cows post-season, over-winter, this translates to 6 bulls per 100 cows if we were out there looking at them in the rut. Maybe you can add to that.

Answer: Well, I think that's what it says in here. I think he (Bill Hines) recommends five and with the spread that you've mentioned.

Question: We recommended 6 in the rut.

Answer: Yeah, that's preseason.

ESTIMATES OF INTRINSIC GROWTH RATES IN THREE ELK POPULATIONS IN WASHINGTON

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Abstract: Population growth rates during the initial phase of irruption in three elk (*Cervus elaphus*) populations in Washington state were compared. Two of the elk populations experienced irruptive growth after introduction into new geographic areas (Rocky Mountain elk), while the other grew exponentially during recolonization of the Mt. St. Helens blast zone (Roosevelt elk). Maximum observed growth rates in the three populations differed, depending on degree of hunting mortality and immigration.

The growth rate of the Mt. St. Helens population exceeded "intrinsic growth rate" (i.e. "r" max.) due to reproduction alone. Immigration was believed to be a significant contribution to growth. The Cedar River Watershed elk population in the western Washington Cascades was below "r max" because elk were lost to illegal hunting mortality, and emigration. The Arid Lands Ecology Reserve elk population, in sagebrush-steppe of central Washington most closely approached maximum "r-max" because emigration, and mortality were minimal. Immigration was not a significant factor.

The comparisons indicate potential affects of the different mortality, reproduction, immigration, and emigration levels. The results also indicate that potential elk population growth rates vary under different environmental conditions.

A population's intrinsic growth rate, "r", is an important population characteristic that is used in a great number of population models (i.e., logistic growth, sustained yield models, etc.). An estimate of "r" can be useful in evaluating the demographic vigor of a given population relative to other populations or under different habitat management systems. Birch (1960) suggested that "r" was a measure of a population's genetic fitness. Unfortunately, the value of "r" is seldom known.

Measures of population growth have been variously defined. The "biotic potential" of a population is defined as the "theoretical, genetically imposed upper limit on a populations rate of growth" (Bailey, 1984:144). The "intrinsic rate of growth" has been defined as the rate at which a population grows when no resources (e.g. food, shelter, space, and water) is in short supply (Caughley 1977). This growth rate is the genetically imposed upper limit, interacting with the quality of the environment (Andrewartha and Birch 1954). Quality here refers to weather, suitability of food, suitability of nesting sites, and so on (Caughley 1977), and not amount of food, cover, etc. Figure 1 contracts "biotic potential", "intrinsic growth rate", and logistic growth.

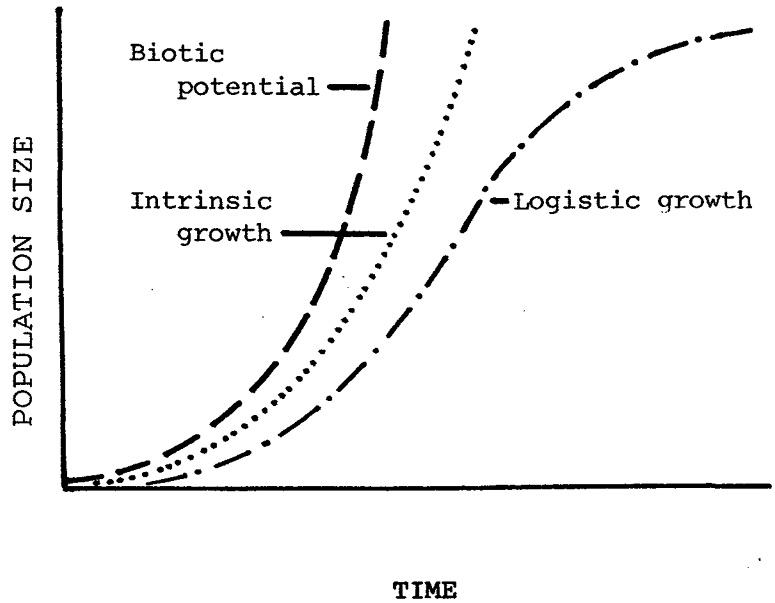

Figure 1. A graphical comparison of the different types of growth.

In the present paper we compare intrinsic growth rates for three elk (Cervus elaphus) populations based on annual population estimates spanning time periods of five or more years. The intrinsic growth rate "r" is defined as the growth rate of a population that is not experiencing any density-dependent regulation (i.e., not having passed the inflection point of logistic growth). Mortality factors such as accidents, predation, and old-age may be operative on the population. Reproductive rates are considered to be at maximum levels possible, given conditions in the specific environment (i.e., forage quality, weather, and so on).

The three populations studied are all "irruptive" populations; that is, populations invading new territories (Bailey 1984). Two of the populations represent elk range expansions, while the third represents elk recolonizing an area depopulated by volcanic disturbance.

STUDY AREAS

Two of the three populations studied were located in the coastal coniferous forest zone of western Washington, while the third was located in the shrub-steppe of eastern Washington. The habitat conditions in each area were distinctly different.

The Cedar River Watershed (CRW) elk population is located 65 km east of Seattle in the Cascade Mountains. The study area is intensively managed coniferous forest. The CRW covers approximately 365 km^2, with elevations ranging from 180 to 1520 meters. By 1985, nearly the entire CRW had been converted to second growth Douglas fir forest. Vegetation, climate, and topography are described in Schoen (1977).

Elk first appeared in the CRW in the mid-1960's, probably as a result of introductions of Rocky Mountain elk (C. elaphus nelsoni) from Yellowstone in the early 1900's in Pierce County to the south, and Yakima County to the west (Schoen 1977). Closure of CRW to hunter access has prevented legal harvest of elk in the study area.

The Mt. St. Helens (MSH) elk population included in the present study is found in northwest section of the volcanic blast zone. The study area includes 225 km^2 within portions of the Green and North Fork Toutle River drainages, and ranges in elevation from 240 to 1200 meters. This area was similar to the CRW before the 1980 volcanic eruption, which eliminated most of the existing coniferous forests in the study area. Current vegetation communities in the study area generally resemble recent clear-cuts that have been burned. Recovery of the vegetation in the blast zone has been described by Means et al. (1982), Adams and Adams (1982), and Stevens et al. (in press).

The majority of the elk in the MSH study area were killed in the May, 1980 eruption. The elk herd in the area before the eruption was thought to have resulted from remnant herds of Roosevelt elk (C. elaphus roosevelti), with possible mixing of Rocky Mountain elk introduced into the Yakima area west of the Cascade Crest (Merrill et al. in press). Since 1982, elk have been harvested in controlled permit hunts.

The Arid Lands Ecological Reserve (ALE) is a 330 km^2 portion of the U.S. Dept. of Energy's Hanford Site, located in south-central Washington, 16 km northwest of Richland. Elevations vary from 150 to 1090 meters. The ALE site lies in the rain shadow of the Cascade Mountains on the west, resulting in an arid climate, with hot summers and cool winters. The ALE site is located in the Artemeisia tridentata/Agropyron spicatum, shrub-steppe zone (Daubenmire 1970). The study site is described in detail by McCorquodale (1985) and Vaughn and Rickard (1977).

Elk were first noted on the ALE Reserve in 1972 (Rickard et al. 1977). They are thought to have come to the site from elk introduced in the Yakima area. The elk are not hunted as long as they remain in the ALE Reserve, which is closed to hunter access.

METHODS

Population Estimates

Elk population estimates for the three areas were obtained using several different methods. Population estimates of the CRW elk were obtained for the period from 1970 to 1982. Elk numbers were estimated from helicopter counts, road transects censuses (Schoen 1977), and mark-recapture censuses (Paige, in prep.).

The MSH elk population estimates for the period 1982-1985 were derived from helicopter counts of elk in quadrats chosen randomly without replacement (Merrill et al. in press). The 1981 estimate was provided by the Washington Department of Game.

The ALE elk population size was determined from direct aerial counts of the entire population (McCorquodale 1985).

Calculation of Growth Rates

The growth rates of the three elk populations were calculated from population estimates made in the same time period each year, over a number of years. The population growth rate, "r", was calculated by least squares linear regression of the natural log of elk population numbers over time. The slope of the line is the estimate of "r".

RESULTS

The factors known to be affecting elk population growth in the three study areas are summarized in Table 1. The estimations of intrinsic growth rates in the three populations range from 0.21 to 0.32 (Table 2). The CRW population had the lowest r value, and the greatest amount of variation (Figure 2). This variation may be due to the use of different techniques used to estimate population size. However, since 1977 the estimates were all calculated by mark-recapture methods.

The observed growth rate in the MSH elk population of 0.29 is greater than can be accounted for by reproduction alone (Figure 3). When the population estimates are adjusted to reflect the population growth without the removal of elk through controlled permit hunting, the growth rate would be 0.35 (Figure 4, curve A).

The expected MSH elk population growth, based on reproductive potential and available age structure data, assuming the only mortality was legal hunting, results in a growth rate of 0.24 (Figure 4, curve C). This comparison indicates that between 34 percent (1982) and 68 percent (1984) of the observed population growth may be attributed to immigration. These percentages would be even greater if natural mortality was a factor in these years (Merrill et al. in press). If the MSH elk population estimates were adjusted to eliminate hunting mortality and immigration, the growth rate would be approximately 0.30.

The ALE elk population growth rate was calculated to be 0.22 over the period 1975-1985 (Figure 5). However, in the period from 1982-1985, when the most intensive elk studies were in progress, the growth rate was 0.32. No hunting mortality or immigration were recorded during this latter time period (McCorquodale 1985).

Table 1. Characteristics of the elk populations understudy.

Population	Population Regulation Features
Cedar River	Moderate emigration and immigration Some "illegal" hunting mortality
ALE Reserve	No known emigration or immigration Minor hunting mortality
Mt. St. Helens	High immigration Moderate, regulated hunting mortality Some illegal hunting
Missouri	No immigration or emigration Some hunting mortality

Table 2. Estimated "intrinsic growth rate" (r-max) of three elk populations in Washington state, and a captive herd in Missouri.

Population	Period	Sample	"r-max"	r^2
Cedar River	1970-82	22	0.21*	0.75*
ALE Reserve	1975-85	9	0.22*	0.98*
ALE Reserve	1982-85	4	0.32*	0.99*
Mt. St. Helens	1981-85	5	0.29*	0.99*
Mt. St. Helens[1]	1981-85	5	0.35*	0.99*
Mt. St. Helens[2]	1981-85	5	0.24*	0.99*
Mt. St. Helens[3]	1981-85	5	0.30*	0.99*
Missouri	1951-59	2	0.27	-
Missouri[1]	1951-59	2	0.30	-

Mt. St. Helens[1] - Corrected for elk harvests
Mt. St. Helens[2] - Corrected for elk immigration
Mt. St. Helens[3] - Corrected for harvests and immigration
Missouri[1] - Corrected for elk harvests

* Significant at $P < 0.01$

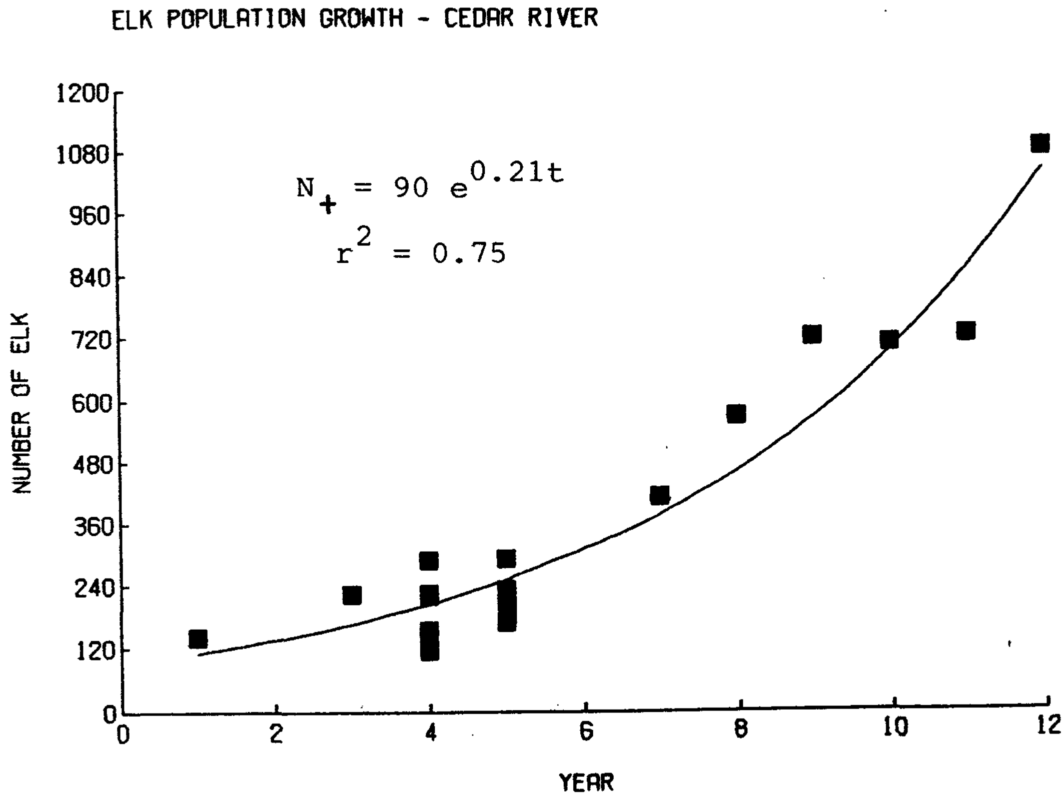

Figure 2. Estimates of elk population size, regressed over time for the Cedar River Watershed.

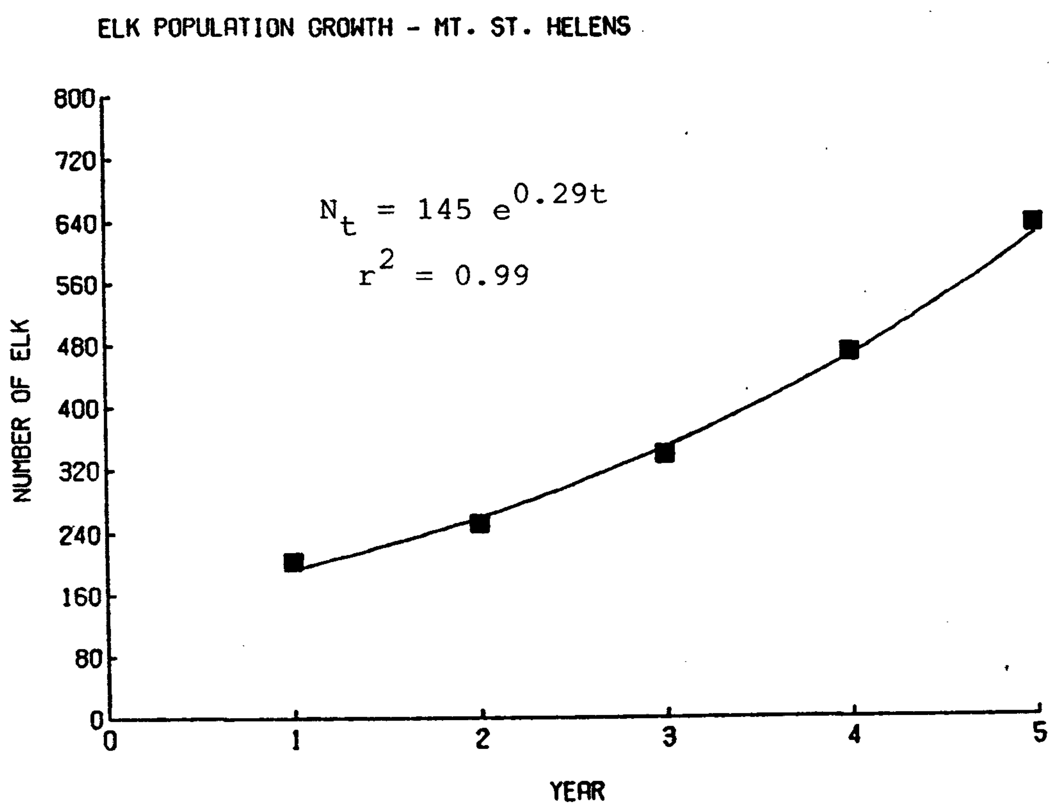

Figure 3. Estimates of the observed Mt. St. Helens elk population regressed over time.

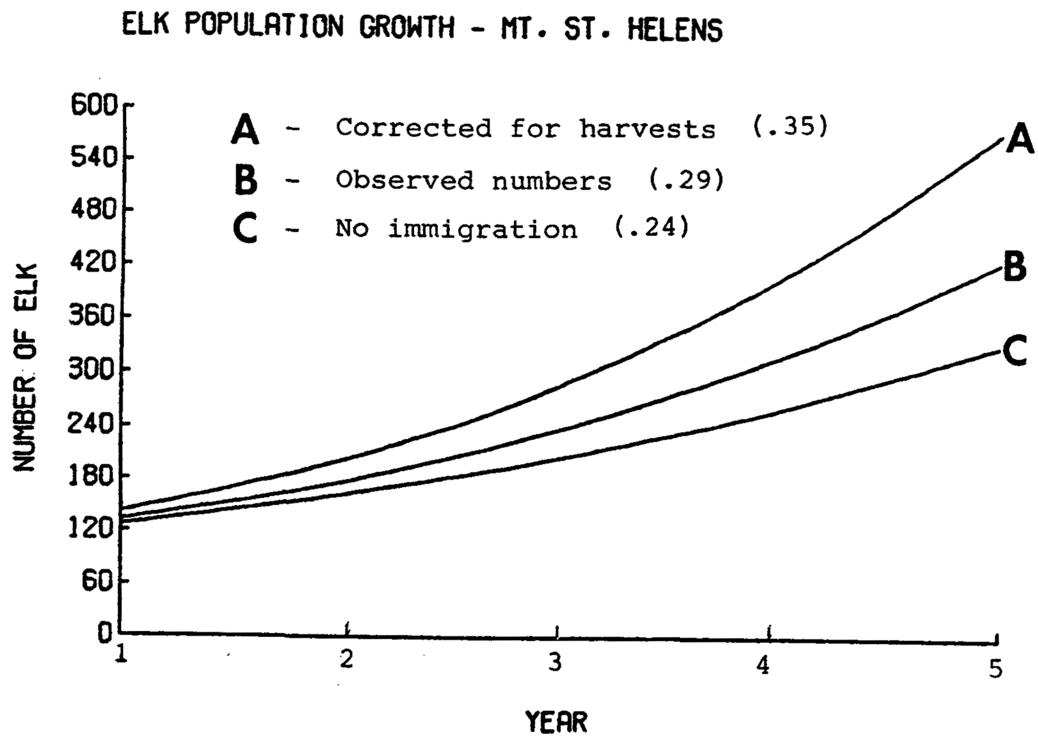

Figure 4. A comparison of the observed growth curve, and curves adjusted for immigration (C) and harvest mortality (A).

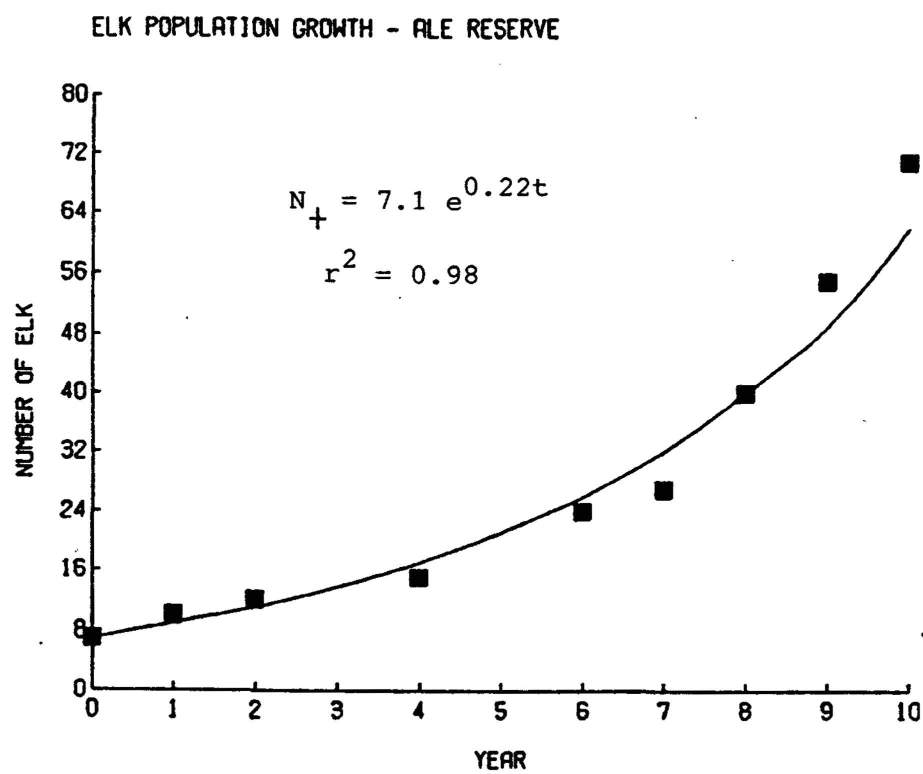

Figure 5. Estimates of elk population size, regressed over time for the ALE Reserve study site.

DISCUSSION

Estimates of intrinsic growth rates are important for determining the speed at which a population can grow and respond to different levels of hunting harvests. Intrinsic growth rates for elk are not readily available. Murphy (1963) reported a growth rate of 0.27 for a lightly harvested, captive elk population, which was corrected to 0.30 when known harvest mortalities were included in the population numbers.

Intrinsic growth rates calculated for two Washington elk populations are comparable to that reported by Murphy. Where growth rates do not reflect hunting mortality or substantial immigration, the values ranged from 0.30 to 0.32. The exception is the CRW population.

Demographically, the CRW elk population apparently differs from the other two elk herds in two respects. First, data from herd composition counts and reproductive tract collections suggest that the elk from CRW have lower yearling fecundity; 31 calves per 100 yearlings from MSH (Merrill et al. 1984), and 11 calves for 100 yearlings for CRW (Schoen 1977). Yearling fecundity rates are not available from the ALE study area.

Second, survival rates of elk in the CRW study area are lower than in the other two areas. Elk mortalities, both adult and calf, are commonly noted in CRW (Paige, in prep), while in the ALE area no natural mortalities have been noted, and few natural mortalities have been noted in the MSH area. Nelson and Peek (1982) indirectly assess the affect in changes in calf, yearling, and adult mortality on intrinsic growth rates. Their results indicated that survival rates have a greater impact on the r value than does fecundity, especially the fecundity of yearlings.

The relatively low growth rate observed in the CRW area may reflect less productive elk habitat resulting in lower reproductive and survival rates. The lower survival rates may be due to relatively high poaching rates, and/or lower habitat quality due to the rapid conversion of the majority of the CRW to second growth forest stands. This second hypothesis is supported by lower blood parameter values in CRW, suggesting reduced physical condition in comparison to MSH elk (Merrill et al. 1984, Paige in prep.).

The use of a single statistic, such as r as an index of demographic vigor to predict future population trends has been criticized by Hanks (1981). The high r value of the reindeer population on St. Matthews Island indicated that the population was in "good condition", yet the population experience a spectacular crash. An index of physiological condition, used in conjunction with the growth rates could have resulted in different conclusions regarding demographic vigor.

The understanding of intrinsic growth rates may be most useful in the comparison of conditions between areas. This has been noted in the discussion of the r values for CRW and the other two areas.

While enumeration of population numbers is subject to many types of bias (Caughley 1977), estimates of population numbers in the MSH and ALE study sites are greatly facilitated by the very open terrain. The ALE reserve population estimates are thought to be total population counts. Also, the controlled nature of the ALE site has resulted in a greater precision in the understanding of factors that could affect population growth. Hence, the estimate of r for this population likely represents a realistic estimate of the maximum r for elk.

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DISCUSSION

Question: Can we assume that all these populations are in about the same place in the logistic curve and are comparable. Or, are some of them threatening to run into a density-dependent factor?

Answer: The high, the .99 R-square value would indicate that that model is as good a fit as you could possibly get. So there is no indication of nonlogistic growth. The Cedar River population is a little bit more problematic. There was that little blip you saw in there. We're not sure if that last data point is a real good one. I think the Cedar River one is the only one that might be sort of tapering off but if you take out that one blip and you take out those two points we leveled off and assume that were the case, actually the R-value up to that point would even be higher. So, I think we try to control for that as much as possible.

Question: Did you say that on the Reserve you don't have immigration?

Answer: We don't think there is very much right now. It looks like there was a sort of a single burst of animals that colonized the area, and they may have been augmented. Scott's here and maybe he would like to comment on that so I don't pontificate too much.

Question: That's a good choice of words. I was thinking if you don't have emigration and you know that they're there now, and they weren't before, maybe we ought to build a shrine. Sounds like divine intervention to me.

Answer: Well there was colonization but there is no immigration continuing since, obviously.

Answer: Basically, we had a small group that came in originally and those seem to be the ones that have resulted in the population that is there now.

ROOSEVELT ELK CALF RATIOS FROM GRASSLAND VERSUS FORESTLAND, N. W. OREGON

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Abstract: Elk herd classification observed on the Northwest Coast of Oregon indicates that the availability of domestic grass increases calf production an average of 33 percent. Ten years of data indicate that herds that find access to grasslands consistently outproduce similar herds that are found over one and one half miles away from such grass forage.

The Saddle Mountain Wildlife Management unit is comprised of approximately 800 square miles (1,280 km) of coast range in the extreme northwest corner of Oregon. The terrain consists of low mountains (to 3,000 ft.) with cut over conifer and alder forests broken by occasional narrow valleys. These valleys, where suitable, are maintained in permanent pastures by beef and dairy farmers.

Native Roosevelt elk abound throughout the area and some take part of their nourishment from the grass pasturelands. While this elk use of private grassland fosters conflict, it has been of interest to compare this apparent increase of nutrition on production of calves.

Several years ago records of elk classification were stratified to reflect the feeding habits of various herds. Sightings of elk within one and one-half miles (2.4 km) of domestic grass fields were segregated from elk located further from fields and apparently taking their nourishment from the typical forest and cutover setting. While the increased calf production could be anticipated the consistency and magnitude of difference is of particular interest (See Table 1 and Figure 1).

Ten years of late winter observation by several biologists using ground and air vehicles leads to the conclusion that typical coastal dwelling elk can produce up to one-third more elk calves when domestic grass is available for forage during critical periods of the year. While the magnitude of better production has not been thoroughly correlated with weather conditions, it is evident that stress factors related to long wet overcast periods have pronounced effect on the grazing behavior of elk and that nutrition is central to calf production in Oregon's coastal elk.

Management implications come to mind in view of the above data. Higher calf production on areas where elk use is in conflict with agricultural interests tends to aggravate a continuing problem. Long term corrective and "once and for all" measures are few and far between.

Table 1. Saddle Mountain Winter Elk Classification Data

	Forestland			Grassland			
Year	Cow	Calves	Ratio	Cows	Calves	Ratio	Gain on Grassland
1976	124	56	45/100	352	186	53/100	+18%
1977	147	55	37	486	227	47	+27
1978	911	311	34	337	134	40	+18
1979	133	45	34	190	103	54	+59
1980	273	95	35	327	127	39	+11
1981	254	80	31	324	131	40	+29
1982	44	13	30	195	72	37	+23
1983	166	34	20	208	86	41	+105
1984	265	69	26	404	155	38	+46
1985	246	97	39	354	171	48	+23
Total	2,563	855	33/100	3,177	1,392	44/100	+33%

Increased production of elk in the deep forest setting can be implemented by providing domestic grass forage during the "cut over" phase of forestry. "Green Forage" seedings of orchard grass, rye grass and several legumes have been found to be compatible with coastal reforestation efforts and thousands of acres are seeded each year along the Oregon Coast.

The segregation of classification data is seen as a simple, but direct way of measuring the increased elk production of such forage producing expenditures.

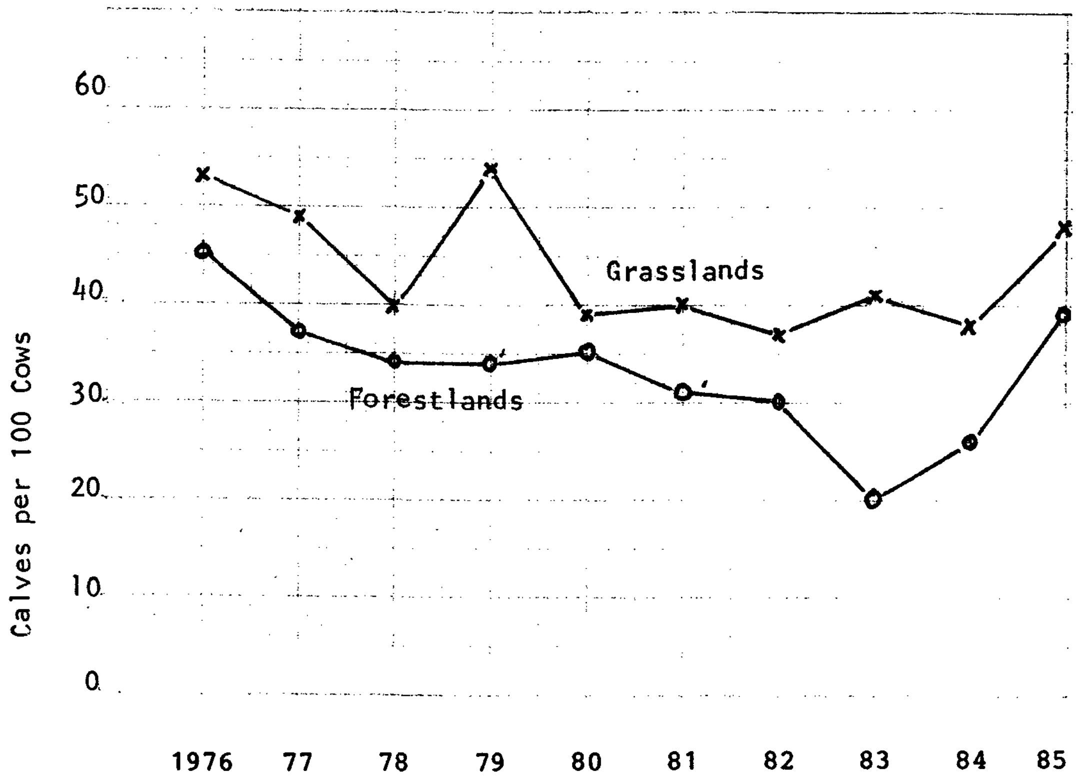

Figure 1. Saddle Mountain Unit Winter Elk Calf Observations

MARKETING THE NONMARKET RESOURCES: A CASE FOR BIG-GAME USER FEES

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> "Obligations have no meaning without reference to conscience, and the problem we face is the extension of the social conscience from people to land."
>
> Aldo Leopold

Abstract: Wildlife user fees are discussed in the context of two broad objectives. The first objective is to present a framework within which to evaluate the comparative advantages of continuing traditional "no fee" access to public lands versus a "user fee" approach. The second objective is to provide a discussion of managerial incentives and relate some perspectives from noted econmists, championing businesslike incentives in state-run enterprises.

I am pleased to have been invited to participate in this conference. I am here first as a sportsman, an outdoorsman appreciative of the vast tracts of land in the United States and Canada available for use by the citizens of these two great countries. My fascination with elk and elk management derives mainly from observation. Observation first of the National Parks, the National Forests, and on private ranches and corporate timberlands. Observation second of my father and his unwavering devotion to elk hunting. For 25 years I have witnessed his early-summer training, his late-summer planning, and finally, the 10-15 day excursions in pursuit of elk. For more than 20 years, a small group of men from several states have gathered to the Wind River Mountains of Wyoming. Each year they spend several days erecting both a base camp and a "spike camp" four miles up the trail. They use the time to reminisce and scout the area, then anxiously await the opening through the long, often sleepless night prior to the crisp dawn.

My second reason to participate is that I am an economist, dedicated to exploring means of using increasingly scarce resources to satisfy unlimited wants (therefore demands) placed on those same resources. To offer meaningful advice to managers it is a requisite that one understand the incentives, controls, and other institutional arrangements that confront the manager. It is in this spirit that I hope to shed some light on the nature of business public land and resource managers undertake.

SOCIAL CHANGE PORTENDS CHANGES IN GOVERNMENT

This is a time of social change. Some changes are dramatic and painful. Changes in the timer industry, the mining industry, and agriculture are now taking place. The cost is high, but would we have it otherwise? Times change, people's wants change, technology changes, demographics change. Those changes force changes in the way we do business.

Peter Drucker (1985, p.259), the elder statesmen of American management thought, recently came to an interesting conclusion:

> "One of the fundamental changes in world view and perception of the last twenty years - a truly monumental turn - is the realization that governmental policies and agencies are of human rather than of divine origin, and that therefore the one thing certain about them is that they will become obsolete fairly fast."

If the system were perfect we would see periodic, if not continual, reevaluation of agency policies coupled with a thorough restructuring of the goals and objectives for various programs. Agencies themselves would be challenged periodically to show that their charter was consistent with the public interest. The system isn't perfect, and many years pass with but slight changes in policy and program objectives. Still, on those rare occasions when change is imminent, it behooves each of us to pay attention and to work toward changes that better align programs and agencies with the public interest as we see it.

I believe that most of us are quite aware that the national debt is now considered the number one problem in the United States. Milton Friedman (1984, p.29), a Nobel Prize winning economist, targets the debt (including unfunded liabilities) at six to ten trillion dollars. Assuming 60 million American families, that amounts to $100,000 to $150,000 per family. This indebtedness derives in part from a pervasive belief that each state or municipality can get more from the federal government that it puts in. The incentives of such a system are those outlined by Garrett Hardin (1968) in his essay, "The Tragedy of the Commons." The current tragedy concerns dollars. Each player petitions for a larger share of the pie. Congress, with no institutional constraint controlling the size of the federal budget and acting on arguably poor economic advice, artifically increases the size of the pie through debt. As a consequence of more than 20 years of deficit spending, the interest on the debt is now the fastest-growing item in the federal budget and a major factor behind the Gramm-Rudman-Hollings Balanced Budget and Deficit Control Act of 1985. This deficit reduction measure (or one like it) will ultimately change the way the federal government does business. In the transition, we will all become more aware than ever of Commoner's (1971) law that there is no "free lunch." Further, we will see major changes in government as we come to grips with the issue. Aside from the current scrambling within agencies to cut costs and personnel, we will hear more about "below cost" timber sales and "below-cost" grazing programs. My question to you is: How far behind are inquiries into "below-cost" elk?

WILDLIFE USER FEES

We face an interesting decision. On the one hand, we can defend historic "budget based" organizations that administer federal programs, organizations with political decisions extending to the annual budgeting process. Alternatively, we may choose to champion what I call "market-based" organizations that are more immune to politics, at least with regard to sources of funding in annual budget decisions. Such organizations rely instead on decisions made in the marketplace to obtain funds for projects and programs. Some of the state game and fish management agencies are largely "market based." The Wyoming Department of Game and Fish is one of these, and appears to be moving further in that direction (Gasson, 1986). A "user fee" could move federal wildlife managers in a similar direction.

Keeping these organizational strategies in mind, consider two alternatives for management of federal wildlife programs. The first alternative uses a wildlife user fee to help fund the program. The second alternative, the current situation, derives funding from traditional sources including general tax revenues. Although the current situation varies from state to state, it is the general case that big-game hunters have free use of federal lands. This is not an entirely true statement, of course, since federal taxes are used to fund the land management agencies and most of us pay taxes. It is true, however, that no direct user fees are imposed for access to federal land. The alternative to the status-quo to be considered here is a user fee for big-game hunters analogous to the "duck stamp" that many waterfowl enthusiasts proudly display as a contribution toward enhancement of marshland habitat and the betterment of the hunting experience. In a nutshell, the big-game stamp could be sold concurrent with state licenses. The program would be administered through the Sikes Act, as amended in 1974 with a "memorandum of understanding" jointly agreed upon between each state and federal land managers. Enforcement would be a joint venture. Funds would be used in the geographic area where collected for mutually agreed-upon projects or programs.

The comparative advantages of the two approaches are displayed in Table 1. Note that the size of the list has no relationship to the perceived worth of one program relative to the other, since a single advantage of one system (or a few advantages) may be viewed as superior to the entire set of advantages of the competing system. My motive in listing the comparative advantages is simply to stimulate thought, not to propose that we rush blindly into a wildlife user fee program. On the other hand, I think that many of the comparative advantages provide a forum from which to evaluate the incentives that motivate managers under each system.

USER FEE CRITICISMS

Critics will present arguments that it is unfair to have self-supporting game management programs when federal timber and grazing programs are "below cost." I would counter that such an argument is without merit. Many pressures exist and more will surface to make all federal resource management programs self-supporting. Since some programs obviously support others and all are interconnected, the task will not be an easy one.

For this reason, it is important that funds collected for wildlife be used for wildlife program objectives and not used to cross-subsidize timber and range programs. This is especially true where program objectives for timber and/or range are to be achieved at the expense of wildlife objectives. In cases where program objectives are shown to be mutually beneficial, joint funding requests could be entertained in deliberations between state and federal agencies.

Table 1. Comparative Advantages of Two Approaches to Wildlife Program Management

ADVANTAGES OF USER FEE

1. Changes wildlife and fish from entirely an amenity or constraint to a position of equal stature with other revenue producing resources.
2. Increased funds for habitat enhancement and other management activities.
3. Can be used as a means to manage use, or change the distribution of use.
4. Encourages use on private holdings.
5. Provides hunters with an incentive to care for the resources. Tendency toward resource abuse as outlined in "The Tragedy of the Commons" is reduced. Abuse of land would cause fee for management to go up, giving user incentive to self police.
6. Establishes a medium where state-federal working relationships could improve. Creates incentives on both sides to cooperative.
7. Public perceptions of Forest Service as a timber/grazing outfit could be modified.
8. Consistent with the present administration philosophy for management of the resources in a business-like fashion.
9. Provides a means of placing a real value on certain wildlife and fish species. Resource management is funded more in accord with the value society places on it.
10. Changes management focus from population management toward a better balance between population management and habitat management.
11. Potential for stabilization or decrease in license fees.

ADVANTAGES OF PRESENT SYSTEM

1. Many people are comfortable with present system.
2. Use of resources free to the user.
3. Simpler - less complex.
4. Provides more opportunity for free use.
5. More cash receipts to retailers and possibly license receipts.
6. States rights - less perceived usurping of state responsibilities.
7. Politically more palatable on state basis.
8. Consistent with administration policy for wildlife and fish user fees.
9. The tendency to maximize short-term profit does not exist.

A second argument critics will likely suggest is that we have spent many years and countless dollars establishing "values" to be used in federal land management planning. Would not, in fact, a $10 big-game stamp undermine the gains made in nonmarket valuation? It is not clear what effect the nonmarket valuation efforts have had with regard to nonmarket resource management. Jack Ward Thomas (1984, p.458) argues:

> "Ostensibly, these values are treated similarly to those derived from market values. Yet everyone knows 'real dollars' (derived from market value) from 'estimates.' Such estimates fare poorly when contrasted against revenues and do not measure monetary impact... Only when game values are expressed as revenues can they receive the same respect as commodities. Other expressions of value will, I suspect, always be viewed incredulously."

Further, Robert Davis (1985, p.399), Assistant Director of the Office of Policy Analysis, USDI, says:

> "The payoff to studies in wildlife economics lies in the application of the results to management decisions. Economics is the science of choosing. Managers do not escape the economic realities of scarcity simply by not being economists."

I would add that neither can managers escape such realities by "buying" economists. Davis (p.400) continues:

> "We have seen that wildlife economists are most active in the area of estimating market values and least active on the problems of devising incentives for management of private lands, and in the economics of wildlife production."

The problem of devising incentives needs to be explored in the public sector as well. On that subject, Milton Friedman and Peter Drucker are of one mind. In Friedman's (1981, p.21) words:

> "[E]nterprises should be made responsible for their own behavior; their targets should be set in generalized terms of profits or money rather than in terms of specific physical outcomes. Let the enterprises bid separately for the resources they need, and let prices be determined at a level that equates supply and demand."

Friedman (1981, p.14) sheds some light on his conclusion:

> "A person who is using his own labor to produce goods for himself has a strong motivation to work hard and efficiently... The person risking his own property has an incentive to make the best use of it... The consumer spending his own money has a strong incentive to spend it carefully. And so on."
>
> "Conversely, in a system in which managers of state enterprises are told to behave as if they were profit-making entrepreneurs, what incentive do they have to monitor themselves? Government officials will seek to monitor them, but what incentive do those officials have to monitor them properly? And how can they obtain the information to monitor them properly?"

The advice of Friedman and Drucker has not been followed in federal land management. Forest Service and BLM programs are budget based and managers have been asked to estimate results as if a free market existed. Friedman labels this phenomenon "playing at capitalism," and suggests that it may have some merit if used in a "trial and error process of adjusting prices to experience." That is, to see what happens as prices are actually charged. In the case of monmarket resources, however, managers are told not to take even this step. Still, "playing at capitalism" fails to provide proper incentives and controls on management. As Samuel Britton (1980, p.38) noted:

"To publish a set of rules asking the managers of state enterprises to behave 'as if' they were profit-maximizing entrepreneurs in competitive private industry ignores the actual personal motivation faced by those men... You do not make a horse into a zebra merely by painting stripes on its back."

CONCLUDING REMARKS

Where then, should we turn? First, we should learn the types of incentives and controls that guide the behavior of managers in the organizations that surround us. Second, we should recognize that economics isn't everything. Rather, each choice made by individuals, private firms, or government entities has an economic aspect. Both Friedman and Drucker recognize that not all aspects of management are market-oriented. This holds true in the private sector as well as the public sector. All managers muddle through as best they can in a world driven by social and political forces that affect their actions. Finally, we should take to heart the principles outlined by Drucker (1985, pp.227-229) in his latest book, Innovation and Entrepreneurship. Particularly, we need to overcome four common, but very bad habits:

1. Arrogance: The belief that "something cannot be any good unless 'we' thought of it." This means that we need to seek out change in many places and from a variety of disciplines. In short, we need to overcome rigidity and inflexibility and adapt our organizational behavior accordingly.

2. Tendency to "cream the market," or charge a premium price: This means that if we use a pricing strategy, then we must be very careful not to maximize short-term profit. Drucker warns that this is a sin always punishable by loss of market. As a case in point, state agencies may be able to auction off a few permits to the highest bidder. To do so as a general pricing strategy would be calamitous. Further, state agencies need to be careful how high they ratchet up out of state license fees. Otherwise, someone else will be collecting "golden eggs" from the "goose."

3. Belief in quality: "Quality is not what the supplier puts in. It is what the customer gets out and is willing to pay for."

4. Tendency to maximize: "As the market grows and develops, firms try to satisfy every single user through the same product of service." Many recent discussions regarding the diversity of experiences and offerings available to wildlife users convince me that there is a growing tendency among state and provincial wildlife managers to avoid this common problem (see, for example, Crowe 1986).

If we are going to become entrepreneurial we have to consider businesslike incentives in the development and management of our programs. We need to differentiate between "playing at capitalism" and the notion of developing self-supporting organizations by marketing the goods and services we offer. As economists A. Myrick Freeman III and Ralph Haveman (1972, p.65) argue, "It is not entirely facetious to suggest that the reason an economic-incentive approach [to public program management] has not been tried is that it might work." If it was tried, and did work, it would certainly change the nature of our bureaucracies. It is left for you to decide whether or not the change would be for the better. For fish and game managers in the states where businesslike incentives now exist, I ask you to evaluate whether or not cooperative agreements with federal managers would be better served if they operated with similar incentives?

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DISCUSSION

Question: How do you think hunter and fishing fees on public lands are going to be established? Are they going to be based on a free market decision process or a political decision process. You're assuming even that state agencies are making their fee structures and budgets etc. on a free market basis and I don't believe they really are. Look at some of the things we're doing. We seem to be doing things very contrary to what the real value is of what we're trying to sell. You look at things like limited entry hunting, special regulations, catch and release fishing. All of these things seem to be reducing our sales rather than increasing our sales. I think we're making more decisions on a political or emotional or social basis than on a free market basis. I'm thinking primarily right now of the New Mexico situation where they tried to institute this. The decision is made politically, not on a free market basis.

Answer: That's a very good question and in the tradition of economist I'll try my best to evade it. Seriously, another of Commoner's laws is that "everything depends on everything". If we were to impose a user fee it would be a political decision, something to help the funding of projects on the ground. The reason that I talked about market incentives was not because we have free markets in this country. In Milton Friedman's article, from which I quoted, he says that one difference between our system and the system in Yugoslavia is about 14 percent points on taxes. A free market is a conceptual ideal to help us understand more about managerial incentives. All decisions, whether they're made by private firms or public firms, are made in political and institutional settings. Personally, I enjoy the notion of these resources being managed in the public trust. I also like the notion that the people who use the resources ought to pay for their use, and that we should fund them through very up-front taxation schemes, not through hidden taxes. Since the states are allowed to collect license receipts and know who their constituents are, it's not inconceivable that the feds might operate under a similar framework if, in fact, they can come into a coop agreement with the states.

THE NOTION OF MARKETING VALUES ASSOCIATED WITH WILDLIFE

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The more distance kept between market forces and wildlife conservation the better it will be for wildlife. Present economic policy advocated by the federal govenment is inconsistent with the economic realities of their decisions. Wildlife was rescued from the market place and restored to abundance by American Conservationists. This restoration was led by sensitive wildlife philosophers and American sportsmen intent on saving one of our nation's finest amenities. Today's advocates for wildlife must be cognizant of the history of wildlife conservation and willing to challenge management institutions and their programs that place wildlife in peril. Strict economic allocation of public resources may be such a program.

The position this presentation assumes on the subject of wildlife conservation and the market place is the position that the more distance placed between wildlife conservation and current notions of market forces and economic decision making criteria, the better it will be for wildlife. This position will be argued from the perspective that; economic philosophies, and realities are fraught with hypocrisy and ideological myopia; the American wildlife conservation movement rescued fish and game from the marketplace; the restoration of our outdoor recreational opportunities was and continues to be driven by human emotions; and our goal must be preservation of the progress already made by our predecessors using proven methods of advocacy.

The observations and opinions offered in this presentation are given from my personal perspective and Montana experience. What feels good for the Northern Rockies may not feel the same for the coastal forests. Ecological and cultural distinctions may well lead to different conclusions and solutions. The homogenization of thought, management objectives, and prescriptions for solutions is probably at the root of many of our public resource management disagreements. Even in Montana a great ecological diversity exists between the cedars of Ross Creek in the Kootenai National Forest and the bunchgrass slopes on the Lewis and Clark National Forest. The point is, solutions purported to reside in either the market or the wild country do not fit unless there is logic in the economic or ecological agruments, support in historical perspectives, and consistency with the aspirations of our constituency. Market place solutions to wildlife conservation problems have none of the above.

To a noneconomist the logic, terminology, and consistency of economic pleadings can be a scary process to participate in. Some of the guiding principles put foward by people reacting to economic pressures include the following statements:

"....the fate of wildlife is being determined....by the way a cost/benefit ratio turns out."(1)

"The times are changing. Today it's a matter of dollars and cents." (C. Rupp Regional Forester cited in (1))

"The effective wildlife biologist understands:....this is a capitalistic free enterprise economy: and....government assets are increasingly expected to produce revenue." (1)

"....We believe the National Forests can turn a profit...and....the American people should expect such a profit...."(Crowell cited in (2))

The above sampling and other exhortations coming to us from the leaders within our federal system could leave us noneconomists with the impression that resource allocation is a no nonsense dollars and cents operation. Amenity lovers and other social benefit recipients could mistakenly leap to the conclusion that the cherished "free lunch" is ready for listing as an endangered species! The time for emphasizing making profit from the remnants of the American commons appears to be once again at hand.

A look at real world events however casts a different image. In October of 1984 Randal O'Toole (3) reporting on below cost timber sales cited a variety of studies that noted among their findings the following:

"Comparing the costs with timber receipts....three Forest Service regions consistently lose money, and three others intermittently lose money."

"....of 118 forests, over 70 lose money."

"....there is growing evidence that nearly every national forest loses money on some timber sales, and a few.... lose money on nearly every sale."

"....nearly 50 forests spend more on timber sale preparation and administration than they receive for timber."

"The General Accounting Office....found...., one third of all sales it examined lost money."

"....as much as one-third of national forest timber sold is cross-subsidized...."

In an article in the Washington Post, Dale Russakoff noted, "....an industry that boasted....independence from flapjack eating loggers to cigar chomping timber barons - is on the federal dole to the tune of several billion dollars a year in forgiven taxes according to the Treasury Department. Timber tax breaks drained enough money from the U.S. Treasury in 1984 to have financed the budget for managing the national forests."

In January of 1985 a U.S.F.S. news release announced the "buy out" provisions of the Federal Timber Contract Modification Act. The reason given was "....to aid the economically hard-pressed industry." A neat twist to free enterprise entrepreneurship, if you profit you keep it, if not the government will help you out. This is really nothing new but a condition so institutionalized that it is taken for granted.

Another so called commodity - forage, follows a similar path. The National Wildlife Federation reported that current below-market grazing fees have lost the U.S. Treasury $15 million since 1978.(5) Surely the purveyors of the "free market" philosophy would have stopped this persistent subsidy.

Not so, in early 1986 our fiscally conservative president extended this long standing public subsidy that results in assessing fees that are 80 percent lower than the rate paid for grazing on comparable private lands. It is a rate that covers only 35 percent of the Federal costs of range management and improvement.(6)

The list could go on and include cost benefit ratios on federal dams, water allocation, Jim Watt's coal sales, power allocation and probably other so called commodities but the point would be the same. Public resources are allocated for social and ideological purposes, to bolster small towns, to aid "hard pressed" industries, to perserve life styles, to redistribute the wealth and perhaps even political patronage. Why so much effort is expended on interminable economic rhetoric is the only real mystery in this process.

As we seek to relate these circumstances to wildlife conservation, it is incumbent on all of us to recognize a few principles evident in the history of wildlife conservation in this country. It is important to realize that we are part of the American Wildlife Conservation effort, a social movement. We are not technicians entrusted with allocation of animal protein masquerading for the moment inside deer and elk hides. Wildlife conservation was born before there was a U.S. Forest Service, a Fish and Wildlife Service, a Montana Department of Fish, Wildlife and Parks or an office of Management and Budget.

There are probably many both vague and precise moments that might be suggested as the origin of the American Wildlife Conservation effort. One such moment occurred in 1887. For historical interest that was before the northwestern states of North Dakota, South Dakota, Montana, Washington, Idaho, Utah and Wyoming were admitted to the Union. It was three years before Sitting Bull was killed, and two years before Don Pedro II Emperor of Brazil was dethroned, the last emperor in the Western Hemisphere. In 1887, Theodore Roosevelt and a handful of hunters created the Boone and Crockett Club for the preservation of big game in North America.

Two important points need to be made here. One is that it was the hunters who spawned wildlife conservation action and the other, a point of interest, is that this particular club is still true to their charter. Last fall they bought and dedicated to wildlife conservation a key habitat along the mountain front in the northern Rockies. In effect they acquired private property and dedicated it to supporting the wildlife of our commons. In this area more than 60,000 acres have gone that way since 1947.

A lot has happened in wildlife conservation and restoration in the century that is now closing. Let us never forget, we began it with wildlife clearly in the market place. We were in the market for tongues, for humps, for hides and finally for bones. Let me give you an example:

In 1850: 5,000 Blackfeet fought an equal number of Crow on the east slopes of the northern Rockies. It is probable that the quality of the hunting ground had something to do with this aboriginal misunderstanding.

In 1857: 36,000 buffalo hides were shipped out of Fort Benton, Montana.

By 1876: the trade had increased to 80,000-it was also the year Custer was killed at the Little Big Horn.

By 1884: the hide trade dropped to zero, the country belonged to the bone pickers.(8)

The market place was working on the northern Rockies and high plains. Although the origins of citizen wildlife conservation preceded the "bone market," wildlife stayed in the market place and their general demise became part of our history. From those ashes grew the American Wildlife Conservation effort. It was an effort originated and fueled primarily by American sportsmen and attended by some remarkable and sensitive professionals, John Muir, Aldo Leopold, Bob Marshall, Olaus Murie, Sig Olsen and others. It was a movement that began by taking wild animals out of the market place and enshrining them as an All-American amenity. It was, and is, a movement that was successful to such a degree that the ghosts of the market are materializing like the "horsemen of the apocalypse" to prey once more upon the abundance of the commons to cure everything from oriental infertility to the depression of American agriculture. Return wildlife to the market place: We don't have the right!

It is not enough to argue that the market place is not the forum to further the interest of wildlife. The argument to be whole must offer positive direction. For that direction we can reflect on the thoughts and philosophies of some of our more perceptive leaders, those mentioned earlier will do. To make the point one line from each will suffice:

John Muir: Any fool can destroy trees. They cannot run away; and if they could, they would still be destroyed, - chased and hunted down as long as fun or a dollar could be got out of their bark hides...Through all the wonderful, eventful centuries since Christ's time - and long before that - God has cared for these trees, saved them from drought, disease, avalanches, and a thousand straining, leveling tempests and floods; but he cannot save them from fools, - only Uncle Sam can do that.(9)

Aldo Leopold "....a system of conservation based solely on economic self-interest is hopelessly lopsided. It tends to ignore, and thus eventually to eliminate, many elements in the land community that lack commercial value, but that are....essential to its healthy functioning."(10)

Bob Marshall and Colleagues declared in 1935:
"For the purpose of fighting off the invasion of the wilderness and of stimulating.... appreciation of its multiform, emotional, intellectual, and scientific values, we are forming.... the Wilderness Society."(11)

Olaus Murie

"Our training in the universities should be such that we do not come out pretty good technicians but philosophical illiterates. We need to look up from our technical study at times and look at the horizon. Evolution is our employer."(12)

Sig Olsen

"Too much attention to scientific detail can rob one of awareness and deeper meanings."(13)

If we accept that we are products of our history then we are more than managers of elk, we are custodians of an American heritage--a heritage from the ranks of forestry and wildlife professionals, a heritage restored by professionals and citizen activists now reaching back three generations, a heritage built on the concept that the commons is not yet consumed by what John Muir referred to as the "....gobble, gobble school of economics." (9 page 34) Our future and the future of the resource from which most of us draw our sustenance must be firmly rooted in our past if we are to prevail. To run to the market place where our interest has historically been pillaged and search for guidance is to abandon the lesson clearly inscribed on our own evolution.

We left those dark days propelled by the desire and emotion of Americans who sought to retain the privilege and joy of having access to a remnant of the great American commons. The fact that we repeat today's debate is ample evidence that our predecessors were successful. To change tactics and fundamentals and declare our resource is now to be a commodity of our commerce would be to chart a new and perilous course. The market place and strict economic analysis can be like a fickle partner at the prom. She will dance with everyone in the ballroom but we all know who she will spend the night with, the one with the bucks. The criteria for her choice are quite simple.

It is possible that the market place advocates could recruit more disciples from the ranks of sportsmen and others emotionally and traditionally attached to wildlife if they engaged in more sensitive communication. In the spirit of offering constructive assistance an example follows.

Writing in Western Wildlands, an economist recently stated the following "....people confuse....capital and noncapital goods and services. The "lucky" hunter converts a capital item to nondurable goods. At the same time, title.... is transferred.... to the.... individual. Since game rights are.... appropriated to successful hunters and fisherman,....powerful rod and gun clubs privatize the commons."(14)

Those of use who unabashedly appeal to the human side of things would have sent the same message as follows.

Patiently we waited, my Labrador and I, as the gray November dawn wedged the night from the marsh. Suddenly through mist and fog we caught sight of shadowy forms swinging in response to our motionless decoys. Our hearts pounded with excitment as the shadows locked their wings and tumbled toward us, fat plump "capital items" down from their distant nesting grounds. The thought of converting them to "nondurable goods" was more than we could stand. If aim were true "title could be transferred." The anticipation was too much to bear, in an instant old reliable spoke and "capital items" fell in the open water clearly in a "nondurable good" condition. The old lab's eagerness to consummate the "appropriation" was unrestrainable and she plunged into the icy marsh to complete the "privatization of the commons." At days end we trudged contentedly across the nearly frozen marsh. The only way this day could have been better was if the president of my powerful rod and gun club and Milton Friedman had been here to share it.

Silly? Of course, it is ridiculous! Most hunters pursue their sport for reasons that have little or nothing to do with market preferences or economic well being. In the duck hunting analogy it's the crisp pre-dawn air, and the smell of that slop we wade through. It is the sound of wings in the dark and wind in dry cattails. It is anticipation of ducks of assorted species and points of origin. It is the excitement of the passing shot and if we should dump one a satisfaction we can't describe very well and that has been bleached out of folks too long removed from the wild stuff we fancy.

Wildlife conservation has come as far as it has because the sportsmen of this country became intellectually, and emotionally involved. They became involved to preserve an American amenity - the hunt - and the right of all people to participate if they chose to. The involvement has traditionally included wildlife and forestry professionals participating with both their intellect and their emotion. Yes, our emotion, our feelings, that stuff that comes from the right side of your brain. It is the thing we have been told on more than one occasion to suppress so we could be "objective."

David Ehrenfeld, who wrote an incredibly stimulating book called, "The Arrogance of Humanism," addressed the point by quoting from Robert Persig's "Zen and the Art of Motorcycle Maintenance": "Phaedrus, the hero of Persig's book, remembered a line from Thoreau: 'You never gain something but that you lose something,' and now he began to see for the first time the unbelievable magnitude of what man, when he gained power to understand and rule the world in terms of dialectic truths, had lost. He had built empires of scientific capability to manipulate the phenomena of nature into enormous manifestations of his own dreams of power and wealth - but for this he had exchanged an empire of understanding of what it is to be a part of the world, and not an enemy of it."

Elsewhere in his book, Ehrenfeld stresses that the "....desperate and selfish attempt to make all modern decisions 'rational' and 'objective' leaves us severely handicapped in the most critical areas of survival, and has the paradoxical effect of ensuring that the only emotions that will help decide our future are the hidden ones too base for public view." Enrenfeld argues well in his book that, "Quality is generated at the interface between emotion and reason."

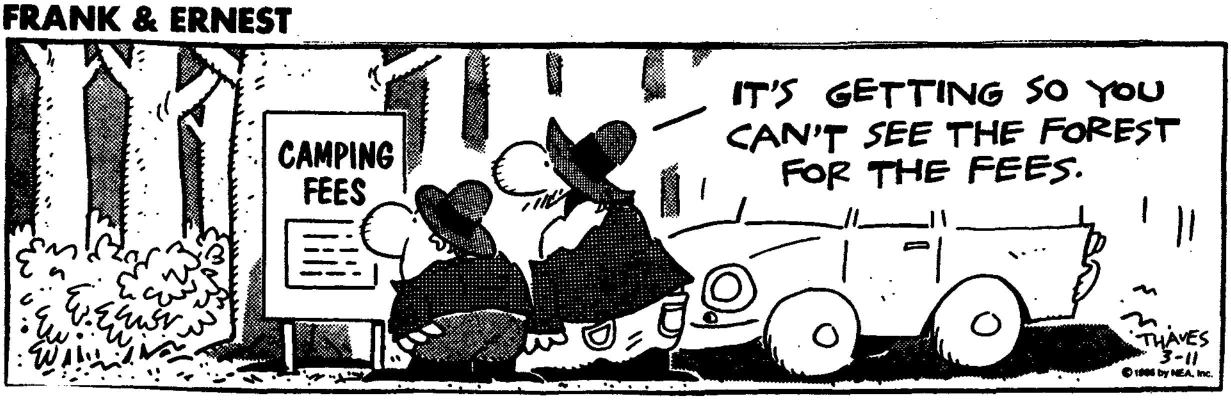
Wildlife and those who protect it, advocate for it and struggle to perpetuate it have come a long way since we rolled over the buffalo and passenger pigeon for the market place and other purposes. Wildlife conservation is a cause that to succeed in perpetuity, must not only remain true to its heritage but must, like all things, adapt to changes in the total environment. In other words it is like the Red Queen told Alice "Now, here, you see, it takes all the running you can do to keep in the same place." The question before us has to do with taking our responsibility to the market place as it is. Let there be emphasis on the "as it is" portion of the preceding sentence for some real things can happen to fish and wildlife in the market place. It is one thing to subscribe to economic principles in theory and quite another to agree to what in fact occurs in today's harsh reality. It is obvious that many things in the market place and in the world of economic theory and philosophy materialize in strange ways.

Perhaps this new world of market forces and economic theory we are being invited to embrace is like Tweedledee's world on the back side of the looking glass, "If it was so it might be; and if were so, it would be; but as it isn't, it ain't, that's the logic."

The truth is, there is only questionable logic in this process of allocating resources in response to market forces and ephemeral economic ideologies. Wildlife would be better served if we patterned our future, and the actions we take to get there on what worked so well for wildlife during its history of recovery.

It was not easy for our predecessors and it will not be easy for us. Today's conservation heroes were yesterday's bureaucratic mavericks, and they paid for being unconventional and honest to their convictions. Aldo Leopold arrived in the White Mountains 25 years after Geronimo's capture. Author Peter Wild comments on Leopold who was with the U.S. Forest Service at the time, "...the young Leopold recognized the problem, while others busied themselves with making it worse."(9) It was a time biographer Dr. Susan Flader describes as Leopold's romantic stage when "as he evaluated the prejudices of his times, he began to realize that accepted methods of forestry were part of a larger mistake"(9). What is being suggested is not simple repetition of what our founding fathers thought, said and did. Rather let us question and challenge the institutions as they did when their instincts told them that wildlife was being denied the consideration it was due as a treasured American amenity. Taking this true remnant to the American commons, wildlife, back to the market place for allocation is surely worthy of our skeptical scrutiny and may be worthy of our unrestrained challenge.

FRANK & ERNEST



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DISCUSSION

Question: A comment then a question. I like the analogy about the ducks but I would point out that that guy probably had a duck stamp and hunting license in his pocket. We already charge a fee for access to those things. It's called a hunting license. Three-quarters of the people in this room are paid by that fee. We're not arguing about whether a fee is appropriate. We're arguing about who to fee for what. Fees are already there. The duck hunter that was converting that to a commodity and possession already paid two fees that he carried around in his pocket. That's a speech and probably that can also be a question.

Answer: There's no quarrel with what you say, that the hunter does pay a fee. The hunter does a lot more though. The point that I would make is that the hunter buys that license and to him it's not an economic big deal. It's a trivial kind of a token that he gives and he probably gives it in the context that it is necessary to have some control, management and regulation of the sport so that the commons is not depleted. What the hunter additionally did is the point that I'm arguing. He has now for three generations seen to the restoration of wildlife because it was something that he personally and emotionally and culturally was attached to. The economic aspect, the fact that he coughs up a license fee is a very trivial part of that commitment to conservation that exists in our wildlife constituency. What I'm arguing against is elevating that thing as if it were some sort of a major decision-making criteria we use, because it's not. It's a trivial aspect that attends the continual progress of the American conservation movement. I think by the same token that three-fourths of the people in this room are making a living as a result of that being true. I think we also recognize that that guy will go to one Ducks Unlimited banquet and spend ten times that amount because he believes in the preservation of the American commons and in some distant wetland that puts waterfowl in the air for all of us. I think that's a very nice gesture and a very nice social arrangement. I don't think we should come together and pretend that it is the economic aspect that drives that movement. What I'm saying is that the economic aspect attends that movement, is a trivial part of that movement and what really drives it is the individual's emotional and cultural commitment to wildlife conservation.

Question: It seems like a big failing of our profession. We talk among ourselves. I think the point that's being debated here between these two persons is the world is segregated into those that operate on economic measures and those that operate on emotional measures. Talking among ourselves about a hunting license or a fee is an emotional thing just like you just said. How are we going to get those decision makers that are in the other camp. How are we going to talk to them in terms of emotion. You don't. You talk to them in terms of dollars.

Answer: I could put a little footnote on that. You talk to those people in terms of constituency as well as dollars and that's the way wildlife has always talked in the political spectrum. It has been represented by a broad spectrum of people who are concerned and insisted on the enactment of legislation that eventually led to the restoration of this stuff. Certainly dollars talk, but dollars speak a funny language. It's a language that is too full of hypocrisy for me to advocate that we throw in on it. I'd rather work out in the political spectrum with the hunters and fishermen than try to drive it by affected anonymous decision makers.

OW NET VALUE OF ELK HUNTING CAN BE USED

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he Idaho Department of Fish and Game, as well as other agencies throughout he west, was able to manage the elk resource quite effectively for many years ithout an explicit dollar value for elk. The citizens of Idaho obviously laced a value on elk by their elk hunting, view of elk throughout the year, nd support for conservation of elk. This nebulous idea of the value of elk as adequate for the management decisions being made at the time.

s all demands for resource use on public lands grew, many federal agencies egan using cost/benefit ratios and economic impact analyses to evaluate lternative resource management actions. At this time, the value of wildlife n relation to timber, range, minerals, watershed, etc., became very mportant. Any decisions based on biased economic values could lead to a iased set of resource management actions.

s a result of concern within the Idaho Department of Fish and Game about the oorly documented values for wildlife, a cooperative study was implemented. ix agencies were involved in this study:

U.S. Forest Service	University of Idaho
Bureau of Land Management	Corps of Engineers
U.S. Fish and Wildlife Service	Idaho Department of Fish and Game

he results pertaining to elk hunting were reported by Sorg and Nelson (1986). Several additional reports based on this study have been published (e.g., Donnelly et al., 1985; Sorg et al., 1984; Sorg et al., 1985; Nelson, 1984; and Loomis et al., 1985a and 1985b), and several more are in various stages of preparation. The purpose of this paper is to review the types of economic values derived from this study and some of the appropriate uses of these values.

CKNOWLEDGMENTS

The success of this cooperative study is due to the involvement of many people and agencies. Several people should be recognized for their activities on this project: George Peterson, Cindy Sorg, Dennis Donnelly, Tom Hoekstra, and Jim McDivitt of the U.S. Forest Service; John Loomis, University of California at Davis; and John Young, Nancy Green, and Ed Parsons of the Bureau of Land Management.

ISCUSSION

The objective of this study was to determine the net economic value of recreation associated with wildlife in Idaho. An important aspect of this objective is the emphasis on net economic value. This is different than the expenditures of sportsmen. Both the net value and expenditures are measured in dollars, but they have different meaning and should be used in different ways. The proper use of the results of this study requires an understanding of the distinction between these two values.

Sportsmen's expenditures are a measure of money spent by individuals in order to engage in an activity. Expenditures on gas, food, sporting goods, etc., are a measure of the impact of these activities on the local economy (Dwyer et al., 1977). Expenditures are benefits to the local businesses, but they are not benefits to the sportsmen. Expenditure data are collected by many states and on National Survey of Hunting, Fishing, and Wildlife-Associated Recreation (U.S. Bureau of the Census, 1982).

Gross expenditures are not an appropriate measure of the relative value of two or more resources (e.g., Dwyer et al., 1977, or Loomis et al., 1984). There are several reasons why gross expenditures are not appropriate. First, expenditures only indicate what was paid, not how much the sportsmen are willing to pay. Second, the value of other resources is measured by net willingness to pay. For example, range and wildlife values are not compared by looking at the cost of a hunting trip versus the cost of operating a cattle ranch. Third, many expenditures have little or no relationship to the resources. Should the value of the rifle an elk hunter carries be the determinant of the value of elk hunting?

The net willingness to pay is the economic value to be used to make comparisons among resources. The net willingness to pay can be determined by a variety of methods depending on the resource and data available (Brown, 1982). The net willingness to pay of the sportsment in this study is directly comparable to the profit of commercial resource-use businesses. The resource has some total value from which the costs of obtaining that resource (a business' expenses or sportsman's expenditures) are subtracted. What remains to the businesses is profit while the net value remains with the sportsmen.

The average values of net willingness to pay (average consumer's surplus) are equivalent to the marginal values under the conditions met in this study (e.g., Donnelly et al., 1985). Since we are often dealing with small (marginal) changes in resource use, this equivalence is of special significance. The value derived in this study can be used for the evaluation of project-level work, as well as for much larger changes.

When the values of wildlife are used in evaluation of trade-offs among resources, several points must be considered to ensure a fair evaluation of all resources. First, the biological inter-relationships among the resources and the management actions must be correctly specified. If the impacts of a change in one resource level on another resource are incorrectly specified, any comparisons among alternative management actions will be biased. Second, commensurate values must be used (e.g., net willingness to pay for all resources). Third, the time frame for analysis should be equal for all resources and appropriate for the items in question. Fourth, all constraints must be explicitly stated and then examined for impact on the range of outcomes considered. If severe constraints limit the outcome to a small range of values, then there is little to choose from among the alternatives.

CONCLUSION

The results of this study certainly have not answered all of the questions we have about the economic value of elk hunting. However, it has provided some well-documented values for the net willingness of sportsmen to pay for elk hunting in Idaho. We would like to know more about the impact of site and hunter characteristics on the net value of elk hunting, as well as some idea of the value of elk for nonconsumptive uses. Hopefully, this study has provided some useful information and will provide the basis for more detailed studies to follow.

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DISCUSSION

Question: Elaborate on elk hunting value.

Answer: The average trip in Idaho was 2.8 days in our survey for an elk hunting trip. Remember this is a net value. The costs are quite dramatic. I left out some slides I have on our fishing survey where the values of coldwater fishing are $63 per trip whereas the values for steelhead fishing are about $28. I feel like I'm going into the lions den when I go into our anadromous fisheries people and talk about those sorts of values. The big thing to look at there, with the typical coldwater fishing trip, the total value is very low and the expenses of going close to home are relatively low. But, that difference between the cost and the total value is very high. I think that's what we're seeing here in elk. It's still one of the higher net values. But, there are also some very high expenditures so that total value when you add up the net $100 per trip plus, it's about that much for expenditures, and that's just the variable expenditures, then you've got all these capital goods out there. It's about several hundred dollars per trip, for the total value.

Question: Lou, you've dealt with residents in your survey, is that correct?

Answer: We surveyed both residents and nonresidents, all sportsmen who could hunt elk in Idaho.

Question: Could you elaborate a little bit more. Were there strong contrasts between nonresident travel cost methods, for instance people that were coming from the east coast to hunt elk in Idaho?

Answer: In terms of expenditures, there are obviously much greater expenditures for people who came from the east. And, most of the out-of-state hunters spent a lot more just by nature of the travel and such. That's one thing that added to the value because you have a total value of the resource out there and as you come from greater and greater distances the cost of getting there and the cost of obtaining that resource becomes greater and greater. The fellow that lives in Lewiston and goes up to Lochsa to hunt might have costs of $50 for his elk hunt. We assume they have the same value of hunt on the Lochsa. The fellow who comes from New York City might spend several thousand dollars doing that hunt. Also, a lot fewer people come from New York City to that hunt. When we look at that, the same thing Dave Iverson talked about is that it's a demand curve. As the price goes up, there's less and less demand. So, we use this relationship between the cost and per capita participation as a way to evaluate that demand curve. So we didn't really separate. There is not really a net value to someone who comes from New York and a net value for someone who comes from Idaho. Obviously, their expenditures and the impact on the economy, whether it's in New York or Idaho or wherever, is quite different because their expenditures are quite dramatically different. Now does that address some of the concerns?

FIELD TEST OF A PC PROGRAM TO EVALUATE HIDING COVER FOR ELK

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In recent years, recognition of the Rocky Mountain elk as North American's premier big game animal has led to development of a number of models intended to assist biologists in evaluating elk habitat quality and the probable changes associated with different land management activities. Security, generally provided by quality hiding cover, has been one of the important criteria in many of these models, but the models by which hiding cover can be evaluated in the field have proved to be time consuming and subjective.

In October 1985, the senior author presented HIDE2, a personal computer (PC) program designated to assist field biologists in evaluating hiding cover in forest stands 1/. The program has since been rewritten for use on U.S. Forest Service Data General 2/ mainframe computers in the Northern and Intermountain Regions. HIDE2 estimates the probability than an elk 200 feet from an observer in a forest stand will be hidden from view by tree stems and low canopy. Using trigonometric calculations, the widths of randomly located tree stems are projected to an arc 200 feet from an observation point. The percentage of the arc visually blocked is determined, but hiding cover is evaluated on sections wide enough to hide an elk (65 inches). Any section with 90 percent visual blockage is considered to be hiding cover. The program utilizes stem diameter and density information provided by the timber inventory, thus enabling the biologist to obtain hiding cover values without extensive field work. This paper presents results of a test comparing field estimates of hiding cover with results produced by the computer program.

Four forest stands managed by the University of Montana School of Forestry were selected for testing. All four stands are near the Lubrecht Experimental Forest on land owned by Champion International and managed by Bill Potter. Trees in these stands, all conifers, have been tagged and recorded if over 2 inches in diameter. Trees under 2 inches in diameter were counted, but were not individually marked with metal tags.

1/ National Workshop on Micro-computer Applications in Fish and Wildlife Programs. Colorado State University, October 9-11, 1985.
2/ Use of trade or firm names is for information only and does not imply endorsement by the U.S. Department of Agriculture.

LABORATORY EXERCISE

In this exercise, members of the Advanced Wildlife Conservation class evaluated the four stands using the HIDE2 program and IBM PCs in the University Business School. Two assumptions were made: 1) trees with 1-inch diameter are open grown (have green crown at 4.5 feet); and 2) half the trees with 2-inch diameter are open grown. A total of 19 replications on each stand were completed by the class and used in the analysis summarized in Table 1.

Table 1. Statistics describing samples of Visual Blockage and Hiding Cover in four stands at Lubrecht Forest, calculated by the Advanced Wildlife Conservation class using the PC program HIDE2 (N=19).

Cover Class	Area	Mean, N=19	Std. Err.
Visual Blockage	1	34.9	1.1
	2	84.7	1.3
	3	35.3	1.1
	4	67.1	1.3
Hiding Cover	1	6.6	0.9
	2	55.0	2.5
	3	6.6	0.9
	4	26.6	2.3

No further analysis of these data seemed necessary. It is clear that stands 1 and 3 are very much alike. Stand 4 has significantly more cover than either 1 or 3, and stand 2 has significantly more cover than stand 4. Significant differences were assumed with more than two standard errors difference between means.

FIELD EXERCISE

Field samples of visual blockage and hiding cover were taken in each of the four stands with two teams completing five replications with each of two sampling methods. The "Gordon Board" method 3/ uses a 20-square (4 x 5) checkerboard of 6-inch squares. A sample estimate is the number of squares visible at a distance of 200 feet. Since each square represents 5 percent, visual blockage is equal to 5 times the number of squares not seen. Hiding cover was taken as the percentage of observations with visual blockage over 90 percent.

The "Hillis" method 4/ is an either/or classification for hiding cover in which the upper torso of the "target" individual is classified as hidden (90 percent) or not hidden at a distance of 200 feet. Cover estimates for each stand were based on 30 observations with the Gordon Board and 50 observations using the Hillis method. Means and standard errors of replications are presented in Table 2.

3/ A sampling method developed by Floyd Gordon, Wildlife Biologist, Bridger-Teton National Forest.

4/ A sampling method developed by Michael Hillis, Wildlife Biologist, Lolo National Forest.

Table 2. Statistics summarizing samples of Visual Blockage and Hiding Cover (Gordon) and Hiding Cover (Hillis) in four stands at Lubrecht Forest. Field samples by the Advanced Wildlife Conservation class (N=10).

Cover Class	Area	Mean	Std. Error
Visual Blockage (Gordon)	1	39.8	16.7
	2	74.8	22.6
	3	32.7	10.6
	4	63.3	21.7
Hiding Cover (Gordon)	1	1/ 14.3	2.4
	2	50.0	5.5
	3	11.0	1.9
	4	30.3	5.4
Hiding Cover (Hillis)	1	1/ 26.0	2.0
	2	58.8	2.7
	3	1/ 25.4	2.3
	4	1/ 51.1	6.2

1/ Mean was more than two standard errors deviant from the comparable mean in Table 1.

Comparison of Tables 1 and 2 reveals no significant differences between visual blockage estimates made with the PC program and samples taken in the field. Estimates of hiding cover, however, were generally higher in field samples. One team using the Gordon Board and three teams using the Hillis method produced hiding cover estimates significantly higher than those produced by the PC program. Although the samples available for this comparison were relatively small and highly variable, we concluded that the observation method, rather than the PC program, was responsible for the inconsistency in estimating hiding cover.

This conclusion, we believe, is verified by a second sampling test of hiding cover values using the PC program. The assumption in the program is that the area required to hide an elk will average 65 inches in width. By comparision, field exercises utilized the Gordon Board, which is only 24 inches wide, and the human torso with a width of 18 to 24 inches (Hillis method). In both cases, it is a mathematical certainty that the field method will produce higher hiding cover values than the computer program.

To demonstrate this certainty, the PC program was rewritten with a hiding cover target width of 24 inches. Estimates of visual blockage and hiding cover with the narrow target for the four forest stands at Lubrecht are presented in Table 3.

Table 3. Statistics describing samples of Visual Blockage and Hiding Cover in four stands at Lubrecht Forest, calculated with the PC program HIDE2 using a hiding cover target width of 24 rather than 65 inches (N=10).

Cover Class	Area	Mean	Std. Error
Visual Blockage	1	32.6	1.2
	2	86.4	0.9
	3	34.2	2.6
	4	71.0	1.2
Hiding Cover	1	14.8	1.3
	2	69.2	1.6
	3	15.0	3.1
	4	47.7	2.0

As expected, PC estimates of hiding cover using the narrow target were significantly higher than PC estimates using the elk-width target. Also as expected, the PC estimates for hiding cover values were closer to the values recorded in field sampling. At the same time, PC estimates using the narrow target reveal a potential source of error in any field sample of hiding cover. Comparison of Tables 2 and 3 reveals that computer estimates of hiding cover in the two relatively open stands were similar to values recorded in the field with the Gordon Board but lower than field estimates using the Hillis method. Conversely, computer estimates of hiding cover in the more dense stands were higher than Gordon Board estimates and closer to the values recorded by field observers using the Hillis method.

In examining these differences, we again detect observer bias rather than computer bias. It is generally recognized that even "unbiased" observers will count a greater proportion of "borderline" samples as the number recorded declines. Sampling for hiding cover, because of the definition used, requires many such decisions. An observer must determine whether a target is visible at all and then determined whether 90 percent of it is visible. With the Gordon Board, both decisions are mechanical when cover is poor and the board is easily seen. In dense cover, however, there is a predictable bias toward counting borderline squares when only a few can be seen. Hiding cover is underestimated. The same process, when the whole target is a single decision as in the Hillis method, results in biased acceptance of borderline (90 percent) observations when cover is poor. Hiding cover values are overestimated.

This field test also emphasizes the difficulty of maintaining consistent visual images of 90 percent cover using the targets represented by the Gordon Board and the human torso. The coefficients of variation associated with field data averaged 10 times greater than coefficients for computer estimates. We conclude that, where timber inventory information is already available, the computer program provides accurate estimates of hiding cover at a lower cost and with greater speed than field observations.

?RELIMINARY NUTRITIONAL COMPARISONS OF BROWSE [N CLEARCUTS AND OLD-GROWTH FORESTS, OLYMPIC PENNINSULA, WA

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Abstract: Browse nutritional quality in old-growth and clearcuts on the Olympic Penninsula was compared. Species response to clearcutting was variable, but no consistent increase in nutritional quality in clearcuts was found.

Nutritional characteristics of four common browse species were compared between old-growth forests and clearcuts on the west side of the Olympic Penninsula, Washington. Samples of vine maple (*Acer circinatum*), salmonberry (*Rubus spectabilis*), red huckleberry (*Vaccinium parvifolium*), and swordfern (*Polystichum munitum*) were collected from four early seral clearcuts and four old-growth forest sites. All sites were on low elevation terraces along the Hoh River, either adjacent to or within Olympic National Park. All clearcuts were 5-10 years old and dominated by deciduous browse. Forage was sampled in July and October 1985, and January 1986. Sampling will continue into April and July 1986. Laboratory analyses are currently in progress, but to date we have results on percent dry matter, leaf/stem ratio, crude protein, cell wall consituents, acid detergent fiber, lignin, *in vitro* digestibility, and minerals.

Preliminary analyses revealed several significant differences between forages growing in old-growth and clearcut sites ($p<.05$). The percent dry matter was significantly greater in clearcuts than in old-growth sites in all three seasons, for all species. The ratios of leaf to stem weight were numerically greater in old-growth forests than in clearcut sites for all species, but were significantly different only during the summer. Leaf to stem ratios during summer in old-growth and clearcuts were 4.8 and 1.7, respectively, for vine maple, and 0.8 and 0.6 for red huckleberry. Crude protein was significantly greater in old-growth sites in all seasons. When all species were combined, crude protein in old-growth and clearcuts averaged 9.9 percent and 6.4 percent respectively, in the summer, and 5.9 percent and 4.8 percent in the winter. This trend was consistent for all species.

The differences in fiber characteristics between old growth and clearcuts were variable among the four species examined. When all species were combined, there were no significant differences between old-growth and clearcuts in levels of cell wall constituents (CWC), acid detergent fiber (ADF-primarily cellulose and lignin), or lignin. However, vine maple contained significantly greater amounts of CWC and ADF in clearcuts than old growth in all three seasons, and greater amounts of lignin in clearcuts in the fall and winter.

CWC and ADF levels in salmonberry did not differ between forests and clearcuts, but lignin was significantly greater in old growth in the fall. CWC in huckleberry also did not differ between sites, but old-growth samples contained significantly more ADF in the fall, and more lignin in the fall and winter when compared to clearcuts. Swordfern contained significantly more CWC, ADF, and lignin in old growth than in clearcuts in most seasons.

In vitro digestibility was low, but when all species were combined it was significantly greater in old-growth forests than in clearcuts in all seasons. Individual species responses were variable. Digestibility of vine maple was greatest in old growth in all seasons, ranging from 45 percent in old growth and 37 percent in clearcuts in the summer, to 38 percent in old growth and 31 percent in clearcuts in the winter. There was no significant difference in salmonberry digestibility between sites. Huckleberry in old growth was significantly more digestible than in clearcuts only in the fall. Conversely, swordfern was significantly more digestible in clearcuts than in old growth in all seasons. Digestibility of swordfern ranged from 19 percent and 24 percent in old growth and clearcuts respectively, in the summer, to 27 percent and 30 percent in the winter.

Macromineral levels (Na, Ca, P, K, S, and Mg) tended to be greater in old-growth forests than in clearcuts for all seasons and species except Ca content in swordfern. Except for Na (x = 206 ppm), macromineral contents appeared to meet the nutritional requirements of cervids on both sites. Micromineral levels also tended to be higher in old growth than in clearcuts. Se levels (x = 0.03 ppm) appeared to be inadequate to meet cervid requirements.

Since this research is currently in progress, conclusions as this time would be speculative. The tannin content of forages, and its effect on in vitro digestibility are still to be assessed. However, at this stage it does appear that each species responded differently to clearcutting, and that clearcutting does not necessarily result in improved nutritional quality in browse species that occur in both old-growth and clearcut sites.

DISCUSSION

Question: I think your results are fascinating today. I think it points out an important point that we try to address in the model that we developed. That is there is an important forage component inside these old-growth growth stands that probably hasn't really been recognized yet because of the lack of studies. The other point I wanted to make; it didn't come out real clear to me... and that is the browse species you're looking at are traditionally looked upon by westside biologists as food that is very low in nutritional quality regardless of its site. I believe that the levels of digestibility that you found, regardless of the area that you were looking at, even in clearcut old growth, indicated that. Is that true?

Answer: Yes it was.

Question: The other point, and it relates back to what we are proposing as a forage quality variable, was that we were assuming that through the treatments we propose to create forage areas or that were used on those forage areas to increase forage quality, was that we would change the composition of that area from domination of browse species with very low digestibility and overall low quality to grasses and forbs that would have much higher quality. I think some followup studies would be very interesting to look at treatments applied to those areas on the same site and the response of the composition of different species related back to changes of quality.

Answer: If it were possible to expand the list of forage species that were occurring both in clearcuts and in old growth, I think that would be the next direction to go.

Question: I think one of the things to remember is that some of the work that's been done, and there are probably people in the room that can correct me or give us values, but on the Alsea District some of the folks at OSU and Range Resources have worked with some species that theoretically should be pretty digestible. As a matter of fact they found some very low levels of digestibility. One of their discussions that stimulated this study was a conversation with Steve Sharrow from Range in comparing their values with our values in some earlier studies and beginning to wonder whether our techniques were okay. Whether people involved in these studies were in fact measuring and doing the digestibilities right. Some of the forbs and grasses on the Alsea District, if I remember correctly, were not very digestible. It was very surprising. So I think that's a very good point. When you change a clearcut and change the species composition, if you move towards legumes or bunchgrasses or forbs, that's a different situation than what we're measuring here. Nonetheless, I think that we do need to do a lot more work to determine whether you are going to get the kind of forage quality response that you're hoping to get by converting these clearcuts to something other than browse.

Question: I assume all of your in vitro tests were with dried samples. Have you considered using quick-frozen green samples to get some of the volatiles involved in determining digestibility?

Answer: No I haven't done that. It's a consideration as I do have some frozen samples.

Question: Frequently, when I used to be with the University of California, we found some very dramatic differences using quick-frozen green samples that presumably preserved the volatiles compared with dried samples of the same plant. Another thing that might be useful to consider is the synergistic relationships of mixed samples, frequently this can greatly alter the digestibility.

VANCOUVER ISLAND ELK - ANIMAL AND USE CHARACTERISTICS

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Abstract: Information related to population dynamics and habitat use of Roosevelt elk (*Cervus elaphus roosevelti*) on Vancouver Island is reviewed. Pregnancy rates of 85.5 percent were estimated for cows 2.5 years of age and older; biennial conception does not appear to be a problem. Annual calf mortality rates, based on expected June calf:cow ratios and the observed late winter ratios, ranged from .46 to .85 for the herds under study. Adult mortality rates, based on life table schedules, were estimated at .082 for 2 to 10 year old cows, and .201 for cows older than 10 years. Corresponding rates for bulls were .110 and .219 respectively. Late winter calf:cow ratios over the past decade were significantly related to winter severity. Wolf (*Canis lupus crassodon*) predation is another important source of natural mortality, although impacts on recruitment of specific herds does not appear to be long-lasting. During periods of mild winter conditions, major causes of adult mortality are related to human harvest. Current harvest regulations, designed to provide a quality hunt experience by limiting the number of hunters on a herd-unit basis, are considered to be conservative. Hunters enjoy a relatively high success rate (average of .68 elk/hunter). Known illegal harvest is approximately 50 percent of the legal harvest and is a major management concern. Movement and habitat use relationships have been investigated in two study areas differing in logging history (old-growth/early seral versus second-growth forests). Seasonal range and individual home range sizes were related to the abundance and distribution of important resources, primarily forage and adjacent cover. Estimates of diet quality indicated that levels of digestible energy over winter were substantially below maintenance requirements. Fecal crude protein concentrations, significantly related to dietary crude protein and dry matter digestibility levels, were used as an index of animal condition. Habitat relationships are being incorporated into habitat suitability models and management handbooks to evaluate the relative impacts of forest development on elk habitat. Increased knowledge of population dynamics is required to focus management activities on factors limiting population growth, refine harvest strategies, and provide indices relating habitat model output to population performance. Increasing elk distribution and abundance by transplant activities also offers opportunities to validate the habitat models.

Prior to the 1970's, little information was available on the ecology of Roosevelt elk on Vancouver Island. General knowledge of distribution and abundance was based on public reports, a few periodic surveys,and harvest estimates. Data pertaining to population dynamics, habitat use, and elk habitat/forestry interactions were essentially non-existent.

Over the past decade, management effort was intensified in response to increases in both recreational demand and opportunities for incorporating habitat requirements in the forestry-wildlife planning process (Janz 1980). Research programs have also accelerated to meet these challenges with deer and old-growth forest relationships being the major topic of many research studies (see Bunnell and Jones 1984). Over the past five years the relationships of deer, elk and second-growth forests have been investigated under the Integrated Wildlife - Intensive Forestry Research (IWIFR) program.

The purpose of this paper is to collate and review the available data on the biology, habitat relationships and public use of Roosevelt elk on Vancouver Island. Although the intent of the review is to provide information that will be useful in the development of more refined management plans, it may also be of value to other biologists interested in the ecology and management of Roosevelt elk.

DISTRIBUTION AND ABUNDANCE

Roosevelt elk on Vancouver Island, the only indigenous Canadian population, number approximately 3,000-about 11 percent of the total provincial elk population. The majority of animals are located on the north Island in management units (M.U.s) 1-9, 1-10, and 1-11, and on the less accessible northwest coast in M.U. 1-12 (Fig. 1). Some watersheds on the south Island (in M.U.s 1-4 and 1-5) also support viable elk herds. Recent observations of elk on the mainland in M.U. 1-15 are thought to be the result of emmigration from the Island.

Historical records are scant, but it appears that north Island elk have expanded in distribution and numbers since the early 1900's, whereas south Island numbers and distribution have declined. Possible factors influencing elk numbers are discussed in later sections.

ANIMAL CHARACTERISTICS

Weights and Measurements

Whole body weights of 18 cow elk collected during winter months are presented in Table 1. Sample size is small but the average adult female weight of 267.5 kg is very similar to winter weights of female elk in western Oregon (Hines and Lemos 1979). The percentage of total weight made up by the hog-dressed carcass (Table 1) is also similar to values for harvested cow elk in western Oregon (Harper et al. 1985). Percentages of hog-dressed and dressed carcasses are variable, likely a result of varying physical condition (Blood and Smith 1984). Comparison of standard body measurements among *C.e. roosevelti*, *C.e. nelsoni* and *C.e. manitobensis* revealed only minor differences that are probably accounted for by small-sample variation and/or nutritional differences (Blood and Smith 1984).

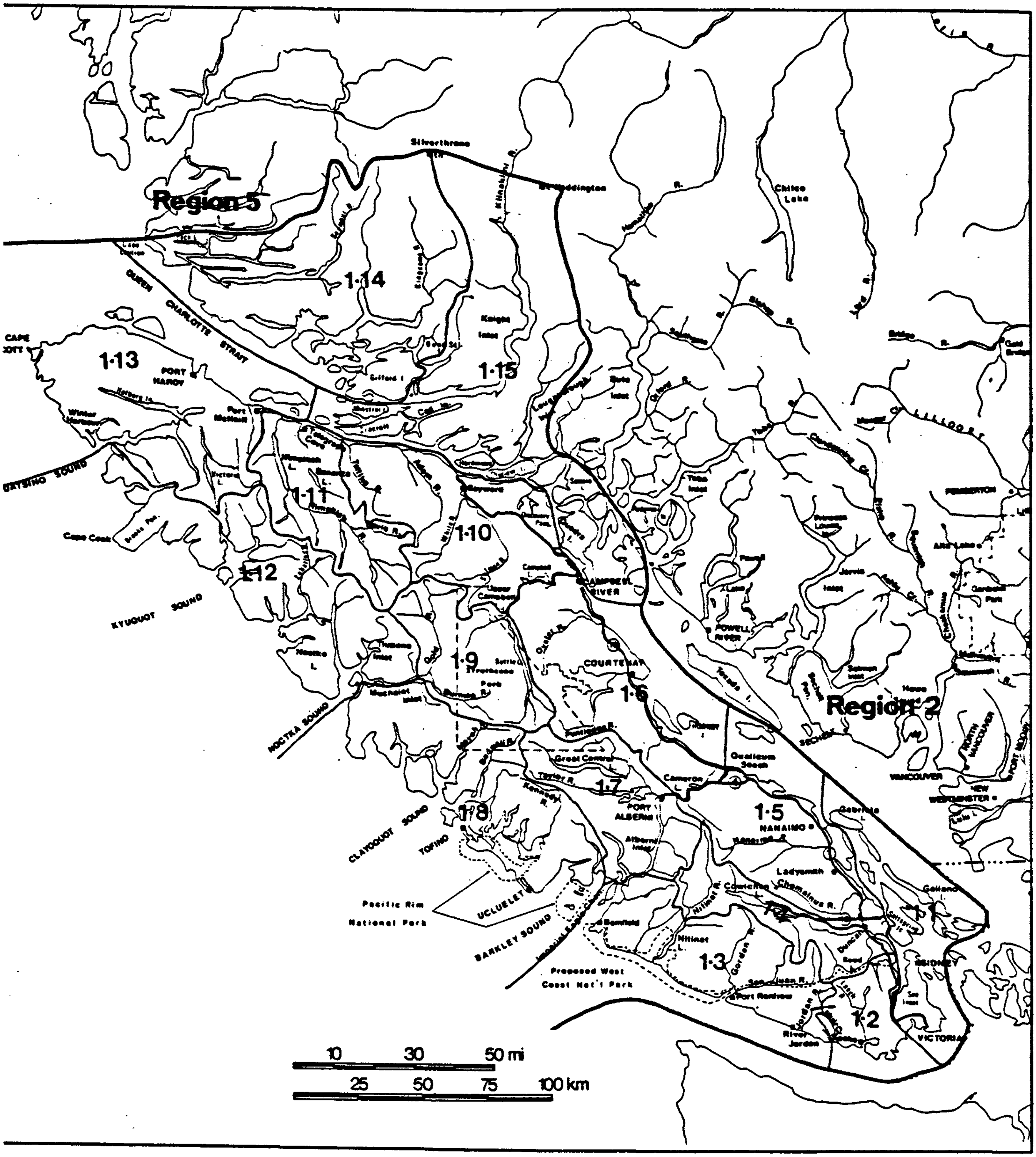


Figure 1. Wildlife management units (M.U.s) for Region 1, Vancouver Island.

Table 1. Whole weight, carcass yield, and physical condition indices of 18 yearling and older female Roosevelt elk (modified from Blood and Smith 1984).

Age Year	Age Months	Month Killed	Kidney Fat Index (%)	Whole Weight (kg)	% of Whole Weight: Hog-dressed carcass	% of Whole Weight: Dressed carcass
1	9	Feb.	19	184.2	72.4	57.9
1	11	May	3	153.8	68.7	52.3
Mean (Yearlings)				169.0	70.7	55.1
2	9	Feb.	61	238.6	65.6	-
2	10	Mar.	-	245.5	66.5	-
2	11	Apr.	0	213.6	61.6	46.7
2	11	May	0	250.4	57.6	44.4
Mean (2-year olds)				237.0	62.8	45.6
3	9	Feb.	71	235.0	70.2	55.8
3	9	Feb.	-	268.2	70.3	-
4	9	Feb.	-	282.3	68.1	-
4	11	Apr.	8	261.7	66.2	52.9
5	10	Mar.	-	250.8	70.9	57.3
7	10	Mar.	4	267.2	68.4	53.8
7	11	Apr.	4	255.8	66.4	50.1
8	9	Feb.	49	297.6	74.5	59.4
9	9	Feb.	51	282.6	73.8	59.2
9	9	Feb.	22	272.2	74.3	59.7
10	9	Feb.	-	309.4	64.2	-
13	10	Mar.	2	227.3	69.1	53.2
Mean (Adults)				267.5	69.7	55.7

Natality

Analysis of reproductive tracts of harvested cows over the 1977 to 1984 period indicate a pregnancy rate of 85.5 percent for cows 2.5 years of age and older (Table 2). These data, collected over a period of relatively mild winter conditions, are comparable to the 83.8 percent pregnancy rate for mature (2.5 +years) cows reported by Kuttel (1975) in southwestern Washington and higher than rates reported in the Olympic Mountain area of Washington (61.3 percent; Smith 1980) and in western Oregon (50.0 percent; Trainer 1971). Of 30 pregnant elk examined for lactation status, 24 (80.0 percent) were lactating (Table 3), again similar to rates reported by Kuttel (83.3 percent; 1975) and higher than figures from the Olympics (67.0 percent; Smith 1980) and Oregon (51.0 percent; Trainer 1971). Biennial conception, indicative of poor maternal condition in the fall, does not appear to be a problem on Vancouver Island.

Mean dates of breeding and parturition, determined by fetal measurements (Morrison et al. 1959) and a gestation period of 255 days (Cowan and Guiguet 1965), were September 28 and June 2, respectively (Fig. 2). Seventy-five percent of breeding occurred by the end of September. A 9.5 year old cow examined in February (not included in Fig. 2) had a viable fetus estimated at 46 days of age, indicating conception on January 4 and a parturition date of September 16. Evidence of recurrent estrus periods and late pregnancies similar to the above have been reported for Rocky Mountain elk (Wishart 1981).

Mortality

Estimates of calf mortality rates from August to April, based on calf:cow ratios and corrections for cow mortality, indicate a range of .10 to .38 over the mild winters of 1982 to 1985 for the Grilse and Greenstone herds (M.U.1-10) (Table 4).

To estimate the mortality of calves from birth to August, the expected June calf:cow ratios were determined from pregnancy rates and the proportion of breeding cows from the age distribution (Table 5; 81.5 percent adult cows x .855 = 70 calves:100 cows). These calculations indicate mortality rates of .21 to .47 by August, and annual calf mortality rates ranging from .46 to .85.

Life tables were constructed from the age-class structure of harvested female and male elk in M.U.'s 1 - 09 and 1 - 10 over the 1977 to 1984 period. Mild winter weather conditions and a conservative harvest prevailed over this period, and annual samples appeared to follow the same age distribution. The sampled age frequencies (fx) were smoothed by transforming the data using the log-polynomial form of the quadratic equation (Caughley 1966; 1977; Adjusted Fx column, Table 5). Values in the zero age class were calculated using the age-specific fecundity rates, adjusted age-class frequencies, and multiplying by 0.5 (assuming an equal sex ratio at birth). The remaining four columns in Table 5 represent the standard life table schedules (Fig. 3). The mortality rate for calves falls within the range of the annual rates determined above, and the weighted mean annual mortality of 2 - 10 year old cows (.082) is similar to the estimated mortality rate of collared animals (Table 4). The corresponding rate for bulls was .110, and .219 for bulls older than 10 years. Due to the hunting restrictions on some younger age-classes, however, the data for males is too skewed to allow accurate interpretation. The female schedules will be used to predict the 1985 harvest age structure to assess the validity of the present model.

Causes of Mortality

Natural mortality agents that are potentially operative on the elk herds include winter severity, malnutrition, predation, diseases, and parasites. Human-induced mortality is discussed in the next section.

Table 2. Pregnancy rates of cow elk on Vancouver Island, 1977-1984.

Age	No Uteri Examined	Number Pregnant	Percent Pregnant	Grouped Pregnancy Rate
1.5	5	0	0	
2.5	11	9	81.8	
3.5	19	15	78.9	79.5
4.5	9	7	77.8	
5.5	3	3	100.0	
6.5	4	4	100.0	
7.5	2	2	100.0	100.0
8.5	2	2	100.0	
9.5	5	5	100.0	
10.5	3	2	66.7	
11.5	3	2	66.7	
12.5	3	3	100.0	
13.5	2	2	100.0	85.7
14.5	1	1	100.0	
15.5	2	2	100.0	
16.5	1	1	100.0	
Adult	6	5	83.3	
Total	81	65	80.2	
Total 2.5+	76	65	85.5	

Table 3. Lactation rates of pregnant cow elk, 1977-1980.

Age	Number Examined [1]	Number pregnant and lactating
3.5	6	4
4.5	6	4
5.5	1	1
6.5	3	2
7.5	2	2
8.5	1	1
9.5	3	2
10.5	2	2
11.5	1	1
12.5	1	1
13.5	1	1
ADULT	3	3
TOTAL	30	24 (80%)

1 Number of pregnant elk with known lactation status.

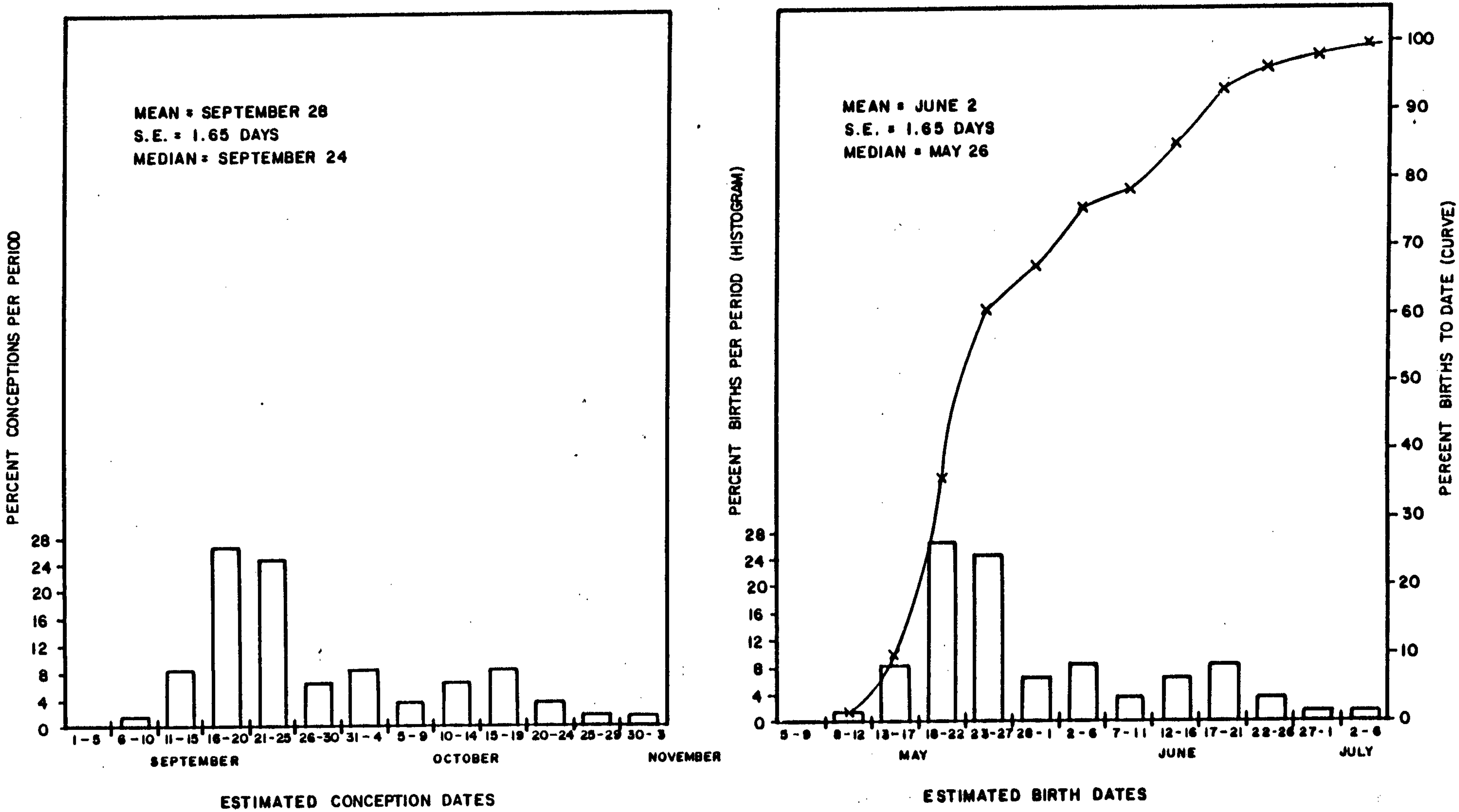


Figure 2. Estimated conception and parturition dates for Roosevelt elk on Vancouver Island.

Table 4. Calf mortality from August to April for the Grilse and Greenstone elk herds, 1983 to 1985.

Herd	Calf/100 F August	Calf/100 F April	Calf Mortality (100% F survival)	Calf Mortality (Corrected[1])
Grilse	49 (1982)	40 (1983)	.18	.25
Greenstone	49	43	.13	.22
Grilse	37 (1983)	26 (1984)	.30	.38
Greenstone	55	44	.20	.25
Grilse	45 (1984)	45 (1985)	0	.10
Greenstone	46	60	-	-

[1] Adjusted for estimated natural mortality (6%) and harvest of adult females, August to April.

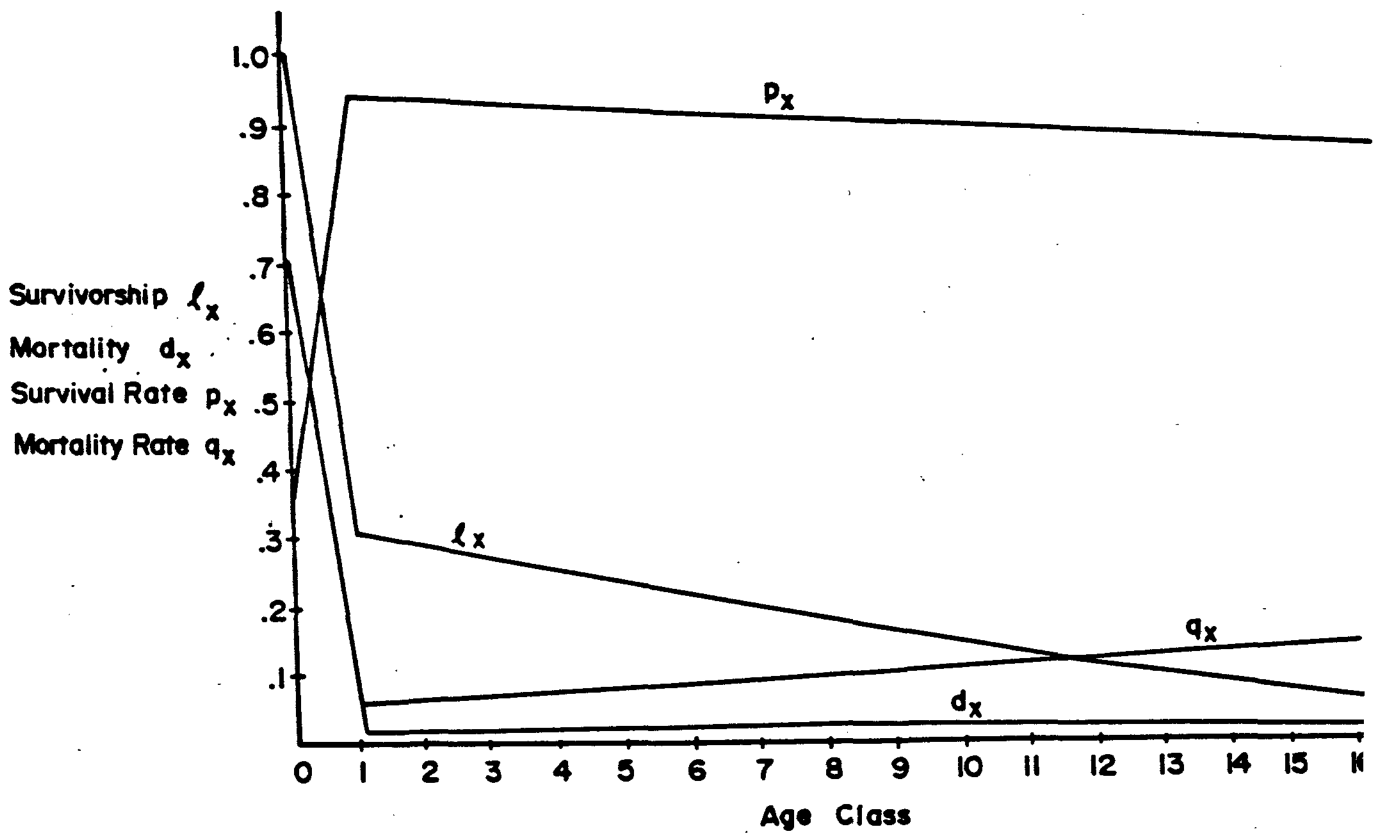


Figure 3. Representation of the four life table schedules of female Roosevelt elk (refer to Table 5).

Table 5. Life table for female Roosevelt elk (M.U.s 1-9 and 1-10).

Age Class	Adjusted Frequency (Fx)	Survival (lx)	Mortality (dx)	Mortality Rate (qx)	Survival Rate (px)
0	74.1	1.00	.6955	.6955	.3045
1	22.5748	.3045	.0181	.0594	.941
2	21.2347	.2864	.0186	.0649	.935
3	19.8550	.2678	.0189	.0706	.929
4	18.451	.2489	.0189	.0759	.924
5	17.0497	.2300	.0188	.0817	.918
6	15.6581	.2112	.0184	.071	.913
7	14.2943	.1928	.0178	.0923	.908
8	12.9714	.1750	.0172	.0983	.902
9	11.7006	.1578	.0163	.1033	.8967
10	10.49	.1415	.0154	.1088	.8912
11	9.35	.1261	.0144	.114	.886
12	8.2848	.1117	.0133	.119	.881
13	7.2963	.0984	.0122	.124	.876
14	6.3874	.0862	.0112	.130	.87
15	5.5584	.0750	.0101	.1347	.8653
16	4.8081	.0649	.0091	.1402	.860
17	4.1342	.0558			

Weighted mean mortality rates:

Juvenile and yearling are read as q0 and q1 respectively.

Adults: Ages 2 - 10 .082
Ages 10 onwards .201

Column 1: Age (x) at intervals of one year.
Column 2: Raw data has been smoothed using the log-polynomial and presented as the number still surviving at one, two, three, and so on years after birth.
Column 3: Formed by dividing each value of the adjusted Fx by the original cohort (74.1) to give the proportion of the cohort still surviving at a given age.
Column 4: The probability of dying during the age interval x to x+1. Calculated as the differences between two consecutive values of lx.
Column 5: The rate of mortality during the age interval x to x+1. Calculated as dx/lx.
Column 6: The rate of survival during the age interval x to x+1. The complement of the respective qx value (Caughley 1977).

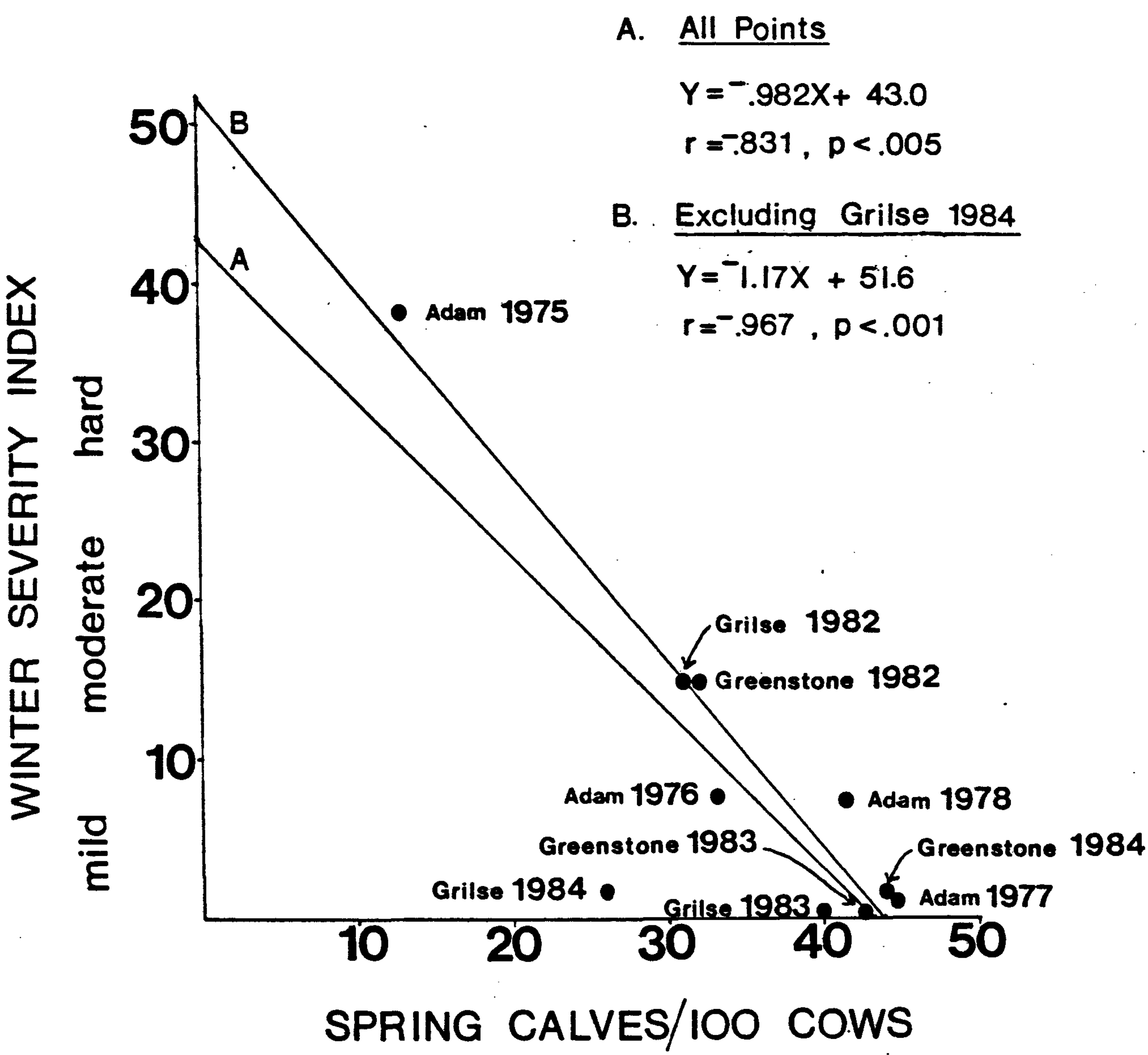


Figure 4. Relationship between spring calf:cow ratios and winter severity.

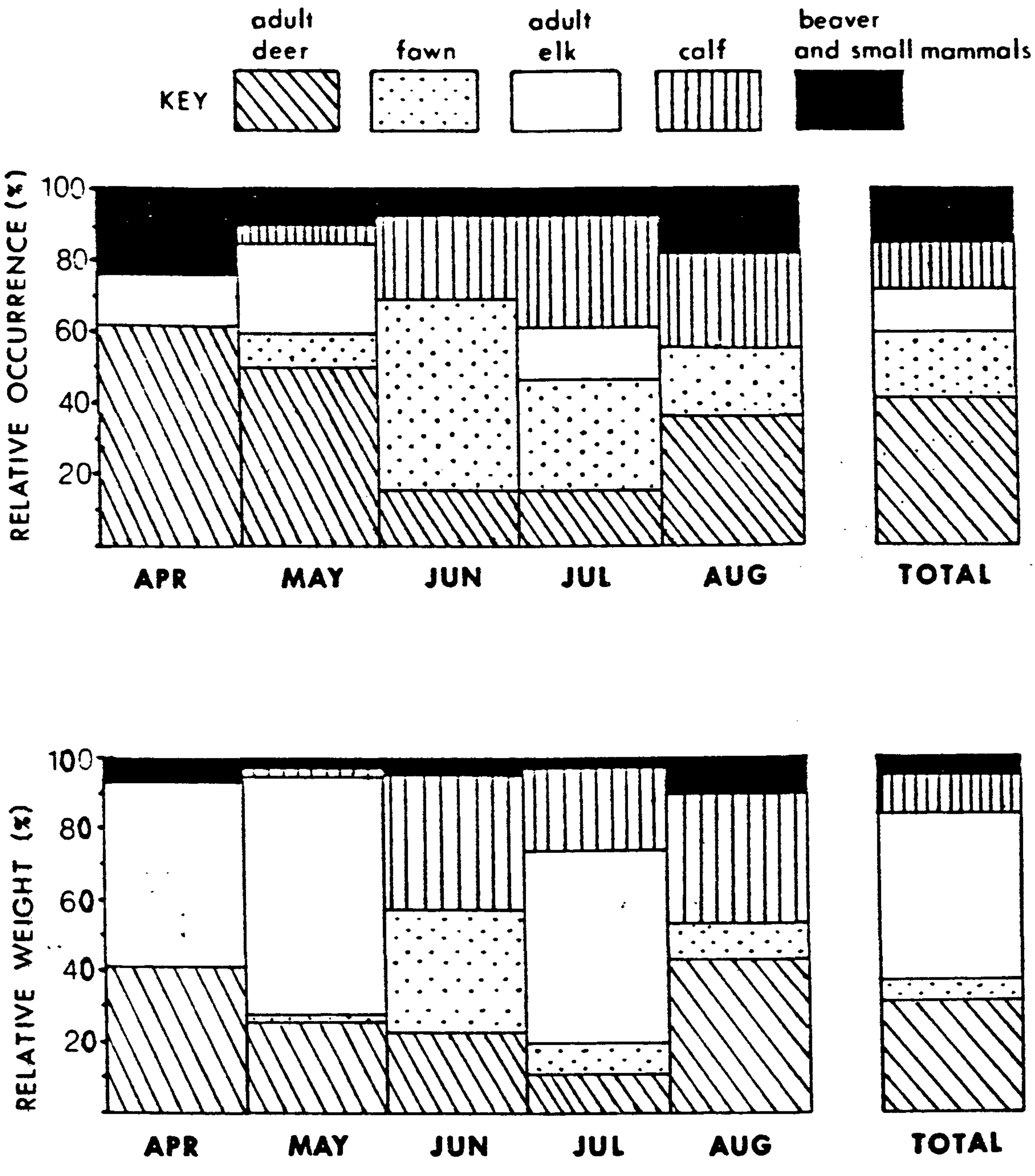


Figure 5. Contents of wolf scats (n=95) collected along logging roads, expressed as both frequency of occurrence (%) and relative weights (%) (from Becker 1982).

Late winter/early-spring calf:cow ratios collected over the past decade were significantly related to winter severity (Fig. 4). Similar to most ungulate species in north temperate regions, overwinter mortality primarily due to malnutrition is a major limiting factor. Female elk with kidney fat indices of 8 percent or less, reported in Table 1, were all collected during the very severe winter of 1968/69. Quality of winter habitat is thus a major issue of elk management of Vancouver Island.

Investigating the effects of predation on ungulate populations on Vancouver Island has received great attention over the past decade, especially the impacts of wolf predation on black-tailed deer. The information indicates that wolves have caused severe declines and are currently limiting deer populations (Atkinson and Janz 1986, Hatter 1984, Hebert et al. 1982, Janz and Hatter 1986, Jones and Mason 1982). The impact of wolf predation on elk numbers is less certain. Scat analysis has documented that wolves use elk and beaver as alternate food sources (Scott and Shackleton 1982, Becker 1982; Fig. 5). Evidence of depressed late winter calf:cow ratios has been associated with increased wolf activity in specific watersheds. For example, the relatively low figure of 26 calves:100 cows observed in the Grilse herd in 1984 under mild winter weather conditions (Fig. 4) was likely the result of wolf predation. Annual surveys of deer, elk, and wolf numbers suggests that in areas where deer populations have been declining due to wolf predation, wolves increase their use of elk as an alternate prey species where available. Under mild winter conditions, these situations have resulted in depressed elk recruitment for a two to three year period. Although wolf densities eventually decline, the availability of alternate prey maintains the predation pressure on the suppressed deer population. Elk vulnerability to predation during more severe winter conditions would likely increase due to increased concentration on the winter ranges, restricted mobility, and declining animal condition.

No evidence of debilitating parasites or disease infections has been documented in elk on Vancouver Island, although intensive examinations have not been undertaken. Seven species of parasites were identified in the examination of 22 elk between 1968 and 1972 (Table 6), none of which appeared to have serious pathological consequences (Blood et al. 1973). The most common parasite reported by hunters is the giant liver fluke (*Fascioloides magna*).

USE (HARVEST)

Historical records indicate that excessive market hunting, in combination with land settlement, reduced elk numbers and distribution in the early 1900's. The hunting season was closed in 1910 and remained closed until a bull season was opened in 1954. Seasons were gradually extended and an antlerless harvest was initiated in certain areas from 1961 to 1968. The season was terminated in 1971 due to declining numbers associated with possible overharvest in accessible watersheds, increased hunting pressure, and adverse winter weather conditions concomitant with the liquidation of most old-growth stands on low elevation winter ranges, especially on southern Vancouver Island.

Table 6. Occurrence of 7 species of parasites in Vancouver Island elk.

Organ Examined	No. elk Examined	No. elk Infected	Degree of infestation*			Parasite
			L	M	H	
Pelage	21	13	8	4	1	Dermacentor albipictus
Pelage	21	1	1			Lipoptena depressa
Lungs	20	5	2	3		Dictyocaulus viviparus
Liver	21	12	4	7	1	Fascioloides magna
Heart	16	0	0	0	0	Nil
Abomasum	12	10	5	4	1	Ostertagia circumcincta
	12	2	2			Nematodirus helvetianus
Small intestine	10	1	1			" "
Caecum	15	6	5	1		Oesophagostomum venulosum
Large intestine	8	1	1			" "

*L = light; M = moderate; H = heavy

Hunting seasons were reinstated in 1977 in response to both the acquistion of more detailed data on population status and general species biology, and public demand. A limited entry hunt (LEH) harvest strategy was favoured over various open season options to restrict the number of hunters on a herd-unit basis and provide a quality hunt experience. Most bull permits allow the hunter to take either a spike or 5-point plus animal, with the season open from early October (following the peak of the rut) to mid-November. About 30 percent of the available permits are allocated to late season (early to mid-December) antlerless hunts. A few either sex, any age permits are directed to areas of elk-agriculture conflicts.

Demand for elk hunting opportunities is very high as evidenced by the number of applications for permits (Table 7). Odds of being drawn in various zones range from less than 5:1 in the more remote watersheds to over 100:1 in accessible watersheds close to the larger communities. Success rates are relatively high, approximately 75 percent for the predominately accessible hunt zones and a mean of 68 percent for all hunters from 1977 to 1984 (Table 8). Corresponding effort per kill levels are low, averaging 7.5 hunter days/kill.

The majority of the bull elk hunters select multi-branched animals over yearling spikes (6:1). The proportions of the 5-point antler conformation class and the 6-point or greater class are similar, and together contribute the majority of the multi-branched bull harvest (Table 9). The relationship between age class and antler conformation is quite variable (Table 9), however broad groupings are apparent. Over three quarters of 5-point bulls are three to five years of age, two-thirds of the 6-points are four to six years, and two-thirds of the 7-point bulls are six to nine years of age. Mean age of adult bulls harvested over the 1977-84 period ranged between five to seven years of age. Over 30 Vancouver Island elk score greater than 280 by the Boone and Crockett Club scoring system, with the number one animal scoring 361 4/8.

Of major management concern is the extent of illegal harvest on many elk herds. Known poaching losses approach 50 percent of the legal harvest, with total illegal kill likely in excess of 100 percent. In addition, recent court decisions allow treaty Indians to hunt year-round on traditional hunting areas (encompassing approximately one-third of the Island) with virtually no control on hunting methods. The elk harvest from this source, presently unregulated, also confounds enforcement activities when responding to reports of hunting out-of-season and pit-lamping.

Resource Values

The economic value of the elk hunting on Vancouver Island in 1984 was estimated to be $48,500, based on a willingness-to-pay figure of $46.00 per day (Reid 1985). Estimated actual expenditures exceeded $50,000. Because of the excess demand and restricted opportunities to hunt elk, values would be much higher than indicated above if based on open bidding for the LEH permits. The high success rates and low number of hunter days also contributes to a relatively low total economic value.

The economic value of various non-hunting wildlife activities by Vancouver Island residents exceeded $37.5 million in 1984 (Reid et al. 1986). Approximately 50 percent of participants were involved in activities associated with deer and elk. Residents also indicated that deer and elk ranked second behind sea mammals as the wildlife group they were most interested in.

Table 7. Supply (number of limited entry hunt permits) and demand (number of applications) for elk hunting opportunities, 1977 to 1985.

Year	Number of permits	Applications (first/only choice)
1977	95	2,231
1978	73	1,159
1979	73	2,090
1980	186	3,227
1981	211	4,521
1982	221	5,569
1983	207	5,369
1984	207	6,936
1985	237	6,817

Table 8. Summary of harvest statistics for Vancouver Island, 1977 to 1984.

Category	Number of Permits	Number of Hunters (% of Permits)	Number Harvested	Elk/Permit Success (elk/hunter)	Hunter Days	HD/Kill
Total	1,273	1,094 (86)	741	.58 (.68)	5,535	7.5
A/L only	388	342 (88)	263	.68 (.77)	1,510	5.7
Male only	861	730 (85)	471	.55 (.65)	3,885	8.2
Access:						
Open [1]	979	874 (89)	648	.66 (.74)	4,419	6.8
Limited [2]	183	118 (64)	22	.12 (.19)	654	29.7

1 Management units 5, 9 and 10.

2 Management units 12 and 13(A).

Table 9. Antler conformation by age for bull elk harvest, 1977 - 1984.

	Age Class																
Antler Points	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Unknown	Total	
3 - 5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.3%
4 - 4	8	-	-	-	-	-	-	-	2	-	-	-	-	-	1	11	
4 - 5	3	7	5	2	1	-	-	-	-	1	-	-	-	-	-	19	10.8%
4 - 6	-	-	1	1	2	-	-	-	-	-	-	-	-	-	-	4	
5 - 5	9	40	23	16	3	3	3	2	2	-	-	-	-	-	13	114	
5 - 6	-	4	3	7	1	1	2	-	1	-	1	-	-	-	7	27	
5 - 7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	45.6%
5 - 8	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	2	
6 - 6	-	-	13	10	10	1	2	3	1	1	1	1	-	1	5	49	
6 - 7	-	-	4	6	5	4	5	1	-	2	-	1	-	-	7	35	
7 - 1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	
7 - 3	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	
7 - 7	-	-	2	2	10	4	4	4	3	-	1	1	-	-	3	34	43.4%
7 - 8	-	-	1	-	1	3	-	2	-	1	-	1	1	-	1	11	
8 - 8	-	-	-	1	-	1	-	-	-	-	1	-	-	-	-	3	
8 - 9	-	-	-	-	-	1	-	-	1	-	1	-	-	-	-	3	
9 - 9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total	20	52	52	45	35	19	16	12	11	5	5	4	1	1	38	316	

HABITAT RELATIONSHIPS

Movement behavior and habitat use relationships have been investigated in two study areas differing in logging history. The Adam River herd, studied over the period 1975 to 1978 (Janz 1980, 1983), inhabits a recently developed watershed consisting of old-growth stands, early seral stages and young regenerating forests. The Greenstone and Grilse Creek herds, studied over the 1981 to 1985 period as part of the IWIFR program (Youds et al. 1985), inhabit watersheds that have been essentially liquidated of low-elevation old-growth forests over the past 50 years. All three herds are migratory and summer in higher elevation natural openings and recent logging cutovers (Table 10).

Movement Behavior

Seasonal home range size (100 percent convex polygon) varied considerably among the different herds, apparently in response to the abundance and distribution of forage resources. For example, summer home ranges of the Grilse herd were smaller than winter home ranges and elk density was correspondingly higher on the summer range, where the majority of animals used a habitat complex of early seral/old-growth forests that is relatively concentrated in spatial pattern. Summer food patches on the Greenstone and Adam summer ranges are more widely dispersed, especially in the Adam where the majority of forage areas consisted of small, natural openings interspersed in old-growth forests (Table 10).

The percent reduction in home range size when including only 90 percent or 50 percent of animal locations reflects the spatial distribution of resources and subsequent movement behaviour of animals. For example, the 90 percent summer home range of the Adam herd is 26.4 km^2 (64 percent of the 100 percent home range size) and only 1.0 km^2 (2.4 percent of the 100 percent home range) for the 50 percent home range. Similar figures on the winter range are 7 km^2 for the 90 percent home range and 1.1 km^2 for the 50 percent home range (59 percent and 9.3 percent of the 100 percent home range size, respectively).

Habitat Use

Proportional use of the major elk habitat types in the Adam watershed indicate high use of old-growth forests throughout all seasons (Fig. 6). Young regenerating cutovers were used primarily for foraging during the winter, with old growth providing adjacent escape and thermal cover (bedding sites), although foraging also occurred in this habitat (Janz 1980). Natural openings provided the majority of feeding activities as green-up progressed and the animals moved to higher elevations. Old growth appeared to function primarily as thermal cover on the summer range. Animal activity declined and use of old-growth habitat increased as summer temperatures increased. During ambient temperature ranges of 6 to 15°C, approximately 75 percent of animal locations were active, whereas only 50 percent were active when temperatures were above 16°C. Activity dropped to 20 percent or less when temperatures exceeded 21°C in late summer.

Table 10. General summer and winter range characteristics for three migratory elk herds on Vancouver Island.

Watershed/Herd	Summer	Winter
Grilse Creek (1981-1984)	- 50% logged; 1-10 year regen; no juvenile spacing. - wide U-shaped valley. - numerous small bogs interspersed in old growth. - vegetated slides near headwaters. - herd range area approximately 20 km^2. - elk density approximately 6.5 elk/km^2. - cow 100% home range size: 6.5 km^2 (3.5 - 11.1; 6)[1]	- 90-95% logged; 8-45 year old regen; limited juvenile spacing 10-15 years old. - wide valley bottom and gentle slopes. Riparian and bogs along major drainage (Salmon River). - herd range approximately 30 km^2. - elk density approximately 4.3 elk/km^2. - home range size: 20.5 km^2 (2.2 - 43.8; 5).
Greenstone Creek (1981-1984)	- 50-75% logged; 2-20 year regen; no spacing. - steep E aspect with numerous bogs on benches. - no vegetated slides. - herd range area approximately 25 km^2. - density approximately 3.6 elk/km^2. - home range size: 29.2 km^2 (1).	- 95% logged; 5-50 year regen (primarily 35-45 years). - large blocks of backlog spacing (1979-1983). - gentle rolling topography with some S aspect slopes. - numerous bogs, deciduous stands, and seepage areas interspersed in second growth. - herd range approximately 30 km^2. - elk density approximately 3.0 elk/km^2. - home range size: 6.2 km^2 (2.2 - 9.9; 4).
Adam River (1975-1978)	- 10-15% logged; 1-10 year regen; no spacing. - numerous small bogs interspersed in old growth. - vegetated slides near headwaters. - herd range area approximately 50 km^2 - elk density approximately 1.6 elk/km^2 - home range size: 41.2 km^2 (4.0 - 90.8; 7)	- 50-60% logged; 1-20 year regen; no spacing. - wide U-shaped valley. - few low elevation bogs. - herd range approximately 40 km^2 - elk density approximately 2.5 elk/km^3 - home range size: 11.8 km^2 (4.0 - 22.5; 7).

1 Mean (range;n)

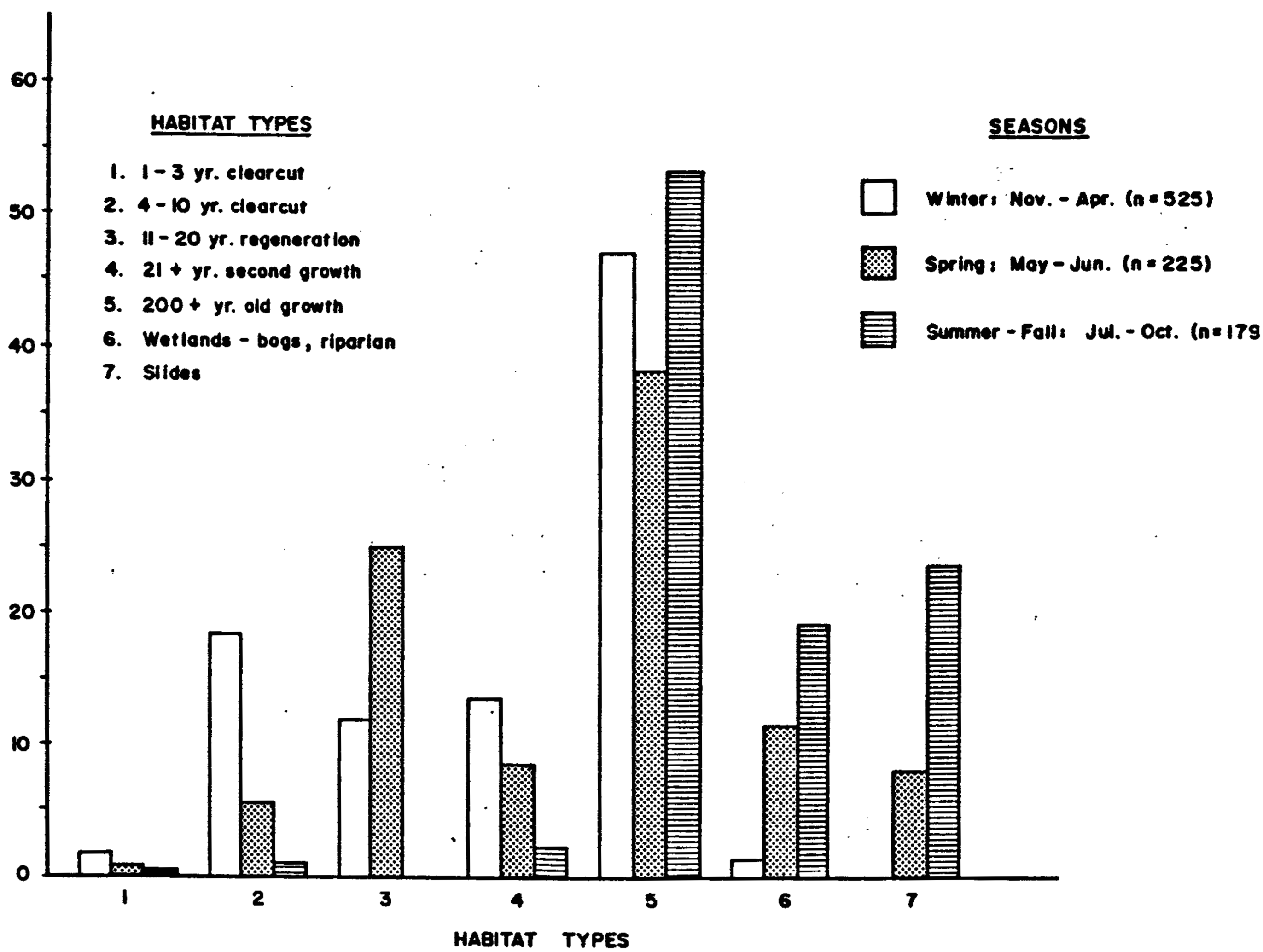


Figure 6. Proportional seasonal habitat use by elk in the Adam River watershed, 1976 - 1978.

On the winter range of the Greenstone herd, non-productive forest cover (bogs, rock bluffs), mixed deciduous - coniferous types, and 21 - 60 year second-growth were selected whereas recent cutovers and spaced second-growth stands were avoided. Old growth was used in proportion to availability, although this habitat type was very limited (1 percent) and widely dispersed in small pockets (Youds et al. 1985; Fig. 7). Comparing winter habitat use between the two study areas, similarities between high use of old growth in the Adam and high use of 21 to 60 year second growth in the Greenstone are apparent. Unfortunately, relatively mild winter conditions over the period of investigation has not allowed evaluation of animal condition and population performance during periods of stress between these two habitat types.

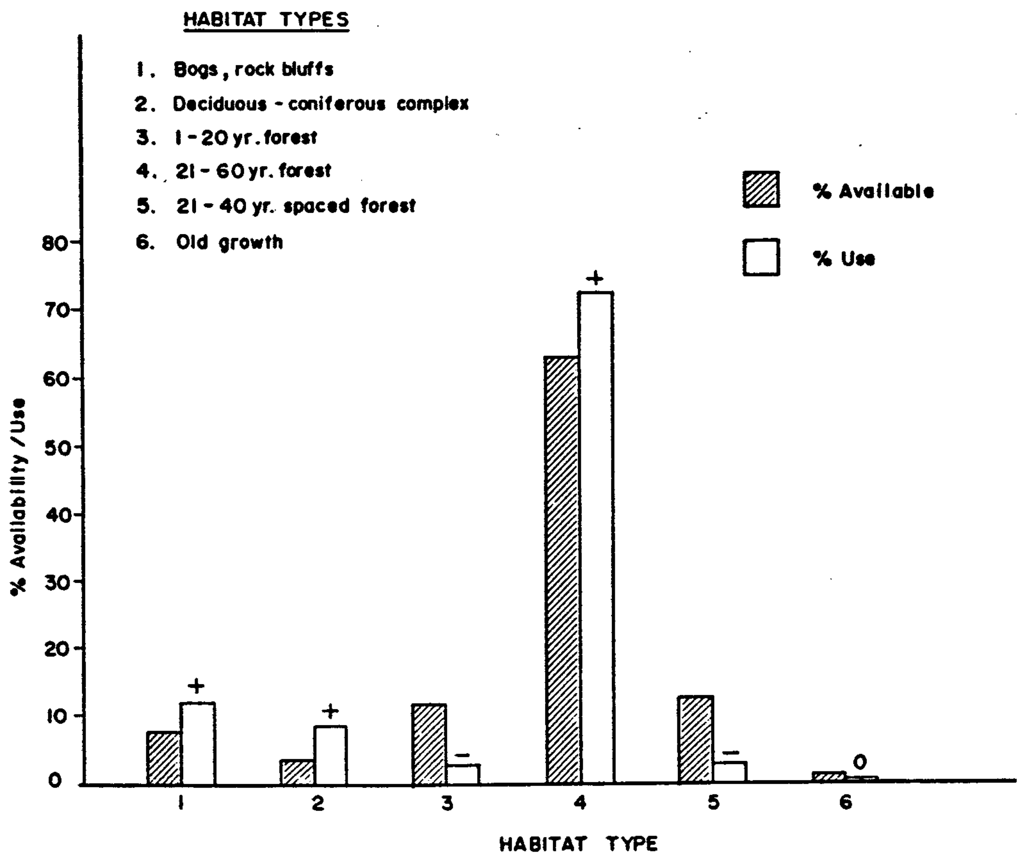


Figure 7. Percent availability - use and selection of winter habitat types by the Greenstone herd, 1983 and 1984. Selection based on Bonferroni-chi-square analyses ("+" = preference, "-" = avoidance, "0" = no selection).

A series of four-day intensive (24-hour) monitoring sessions on the Greenstone winter range further illustrates the relationship between home range size and availability of forage resources within the home range (Fig. 8). During low

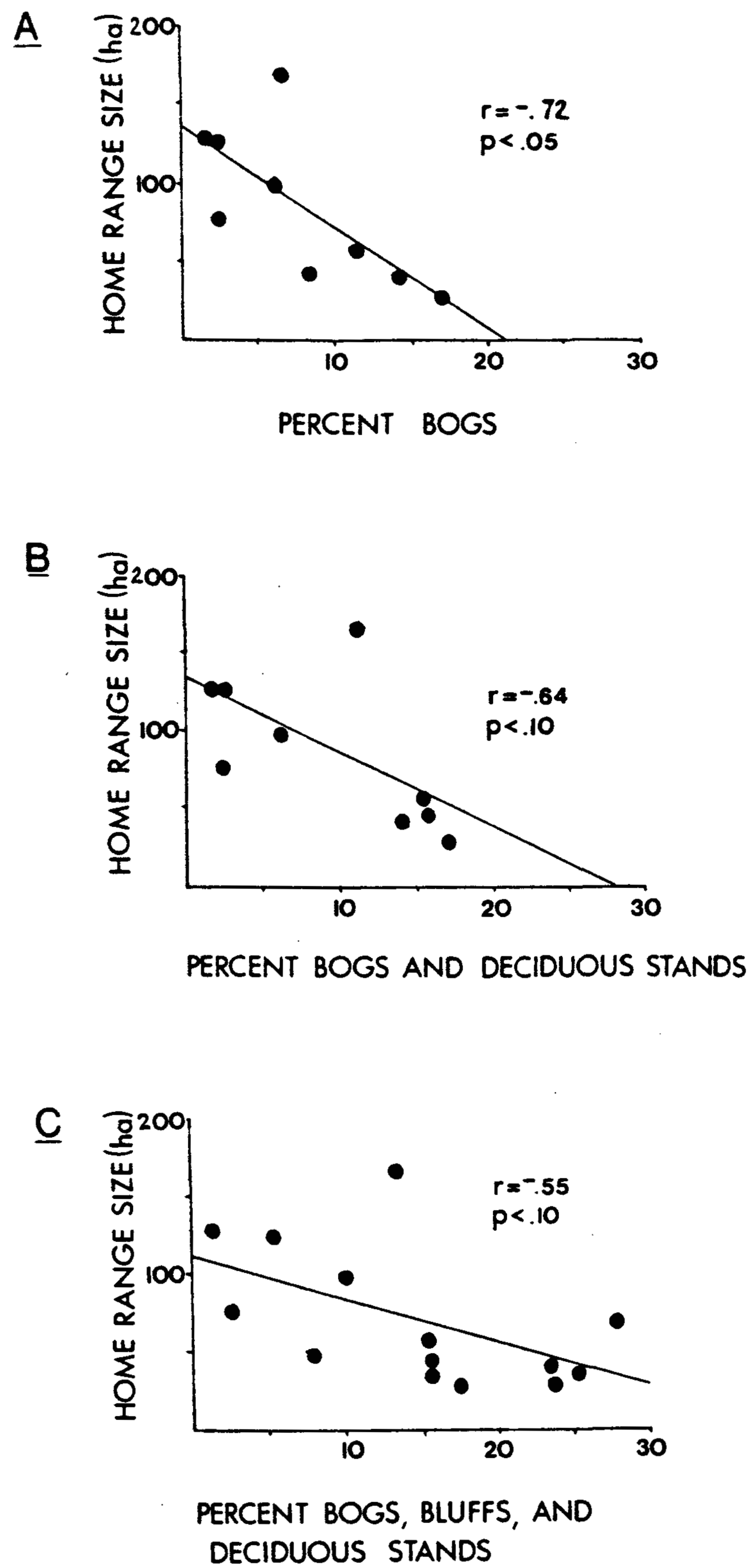


Figure 8. Relationships between 4-day home range size and (A) the percent bogs, (B) the percent bogs and deciduous stands, and (C) the percent bogs, bluffs and deciduous stands within the home range (from Youds et al. 1985).

snow conditions, the proportion of bogs is inversely correlated with home range size, suggesting that the carrying capacity of a mild winter range increases with the proportion of bogs. The importance of deciduous and bluff habitat types likely increases with deeper snow depths, although more information is required to verify these relationships.

Results from the above studies and other pertinent research projects have been used to develop a habitat suitability model for Roosevelt elk in southwestern coastal B.C. (Brunt and Ray, this volume). Various relationships, including topographic and inherent site characteristics, forage abundance, and interspersion and ratios of forage and cover types have been developed to assess seasonal elk habitat suitability in order to assist forest and wildlife managers in the preparation and evaluation of forest development plans.

Diet Quality

In addition to habitat relationships, information has been collected on food habits, diet quality and animal condition relationships (Janz 1983, Youds et al. 1985). Important seasonal forage species have been summarized by Brunt and Ray (this volume). Seasonal dietary estimates of crude protein content appear to meet animal requirements, as do levels of calcium and phosphorus (Janz 1983; Fig. 9). Estimated diet dry matter digestibility values, however, indicated deficient energy levels over the winter. As fecal crude protein values were related to diet quality (Fig. 10), the duration of submaintenance diets can be monitored and related to population performance. As an index of diet quality, fecal nitrogen may also be useful to compare relative animal condition between herds occupying seasonal ranges that differ in habitat composition.

MANAGEMENT IMPLICATIONS

Public demand for both hunting and non-hunting activities associated with elk on Vancouver Island is high. Thus, management priorities for the species must be aimed at increasing animal supply and determining optimum use levels. Transplanting animals into suitable habitat is a proven technique for increasing elk distribution and abundance, although efforts to increase elk numbers are ultimately related to forest management. The impact of various harvest patterns and silvicultural regimes on elk habitat will be aided by the development of tools such as management handbooks and habitat suitability models. Use of these tools on a routine basis by foresters and biologists will be required to plan forest development in a manner that promotes integrated management. Application of the model and formulation of specific prescriptions to enhance elk habitat must be priorized by watershed to ensure the greatest return of benefits. Current efforts by the Wildlife Branch at developing population objectives by supply/demand analysis will identify high priority management units and watersheds for planning purposes.

Transplant activities provide opportunity to test and further refine the existing model. Also, incorporation of temporal aspects of habitat change and pattern will be required to project the future consequences of various management scenarios. In order to relate habitat prescriptions and habitat quality to population objectives, correlations between model outputs and

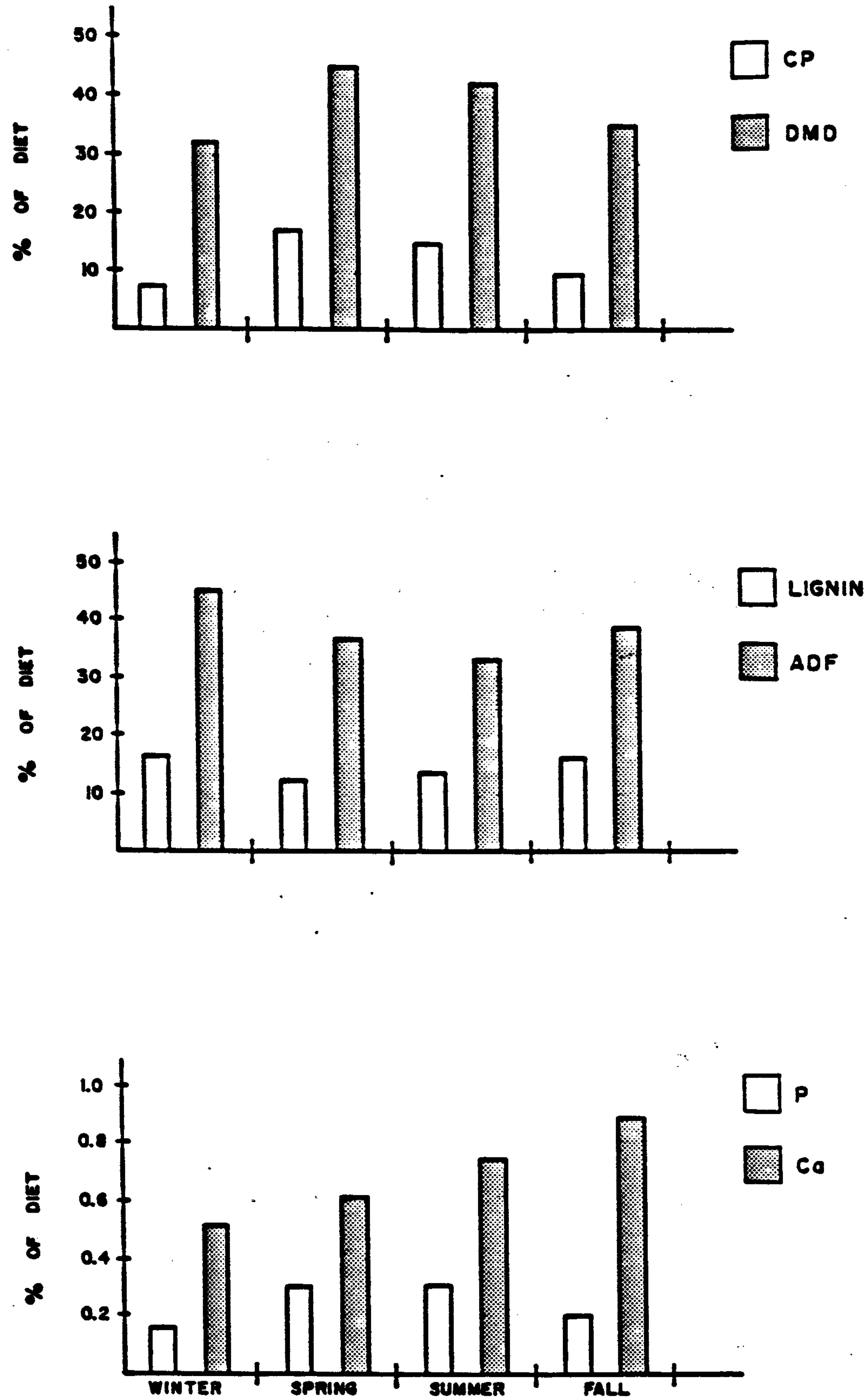
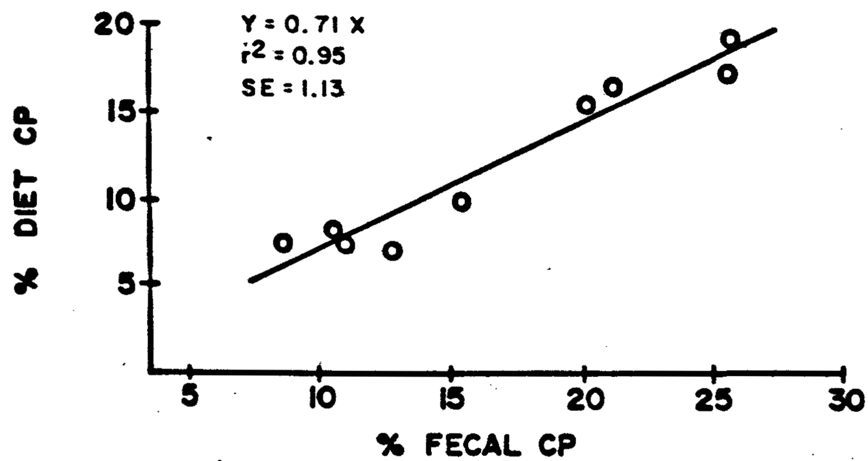


Figure 9. Estimated nutrient levels in seasonal elk diets on Vancouver Island, 1975 - 1978.



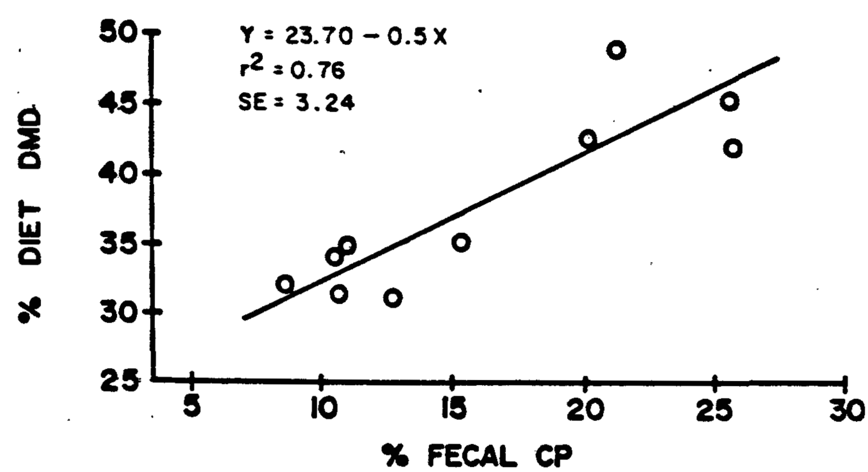


Figure 10. Relationships between fecal crude content and estimated crude protein content and dry matter digestibility of seasonal diets for elk on Vancouver Island, 1975 - 1978.

density or other indices of population dynamics must be investigated. Our ability to answer foresters' questions relating to the amount of specific habitat components required to produce and maintain a target population will remain poor until these relationships are better understood. Simply, we want to be able to predict not only the change in habitat suitability over time but also the corresponding change in elk numbers. Recreational benefits associated with the resulting population could then be used to help evaluate cost-effectiveness of the various prescriptions.

The existing harvest regime has probably been in place long enough to allow a more intensive analysis of estimated harvest rates and effects on population status. Together with the information on natality and natural mortality, including predation, various scenarios should be simulated to explore alternate harvest strategies and resultant population performance and recreational use. The present LEH harvest system offers opportunity to implement various harvest tactics in specific watersheds under conditions of controlled hunter effort and animal selection. More effort should be directed at securing better census data of the living population to monitor the impacts of various harvest levels.

Implementation of a wolf control program on Vancouver Island, designed to allow recovery of important deer herds (Janz and Hatter 1986), will also increase elk recruitment in certain watersheds. Efforts to reduce poaching and unregulated harvest must entail a variety of activities, including increased public education and involvement in assisting the limited enforcement capabilities, increased deterents in the form of harsher penalties for convictions, and use of access control in problem areas.

Agreement and compliance to harvest allocation and regulations by all user groups is required to ensure the success of present and future elk management programs on Vancouver Island.

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DISCUSSION

Question: I'd like to ask if you have any information on black bear mortality upon elk calves.

Answer: We know black bear and cougar are taking some of our elk calves. Again, based on our scat analysis, black bear predation on young deer fawns and calf elk during the month of June is less than 5 percent of the wolf diet during that time. In terms of more quantified information, we don't have it for elk but we have some for deer. On fawns that were collared with collars detecting cause of morality, black bear predation on the deer fawns was relatively insignificant compared to wolf predation. So, we know that black bear and the cougar predation exists and is an additive mortality factor, but it's relatively insignificant in terms of population regulation or population control.

Question: We look forward to your manuscript. I think you've got a lot of really good information in there and with that manuscript, we'll have a chance to really look close at what you've presented us.

Answer: That was one of my objectives for throwing out some of this information that we've collected and getting your feedback on it. It's just another lesson. I think when we go back home we're going to try working on our slides a little more!

INFLUENCE OF SNOW ON WINTER HABITAT USE BY ELK IN THE NORTH FORK OF THE FLATHEAD VALLEY, MONTANA

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Abstract: Winter habitat use patterns of elk varied with snow conditions in the North Fork of the Flathead Valley, Montana. Elk preferred mature coniferous forests when snow depths exceeded 60 cm, and open-canopied vegetation when snow depths averaged 40 cm. Implications for managing floodplain forests on elk winter range are discussed.

Winter habitat use patterns of elk were investigated in the North Fork of the Flathead Valley along the western boundary of Glacier National Park, Montana. Preferences for vegetation types, vegetation structural characteristics and snow depth classes were evaluated during January to May 1982 and 1983 by counting fresh elk tracks along a 110 km survey course. Chi-square analyses and Bonferroni z - tests were used to identify which habitats were selected by elk in proportions greater or less than their availabilities. Annual differences in snowpack provided an opportunity to compare habitat use patterns during a harsh winter and a mild winter when snow depths averaged 90 cm and 40 cm, respectively. It was hypothesized that cover selection patterns of elk would reflect annual and seasonal differences in snow depth.

Seventeen discrete vegetation types were identified for the analysis of habitat use. Vegetation communities on active floodplains comprised a sere from pioneer and mid-seral cottonwood communities on young river terraces to old-growth spruce forests on older terraces. On adjoining upland terraces, even-aged lodgepole pine forests occupied sites that burned in the early 1900's, whereas Douglas-fir dominated sites that escaped recent wildfires. Grasslands, shrub, and aspen communities occurred sporadically among the coniferous forest types. Selectively cut spruce stands and clearcut or selectively cut lodgepole pine stands occurred in the study area outside Glacier National Park.

Habitat preferences of elk differed between years ($P<0.05$). During the snowy winter, elk selected open-grown lodgepole pine and late-seral spruce and Douglas fir stands. In a comparatively mild winter, elk also favored open lodgepole forests, but they selected other open-canopied vegetation, including cottonwood-spruce, cutover spruce, and grassland communities, rather than late-seral coniferous forests. Elk also demonstrated a greater preference for gravel bar/shrub communities and cutover lodgepole forests during the milder winter. Lodgepole pine and larch stands were avoided during both winters.

Principal components analysis was used to identify two independent gradients of vegetation structural characteristics for the evaluation of elk habitat preferences. Gradient analyses were based on vegetation measurements in 102 stands along the elk survey course. The first component corresponded to a successional gradient of overstory coniferous development, marked by early successional characteristics at one extreme (e.g., small trees, open canopies, low structural diversity), and climax characterisitics at the other (e.g., large trees, dense canopies, high structural diversity). The second component corresponded to a gradient of shrub development. Habitat preferences of elk were correlated to the successional gradient ($P<0.05$) during a snowy but not a mild winter ($P>0.05$). Vegetation use was unrelated to shrub development ($P>0.05$), which perhaps reflected the diverse dietary preferences of elk or the influence of prevailing snow depths on winter availability of browse.

Snow depths were measured during each track survey. During a harsh winter, elk occupied areas with up to 80 cm of snow, but preferred areas with less than 60 cm. In a mild winter, when areas of shallow snow were more available, elk avoided areas with greater than 60 cm of snow.

Visual observations of elk were used to document seasonal shifts in habitat selection. Elk were observed primarily in coniferous forests during a harsh winter and open-canopied communities during a mild winter, which corroborated results based on track counts. As snow depths diminished each spring, elk favored open-canopied communities, especially grasslands and cutover stands.

In conclusion, habitat use patterns of elk varied in response to a changing snowpack. Mature bottomland forests were important winter habitats of elk during severe winters, but open-canopied communities were preferred when snow averaged 40 cm deep. Floodplain spruce forests comprised a small proportion of the elk winter range, but provided a unique interspersion of important cover and forage values for elk during periods of deep snow. Therefore, logging in floodplain spruce stands would likely reduce habitat quality for elk on winter ranges where maximum snow depths exceed 60 cm during severe winters. Select cutting, however, may temporarily increase forage production that would benefit elk in areas of less snow, providing that cover was not limiting. Because elk avoided lodgepole pine forests during winter but used cutover stands during spring, block-cutting in lodgepole pine forests may enhance spring range. Effects of habitat modifications on white-tailed deer and moose, and on elk population densities within Glacier National Park are additional important considerations for land-use planning along the North Fork of the Flathead River.

We extend our thanks to P. Happe, B. Griffith, J. Peek and C. Martinka for their assistance throughout our study. This research was supported by funding from the Environmental Protection Agency and the National Park Service administered through the Cooperative Park Studies Unit at the University of Idaho.

DISCUSSION

Question: Did you see any crusting pattern differences between the different types on the snow?

Answer: It's very good point. Not consistently and that was the difficulty that I had. I had a hard time quantifying it because the differences in crusting patterns seemed to vary from time to time. I should also point out that crusting, obviously, is a very important component of habitat selection. It's not just snow depth. I didn't address this in this talk for a couple of reasons. First of all, crusting patterns were extremely variable. Often times when I was out counting tracks, the crusting patterns were completely different than during the period that the animals were there laying down tracks. I do acknowledge the importance of crusting patterns.

ELK MANAGEMENT - NEW DAYS AND NEW WAYS*

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Prologue: Three men on horseback with three pack horses in tow had just topped out at 5,000 feet on the last mountain pass that separated them from their intended campsite down below in Oregon's Eagle Cap Wilderness Area. It was mid-November and the sun was low in the afternoon sky. The breath of the men and horses left foggy clouds in the air and steam hovered around the horses. Ice crystals glinted in the fading sunlight. The riders stepped down from their horses to adjust the breast collars, britchens and cinches for the downhill ride into the valley below. Down there was the campsite the hunters used each year during their elk hunt. As numbed fingers fumbled with the cold-stiffened leather straps, the shrill bugle of a bull elk cut through the stillness. The bull was so close the hunters could hear the grunts that followed the bugle. Then, from far down the drainage, another bull bugled. Suddenly the cold mountain was alive and vibrant--the spirit of the place was manifest. For these three men it was a rare and delicate moment of beauty and harmony. The hunting season did not open for two more days--but, no matter what ensued from this moment, the trip was a fulfilling experience. If there is a single species that personifies the forested mountains of the West, it is the elk. The three hunters that stood in that mountain pass were wildlife biologists--one retired, one with 30 years of professional service, and "the kid" with some 10 years in the game. Three generations of professionals heard those bugles and smiled knowingly at the others. Each felt privileged. They mounted their horses and descended into the valley.

THE END OF AN ERA

The period from 1900 to 1980 was a great time for elk managers as one of the great success stories of wildlife management unfolded. Elk numbers in the United States increased from some 3,300 in 1935 to about 104,000 in 1979. The number of elk hunting licenses and tags increased from less than 1,000 in 1930 to 755,179 in 1979. There was success beyond the wildest dreams of the early elk managers.

But now, there seems to be increasing trouble in maintaining elk habitat and regulating hunting activities along with a great indecision among those who are responsible for elk management--population and habitat--of how, or even whether, to react to emerging economic, social, and political trends. The times, indeed, are changing.

Wildlife biologists and administrators concerned with elk management, seeing these changes and fearing more, almost seem transfixed as they eye the uncertain future--almost like a rabbit that seems paralyzed watching an advancing snake. Many of those who react at all respond by adopting a reactionary stance and standing four-square for the old days and the old ways;

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* A presentation at the elk workshop banquet

never mind that those days are already past. Looking back for the good old days is useless; they are gone and will not return. Looking around for someone else to lead is not productive; we are, or should be, the leaders.

We have come to the end of an era. The milieu in which the successes enjoyed by elk managers from 1900 to 1980 were achieved has dramatically and forever changed over the past 10 years. The land-use planning activities of the USDA Forest Service marked the transition from one era to another in elk and associated natural resource management. Those planning activities made it painfully obvious, as Barry Commoner said, that "everything is connected to everything else and there is no free lunch." Of course, most people connected in more than a casual way with natural resource management really knew that. But the relatively piecemeal and segmented natural resource management that was the order of the day until this decade kept these obvious truths subliminal. In the 1970's and 1980's the planning process produced widespread recognition that choices had to be made about how the public's lands were to be managed, and for what, and that consequences--economic, social, and environmental--followed each allocation. The times, indeed, they were a-changing--and in a twinkling. It is a new day. Old ways alone and unaltered won't maintain elk in tommorrow's world. We must examine our modus operandi and produce new strategies to ensure that we can deal with the new days and new circumstances that are upon us.

I will discuss some trends in natural resource management that bear directly on the future of elk and elk hunting in North America. And I will suggest some new ways that might help to ensure that the continuing saga of elk management is one of success and achievement.

ELK--A PRODUCT OF NATIONAL FORESTS

Some 94 percent of the elk in the United States in 1979 resided for at least part of the year on national forests managed by the USDA Forest Service. Less than 10 percent of the areas on national forests occupied by elk in 1979 are likely to end up with legal classification as Wilderness. It is blatantly obvious, then, that the fate of elk and elk hunting in the United States depends largely on how national forest lands committed to multiple-use are managed and how the hunting of elk on those lands is handled.

Most persons concerned with the welfare of elk and elk hunting, and that includes wildlife biologists, have not fully recognized that the future of elk and elk hunting depends so heavily on management of national forests. This was illustrated by an incident in my hometown of La Grande, Oregon, some months ago. A local conservation group sponsored a workshop on elk management. A meeting room designed to accommodate 80 people was jammed with over 200, and many were turned away. The subject that brought out the crowd was a discussion about hunting regulations. Should the season open in mid-week or on a week-end? Should the season be this length or that length? Was there too much or too little concession to bow hunters? Should spike bulls be declared legal for hunters to kill? And so on.

One speaker finally stated that the points being discussed were a luxury afforded by the existence of a large elk herd that was, in turn, the product of abundant suitable habitat and that depended on how national forest's were managed. Further, the speaker pointed out that the Forest Service was producing plans for each national forest that, when executed, would have more effect on elk numbers and distribution and on elk hunting than any set of hunting regulations. Most of those at the meeting nodded agreement. But when the next round of meetings on the forest plans were conducted by the Forest Service, few were there to speak about elk habitat and elk welfare. This showed the public, even those most concerned about elk welfare, did not fully appreciate how critical the management of national forests would be to the future of elk in the United States.

MODELS FOR CONSIDERING ELK HABITAT IN MANAGED FORESTS

It seems fair to say that, no matter which management alternative is chosen for each national forest, the amount of land that is actually managed for the joint production of timber, forage, recreation, and wildlife will increase steadily and dramatically. Such forest management can be done in a variety of ways, and the way chosen can make all the difference to the future of elk and elk hunting. The clear challenge to wildlife biologists is to provide to forests well-founded models for evaluating elk habitat -- models that have been tested and validated.

Wildlife biologists must be absolutely clear and straightforward when describing the habitat evaluation models to be used. To do otherwise causes confusion among natural resource managers and leads to the loss of credibility for wildlife biologists. For example, I have been asked, rather forcefully, to explain how elk habitat evaluation models prepared by different biologists in different areas came to be so different. In one particular case, the answer was simple. One model described elk habitat with the caveat that it was not designed to protect elk during hunting season or to produce desired levels of hunting quality. The other model has as its prime objective the production of a hunting situation where hunters could hunt a long season but with a large number of mature bulls surviving the hunting season. Both models were conceptually acceptable and seemed likely to produce the anticipated results. But they were very different and designed to measure different things. One was a model for producing elk and the other was a model for producing a desired hunting situation. The trouble was that the managers who had to use the models did not know that, perhaps because the biologists did not explain it clearly. As a result, the credibility of all wildlife biologists was called into question by the forest managers that considered those models.

ELK AND ECONOMICS

Wildlife does not receive the same degree of emphasis, particulary in terms of funding and personnel assigned in public land management as do commodities such as timber and forage. A regional forester of the Forest Service put it this way: "Today it's a matter of dollars and cents. That makes it tough on uses that don't produce income, such as recreation."

I suspect that most, if not all, wildlife biologists interested in elk management agree that wildlife management on public lands is receiving less attention than they, as wildlife biologists, would deem appropriate. And, most think that a more balanced program of natural resource management would enhance the long-term outlook for wildlife, and certainly for elk, on the public's lands. Can a more balanced management program be achieved?

We heard a stimulating and well-done debate at this workshop entitled "On The Notion of Charging a Fee to Hunt on the Federal Lands." In this debate, two of our astute and articulate colleagues explored the details of the argument, pro and con. Two ways appear likely to assure adequate attention to the production of elk and elk hunting from public lands-- either make it pay in returns to the land or insure adequate attention to and resources for elk and elk habitat management through the political process, or both. My instincts and experience tell me that directing attention to elk requirements through the political process is declining in effectiveness. To make elk and other big-game hunting produce revenues for landholders (in this case, the Federal Government) has, I believe, the best long-term chance of success. Commodities don't always win over amenities when compromises are made--but, over the long run, it is the way to bet.

Many political scientists and pundits proclaim that the way that the American people see things--in terms of how government activities are formulated, executed, and funded--has fundamentally changed. This change has led to increased emphasis on balanced federal budgets and a greater and increased reliance on such techniques as "user pay" to fund federal and state programs. These are new days, and we must look for new ways to gain objectives for wildlife--in this case elk. Shakespeare had one of his characters say: "There is a tide in the affairs of men, which taken at the flood, leads on to fortune; Omitted, all the voyage of their life is bound in shallows and in miseries. On such a full sea we are now afloat, And we must take the current when it serves, Or lose our ventures" (Julius Caeser, Act 4, Scene 3). These new days may represent a chance for wildife professionals and those of our constituents who are big game hunters to seize such a moment and make something profitable and long-lasting happen for big game and big game hunters. That can happen if we lead and make fee-hunting happen in a way that yields maximum influence for those who are interested in wildlife. Such influence can yield long-term benefit to the wildlife resource.

Perhaps fee-hunting is not the best way to go. If not, we still need to recognize that new days are upon us. New ways are needed to assure that elk and elk hunting remain part of our culture. It is the obligation of wildlife management professionals to lead in the development and institution of approaches that ensure effectiveness in the continuing effort to maintain big-game hunting in these new days. What we cannot do, if we really value elk and what they represent, is to set firmly on our duffs with a laissez-faire attitude and a firm fixation on past accomplishments and impending change.

MONEY PROBLEMS--INCREASING COSTS AND DECLINING REVENUES

How are we going to pay for the increasingly intensive management of elk, elk hunters, and elk habitat that is increasingly required? Let us examine some trends. Elk and the range they occupy increased steadily from 1930 to 1980. Now the curves seem to have leveled out and even begun to decrease in some areas. More roads are being constructed into previously unroaded elk habitat which lead, in turn, to increased access by hunters. Numbers of elk hunters continue to increase faster than elk numbers and that has caused dramatic declines in hunter success rates over the long run in many cases. Funds for game management come largely from hunting license fees. Usually increases in those fees have not kept up with inflation, and shortfalls in funds required for management have been made up in most states by increases in license sales and higher fees for out-of-state hunters. That, my friends, is being caught on the horns of a dilemma. Intensified management increases costs. If regulation of hunter numbers (rationing of hunting opportunity) is part of intensified management, revenue is reduced. This problem is exacerbated by the usual reaction of reducing the number of out-of-state hunters first. But each non-resident hunter pays three to eight times more for a license and tags than does the resident hunter. So, reducing non-resident hunters reduces revenue faster than it reduces hunter numbers.

THINNING THE SOUP--LESS GOODIES FOR MORE FOLKS

There is still more trouble. To satisfy the burgeoning demand for elk hunting, managers have allowed hunter numbers to increase more rapidly than elk numbers. But this produced a cost that showed up in giving each hunter less and less to accommodate more and more hunters. Some of the machinations included acceptance of declining hunting quality, shorter hunting seasons, split seasons, heavier harvest of males, declines in numbers of trophy bulls, increased access to previously remote areas, distorted sex ratios, special weapons seasons, lowered hunter success, and so on. Facing that inevitable conclusion brings managers face to face with three serious problems. We are running short on quick fixes and hunter numbers must be increasingly controlled; decreased hunter numbers means decreased revenues; intensity and sophistication of management must increase--which, of course, costs more money. The equation simply does not balance.

Telling elk hunters that they cannot be guaranteed that they can hunt elk where they want, nor perhaps every year, will not make hunters happy. Turn the political heat up another notch.

Further, any reduction in hunter numbers leads to a direct decline in the value of elk in the planning and analyses of federal land management agencies. Those analyses usually merely count hunters times the average number of days hunted times the amount he or she would pay, if required to, for a days hunt. There are other methods, but in the end the value of elk is directly related to the number of hunters. Want to increase the value of elk in such an analysis? Pack in the hunters. Want to decrease the value? Reduce hunter numbers. There are no points scored in this game with considerations of quality.

But now, in several states, this string has been about played out; the twists and turns have been about used up. The point has been reached where game managers will increasingly have to limit hunter numbers. Decreased hunter numbers decreases revenue, while simultaneously increasing the intensity of management required which costs more money. The unbalanced equation strikes again.

LOOK OUT -- THERE IS TROUBLE AHEAD

But it goes further than that. My friend and respected colleague, James Peek of the University of Idaho, had a little fun in his talk to us earlier today at the expense of the Oregon elk situation. The hunting regulations in Oregon have led to sex ratios in adult elk being badly distorted with very few mature bulls. As an elk biologist that works in Oregon, I didn't mind the ribbing.

Why? Because he was right. But those of you from other states should feel neither smug nor very comfortable. Oregon is one of the first states where these problems have come into clear focus. But it seems likely that the other states where elk are hunted will have their turn--and sooner than most elk managers care to contemplate.

But, that is what makes Oregon a fascinating place to work in elk and elk-hunting management. The situation emerging in Oregon seems a likely harbinger of the future for most of the elk range in the United States. In terms of the old days and the old ways, Oregon is merely one of the first to reach the end of the biopolitical tether. Those of us in elk and elk-hunting management will be forced to regulate hunter numbers, intensify management of hunting, assure elk habitat in more intensively managed forests, control access for hunters and others, increase coordination with land management for timber and grazing, and find a way to pay for it in state and federal agencies. New days are upon us and it is up to us, the wildlife management professionals, to devise, sell, and institute the new ways--additional ways--of management and funding that will be required to sustain elk and elk hunting as part of the way of life in the American West.

Does that mean that I am pessimistic about the future of elk and elk hunters? Not one bit. Does that mean that we are going to have to do a better and different job of management? You bet.

Jim Peek coins some really good lines. He says sobering things with humor that makes the medicine go down. He chided us earlier today for being more and more inclined to forget or overlook in our management the welfare of the elk, about the cultural values of elk hunting, about ethics, and about dignity of the pursued and the pursurer. Dr. Peek is not the first to caution about such things. The daddy of our profession of wildlife management, Aldo Leopold, warned that "wildlife administrators are too busy producing something to shoot at to worry much about the cultural value of the shooting. Because everybody from Xenophon to Teddy Roosevelt said sport has value, it is assumed that this value must be indestructible." Those values are not indestructible. They are very fragile. We need to carefully consider where we've been, where we are, and where we are going regarding the cultural values of hunting.

Oh, I fully understand that such things as ethics and cultural values don't fit well into cost/benefit analyses or linear programs. But we ignore those values at our peril and at the peril of elk and other big-game animals. We ignore such considerations because, I think, somewhere in the evolving drama of elk and elk hunting management we have indeed forgotten the welfare of the animals, the deep cultural values of hunting, and the respect that the hunter owes to the quarry. Somehow as professional wildlife managers we have forgotten that elk are really a precious relic of our past preserved as part of the modern world to serve as the spirit of place and a link with hunters and hunted of a thousand generations. Elk and elk hunting are symbols that we, as a society, want to keep with us as we move into the future increasingly dominated by technology and a pervasive tameness and sameness.

When we allow, even encourage, hunting situations that essentially remove mature bulls as a functioning part of elk ecology, we need to carefully examine our motivation and rationale. When we allow the elk's highly evolved breeding ritual to essentially disappear in more and more places within one or two generations of our stewardship as elk and elk hunting managers we need to look closely at what we are doing. When we allow hunter densities so high that on opening day of the hunting season in more and more places groups of elk run from hunter to hunter until they stop, tongues lolled out, too exhausted to run any more, we need examine why we allow such to occur.

Have we become followers? Have we slipped into the role of functionaries who merely produce recreational hunting opportunities. Do we merely provide targets? Elk deserve better from us. Hunters deserve better from us. Our culture demands better of us. It seems to me essential that hunting shame neither the hunter nor the hunted.

We were dynamic leaders once. We can be such again. The times will change with or without us--but, we can influence those changes. We can and should speak for elk--for their welfare, for their dignity, and for their proper place in our culture. To paraphrase Leopold, we know that the autumn landscape in the Rockies is the land, plus the golden trembling aspen, plus an elk. In terms of conventional physics, the elk represents a small fraction of the energy or the mass of the living things. Yet substract the elk and the whole thing is dead.

Our role and our vocation should be to assure that the elk continue to bring life and the spirit of place wherever they are found. We and our predecessors have done well at that mission. But these are new days and it is up to us to develop, sell and employ, the new ways that will be required to maintain elk as part of the American landscape and culture.

EPILOGUE

One rider leading three pack horses and two men afoot, each leading a horse carrying manta packs lashed to the McClellan saddles, had just topped out at 5,000 feet on the first mountain pass they would cross on their journey from their camp in the valley below to the trail head some 20 miles in the distance. The manta packs contained four quarters of the carcass of a bull elk. The antlers were tied to the diamond hitch that held the panniers and top pack on one of the pack horses secure. It was late in November and early in the day. The men's clothes were dirty and beards were beginning to show on their faces--dark black on the younger men and grizzled gray for the older man. Each was a little thinner, as were the horses, than when they stood in this same spot two weeks earlier. Some six inches of crystalline snow lingered in the pass and the warm breath of horses and men hung in the air. As the men fumbled to tighten cinches and ropes that had loosened during the steep climb on the frozen trail from the valley below they heard, faintly but clearly and from far away, the shrill bugle of an elk. The men looked knowingly at each other and in communion of appreciation of what their experiences of the last two weeks. America still has the vast wild lands of the mountain West. And the living spirit of the place - the elk - not only survives but prospers there. Without the elk, the mountains would be beautiful and awe inspiring. But with the elk, and the other wild things, the mountains were alive and they were whole--a wonderful legacy made possible by the dedication of those who saw to it that the elk survived and prospered. The men knew that each generation must pass this legacy to the next generation. The fate of these places and the animals they harbor are entirely in the hands of people who care. The older man had made his choices, and he and his colleagues and allies had succeeded--for now. The two younger men, the "sons" and successors of the older man, along with their compatriots, would very soon bear the sole responsibility for their legacy.

The older man looked back once and stepped stiffly onto his horse. Two weeks of hard hunting and sleeping on the ground had exacted a temporary toll on old joints and muscles. The two younger men gathered up the lead ropes on the horses carrying the elk. The sun was fully above the horizon as they started down from the pass on the last 20 miles to the trailhead on the Minam River. Then they heard it again--the shrill, spine tingling bugle of the elk. Without a word, each of the men reaffirmed his choice for his life's work. That last bugle, always reverberating in the mind, sealed the bargain.

WESTERN STATES AND PROVINCES

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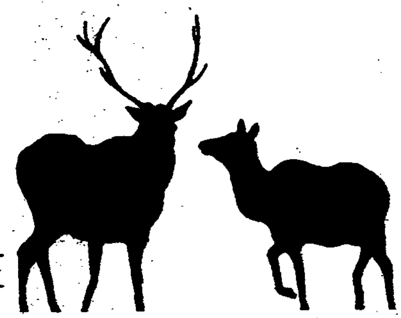

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