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Proceedings Of The Western States Elk Workshop

Province of British Columbia
Ministry of Environment

February 27,28,1980

Cranbrook, British Columbia

PROCEEDINGS OF THE
WESTERN STATES ELK WORKSHOP

Cranbrook, British Columbia
February 27-28, 1980

CHAIRMAN: Ken Sumanik - B.C. Fish & Wildlife Branch, Nelson, B.C.

EDITOR: W. Macgregor, B.C. Fish & Wildlife Branch, Victoria, B.C.

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ELK WORKSHOP PROGRAM

Meeting - Moderator - Dennis Demarchi

0900 Introduction, announcements - Ken Sumanik, B.C. Fish and Wildlife

0915 Welcome - Ray Halladay, B.C. Fish and Wildlife

0920 Update on elk management in the various states and provinces

1300 New Perspectives for Elk Management - Glen Smith, Victoria, B.C. (Oral Presentation only).

1345 Elk Management at Vermejo Park - Gary J. Wolfe, Vermejo Park, New Mexico.

1430 Disbenefits of Increasing Elk Herds in Colorado - Bob Hernbrode, Colorado Fish and Game (Abstract only).

1515 Coffee break

1530 Strategy for Elk Management During Intensive Oil and Gas Exploration in Alberta -Kirby Smith, Dept. of Natural Resources, Edmonton

1615 Importance of Quality Elk Herds to Guide-Outfitting - Don Peck, Albert Cooper and Hank Campsall, members of Western Guides and Outfitters (Oral Presentation only).

1900 Banquet - Guest Speaker - Ray Demarchi - B.C. Fish and Wildlife

Thursday, February 28, 1980

Moderator - Dr. Daryl Hebert

0830 Tuchodi River Elk, an Historical and Economic Perspective - Ross Peck, University of Idaho.

0915 Managing Elk in the Olympic Mountains - Jack Smith, Washington State Fish and Game

1000 Coffee Break

1015 Land Use Planning and Habitat Management on Critical Wildlife Ranges

1100 Roosevelt Elk - Forestry Interactions on Vancouver Island - Doug Janz, B.C. Fish and Wildlife, Nanamio

1130 Analysis of the Five Tag Elk Season in Washington State - Zeke Parsons, Washington State Fish and Game, Olympia

1200 Lunch break

1300 The Economics of Feedground Elk vs. non-feedground Elk in Wyoming - Ron Dean

1345 State Involvement in Wildlife Issues and National Forest Land Use. Tom Leege, U.S. Forest Service (Oral Presentation only).

1415 Integration of Elk Management in Montana - Terry Lonner, Bozeman

1500 Coffee break

1515 Elk Management on the National Elk Refuge - Russell Robbins, Jackson, Wyoming

1600 Current Elk Management and Research in New Mexico - Dusty Hunt

Editors Note: No written manuscripts were submitted for the three talks marked "Oral Presentation only." Only an abstract of the paper on "Disbenefits of Increasing Elk in Colorado" is included because of space limitations.

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February 27-28, 1980

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INTRODUCTION

Conventional elk management to most wildlife biologists is a pleasant responsibility. Gathering and processing biological information; establishing harvest plans and preparing flexible regulations in order to achieve proper harvests becomes a permanent and important list of activities. Research becomes an integral part of this process and ultimately it serves to facilitate the greatest production and allocation of elk to specific users.

However, over the years we have been led to believe that the limits to elk management were largely technical and we poured large sums of money and time into expanding our technical base.

Competing land uses and social and economic constraints have evolved quickly and in the coming decade will bring very serious problems to bear on elk populations in the U.S. and Canada. For this reason we decided to break from the traditional technical workshop format and replaced it with one aimed at examining social and economic factors and how they influence elk management. Our first attempt failed; a call for papers resulted in five offers for participation. We made another attempt and received little or no interest in a workshop.

Reasons for this lack of interest were attributed to: an Elk Symposium in Laramie, Wyoming the previous year; difficulties in government Fish and Wildlife staff getting out of state or province travel and a mild resistence to examine some of the social and economic circumstances which constrain elk management.

This past fall we tried again and to much surprise the response although not overwhelming was indeed encouraging, so we proceeded to organize this session. Offers to participate came from a variety of places so regional representation was generally good. Phone calls to some of you indicated that notices of the workshop which were sent to head office were not passed along to appropriate field staff. These communication problems are an impediment to those who are trying to organize workshops so I would recommend some attempt to rectify the situation.

Participants were well prepared, topics diverse, material well presented which in turn fostered much candid discussion.

As the meeting progressed, some of the philosophical differences emerged among the participants but through encouragement by the chairman, each point of view was well received by the participants.

The meeting terminated on a very positive note and to a person each of you expressed the need to continue with these sensitive and often contentious subjects.

On behalf of the Western Fish and Game commissioners I would like to thank you for your participation and look forward to the next workshop.

K. Sumanik
Chairman
Elk Workshop Committee

ALBERTA

Eldon Bruns

Alberta Fish and Wildlife Division

We estimate that we have a maximum of 20,000 elk. The best densitities are south of the Bow River (approximately 10,000). Elk herds in south and central areas are increasing the fastest. Harvest 1,726 elk. Resident hunters have a 6% success rate.

Some highlights of our management program are the following:

Compulsory registration of kill and incisor bar returned within 30 days of date of kill.

Jaw return envelopes.

Antlerless authorizations.

- Tag first
- Single W.M.U.
- Proposed free in 1980
- Most of the seasons are for an uncontrolled number of residents.
- Special Draws for exceptional areas.
  - Provincial Parks
  - Areas adjacent Federal Parks.
- Extensive Trophy Zone (4 points off main beam = 5) 3" long.
- Part of 3 Antlered Licence Combination
- We have transplanted a few elk from Parks as they are available. (Approximately 140 in the last 4 winters).
- Our major habitat problem is control of public access into elk range being developed for petroleum, followed by recreational activity.
  - A.T.V.'s
  - Snowmobiles
  - Golf Courses
  - Forest Operations.

Research Grants

- Univ. of Alberta - Bioenergetics
  - Competition
  - Behaviour and resource allocation

ARIZONA STATUS REPORT

T.L. Britt and J. O'Neil

Arizona Game and Fish Department

By the late 1800's native elk (Cervus canadensis merriami) were believed to have been extirpated from Arizona. Consequently, Arizona's current elk herds are a result of reintroduction efforts which took place in the early 1900's. In 1913 the B.P.O.E. Lodge in Winslow succeeded in obtaining 86 animals from the Yellowstone herd. These animals were transported by rail to Winslow. From Winslow they were transported south by wagon some 40 miles and released near Cabin Draw, in what is now the Apache-Sitgreaves National Forest (White, 1968 unpub. manu.). Several additional reintroductions took place between 1913 and 1928. These early efforts are credited for reestablishment of elk in Arizona.

The transplanted animals rapidly expanded their range. In 1935 Arizona's newly formed Game and Fish Commission authorized the first hunt and issued 276 permits to Arizona sport hunters. The first hunt was a success. Hunters reported harvesting 145 bulls and spikes. Annual seasons continued until 1944. During the two year span of 1944-45, elk season was closed in Arizona. Sport hunting resumed in 1946 and has been continued to date without interruption.

For the purpose of wise use of time, we will avoid any additional historical narrative and update the status report of 1977.

Population Status

All historical elk habitats are currently occupied in Arizona. In general, most ranges are either near or at carrying capacity. Some major ranges in eastern Arizona are capable of supporting more animals than are currently present and management efforts are underway to encourage herd expansion. Elk are, in some instances, becoming numerous in previously unoccupied habitat. This is the case along the south rim of Grand Canyon where elk in herds of up to 40 animals have been observed recently feeding adjacent to the runway at Grand Canyon Airport. Populations transplanted to marginal ranges such as the Hualapai Mountains near Kingman appear to be hanging on, but only barely.

Currently we estimate 10,000 to 12,000 elk inhabit 6,884 square miles of habitat in Arizona. Most of the elk habitat, 83 percent to be exact, is under jurisdiction of the U.S.F.S.. This estimate does not include elk found in the Fort Apache, San Carlos and Hualapai Indian Reservations.

During the past three years, statewide prehunt calf survival has averaged 54 calves per 100 cows. During this same period, prehunt bull:cow ratios have averaged 37 bulls per 100 cows.

In summary, Arizona elk herds are extremely viable at present.

Research Status

Currently two elk research projects are active in Arizona. One, initiated during the past summer, involves an investigation of elk-cattle grazing relationships. This study, a cooperative effort involving the U.S.F.S, University of Arizona, and Arizona Game and Fish Department, is scheduled for three years. The study area is located south of Winslow on the Apache-Sitgreaves National Forest and is confined to elk summer range.

The second project, staffed by the department, has been active since 1974. It involves the capture and marking of elk to determine herd discreteness within specific wildlife management units. To date, in excess of 600 elk have been marked in eight locations utilizing both permanent corral type traps and portable clover type traps. Trapping has occurred on both summer and winter ranges, with summer range trapping so far being the more efficient method.

Lack of adequate monitoring efforts of collared elk resulting from other priority use of the department aircraft has limited the quantity of data collected in this project. Despite this limitation, much useful management oriented data has been collected.

Future plans for this project include termination of summer trapping south of Winslow and initiation of trapping adjacent to the Fort Apache Indian Reservation to develop knowledge of an elk herd which occurs under joint jurisdiction of the State of Arizona and Fort Apache Indian Tribe. Trapping operations in the Flagstaff area will continue with more effort placed on utilization of portable clover type traps. Radio-telemetry will also be incorporated to increase the observation rate of marked animals.

Management Problems

Timber Harvest. Commercial timber harvest practices in Arizona have been based primarily on a shelter wood, modified shelter wood or strip cut harvest technique. The overall effect of saw log harvest to date appears to have been beneficial to elk, however, other associated silvicultural practices such as pre-commercial thinning and commercial thinning have an undefined status. The loss of concealment cover is accelerating

annually. The importance of this cover is not fully understood in the ponderosa pine forests of Arizona.

Grazing. In general elk range conditions are fair to good at present.

Several livestock permittees in the Flagstaff area have become critical of our elk management program. They contend permit reductions on their allotments resulted from over use of forage by elk. Needless to say, such accusations produce lively discussions during allotment inspections.

Encroachment. Many valuable meadow lands were lost to summer home development during the sixties. The rate of loss has slowed as a result of rising energy costs and tougher zoning laws. Nevertheless there are many inholdings, surrounded by U.S.F.S. lands, which could be sold and subdivided.

The department land purchase program is inactive at present because of an austere budget.

Illegal Taking. Illegal taking was on the upswing in the early seventies, but appears to have stabilized in the late seventies. It is still a significant problem.

Predation. Predation does not appear to be an important factor in Arizona elk herds. The presence of remote subdivisions and associated dogs are a greater threat to elk than natural predators.

Disease. Blindness in elk produced by the blood parasite Elaeophora schneideri is a problem in Arizona elk herds. Smith (1969) reported infection rates as high as 85 percent.

More recent information from eastern Arizona, where the problem appears to be most severe, resulting from trapping operations in 1974 thru '78, indicates seven percent of 213 yearling or adult elk exhibited enternal symptoms of the disease. In contrast, the rate in north central Arizona has been less than one percent.

Jurisdiction. An elk herd located in eastern Arizona summers on lands under jurisdiction of the Fort Apache Indian Tribe and winters on lands under the jurisdiction of the U.S.F.S. In recent years several legal questions have been posed concerning sport hunting of this herd. Currently a case is in its second stage of appeal which could answer certain questions concerning legal jurisdiction of this herd.

Seasons and Harvest

All elk hunts held in Arizona are on a permit basis. Permits are obtained through a computerized drawing administered by the Arizona Game & Fish Department. Permits are equally available to both residents and non-residents.

Firearm hunters are eligible to apply every third year after obtaining a permit. Archery hunters are eligible to apply each year; however, an archer must wait three years to apply for a firearms permit after obtaining an archery permit.

Several seasons are available for hunters to choose from. An early firearms season in late September (six days in length), a late firearms seasons beginning the Saturday after Thanksgiving (nine days in length), and an archery season during the last two weeks of September (16 days in length) provide a wide selection. During the past two years a special post hunt season (six days in length), was offered in a portion of a wildlife management unit to apply additional pressure to a rapidly expanding herd which was not being hunted during the general season.

Firearms Hunt Statistics. During the period of 1977-79 a mean of 5,960 firearm elk permits were issued annually. Hunter numbers during this period averaged 5,583. These hunters harvested an annual mean of 1,495 elk (1,010 bulls, 407 cows, and 77 calves) during this period and the harvest resulted in a mean annual hunt success of 27 percent.

Archery Hunt Statistics. Archery elk hunting was initiated in 1972. It is unique in that archery deer, turkey, bear, lion, squirrel and rabbit seasons run concurrently. No special permit is needed for taking the above species, but a tag is required for each of the big game species.

Archery elk permit numbers have increased from the initial 750 bull permits in 1972 to 2,990 bull and any elk permits in 1979. The harvest also has increased from 22 bulls in 1972 to 184 bulls, 68 cows and two calves in 1979. Our five year Elk Strategic Plan directs 20 percent of the total elk harvest to archers by 1985. Currently archers claim 14.6 percent of the total.

Prospects for the Future

Arizona like many western states is enjoying productive elk populations at present. The continuation of this present condition depends primarily on being able to manage habitats which are to become targets for exploitation during the upcoming decade. To our knowledge we have no energy resources in our elk habitats, however, our elk habitats do support large quantities of timber, range forage, and possess potential for recreational development.

Overcoming the "get more quick" hysteria now prevalent to insure proper use of elk habitats will be the challenge of the '80's.

Properly utilized Arizona's elk habitats can continue to produce timber, forage, recreation, and elk indefinitely if we can overcome the stigma of short term gains at the expense of long term production.

Literature Cited

Smith, R.H. 1969. Wildlife research in Arizona. Arizona Game and Fish Dept., Phoenix, Az. pp 97-99.

COLORADO ELK MANAGEMENT

Jim Olterman

Colorado Game & Fish Department

Elk inhabit approximately 58,500 square miles of Colorado. Populations have increased in numbers since the early 1900's and have more than tripled since 1950.

The second edition of Colorado's Strategic Plan for wildlife established the goal of increasing posthunt elk numbers from an estimated 109,400 in 1974 to 118,500 in 1983. The 1978 posthunt population was estimated at more than 124,000. The Strategic Plan harvest goal for 1983 was 27,300. That goal was surpassed in 1978 with an estimated harvest of almost 29,000.

Colorado's elk management policy is to balance populations with available habitats. The primary method of population regulation is the designation of specific numbers of antlerless only hunting licenses for specific areas (Game Management Units). Antlered only hunting is provided on an unlimited basis in most units. Hunting opportunity is provided in the form of two regular rifle seasons, an archery season, and a muzzleloading rifle season. Hunters may participate in only one elk season per year.

Population estimates are made with the aid of the computer population simulator "onepop." Each estimate is made for a specific geographic area defined to encompass a single population of animals. Data points used in the model include observed sex ratios, age ratios, hunter harvest, and nonhunting mortality.

Sex and age ratio information is obtained from helicopter counts conducted in December and January. During most winters between 15 and 20 thousand elk are classified.

Hunter harvest estimates are obtained by mailed surveys. Antlerless license holders are sampled at the 40% level. Antlered license holders are sampled at approximately 20%. Three follow-up letters are sent to nonreporters and a 90% return rate is usually achieved.

Nonhunting mortality is estimated by walking ground transects or simply by observing winter conditions. Animal-vehicle accidents are recorded and added to winter loss.

The 1978-79 winter was one of the most severe experienced in Colorado in the past fifty years. Heavy snowfall began in early December 1978 and continued through January 1979. Temperatures were well below normal. For example, the average daily temperature at Gunnison for December, January, and February was 0^{o}F., 8^{o} colder than the 20-year average. Stress on elk produced by cold, lack of forage, and energy requirements for moving through 40-50 inches of snow was severe. Elk began to die in several locations by late January.

Although Colorado does not advocate winter feeding of big game animals, the unusual situation presented a choice of supplemental feed or suffering exceptionally high mortality. More than 800 tons of hay (both grass and alfalfa) and 10 tons of high protein pellets were fed to approximately 4,000 elk during February and March. Feeding was accomplished with snow vehicles and helicopters. Elk were fed approximately seven pounds per day. Some natural forage was available.

Mortality was minimized. Winter loss was estimated at 15-20%. On one area where supplemental feed was not provided 100 winter-killed elk were aged. Winter loss occurred at the rate of 458 calves/100 cows, more than 9.5 times the rate that calves occurred in the population.

It now appears that winter stress induced either low mortality or calf survival. Age ratios are as low as 32 calves/100 cows this winter.

The population estimate process will begin in late March. Antlerless license recommendations will be finalized in May and presented to the Wildlife Commission in early June.

The greatest elk management problem in Colorado is coping with habitat loss. Energy development in Western Colorado is growing rapidly. Large influxes of people will undoubtedly result in habitat loss due to housing, transportation, and support facility needs.

The Division of Wildlife must work with developers to minimize impacts and suggest mitigating measures where possible. In addition, we intend to cooperate with federal land management agencies to increase carrying capacities of present habitats.

ELK STATUS IN BRITISH COLUMBIA

R.A. Demarchi, D.M. Hebert
British Columbia Ministry of Environment

Both Roosevelt elk and Rocky Mt. Elk occur in British Columbia. Roosevelt elk are found on Vancouver Island and the Rocky Mountain elk on the mainland and on Graham Island. The elk population in the Province is estimated at 23,000 (3,000 Roosevelt elk, 20,000 Rocky Mt. elk). The East Kootenay area comprises about 5% of the land area of the Province but supports about 60% of the elk population. The annual hunter take of elk is between 1,500 and 1,600 animals.

Little work had been done on Roosevelt elk until about four years ago when a program was initiated to investigate logging-elk relationships and inventory techniques.

Elk have been introduced in many locations throughout the Province. These introductions have resulted in the establishment of elk populations in the following areas: Graham Island, Lytton, Adams River, Okanagan Region (Princeton, Christina Lake, Kettle, Naramata). Most of these populations are now supporting hunting seasons and providing recreation to the Province's hunters and enjoyment of others who have the opportunity to view elk.

In some instances, the elk introductions have led to complaints from ranchers about elk depredation on irrigated pasture and fences, however, liberalized seasons have eliminated or usually reduced the depredation to an acceptable level.

Relationship regarding elk management with the Ministry of Forests, the single most important land use agency in the Province has been greatly improved in recent years especially in the East Kootenays through coordinated resource management planning. Coordinated resource management plans have benefited elk populations. Approximately 500 miles of fence have been constructed to provide better control and distribution of livestock grazing over more than 500,000 hectares of open and timbered range occupied by elk in the East Kootenay.

A legal bull must have a minimum of 3 tines in many areas of southern British Columbia and most antlerless harvests are controlled by Limited Entry Hunts. Some limited entry elk permits on Vancouver Island provide for a certain number of antlerless, spike bull and 5 point or better bull permits.

British Columbia's approach to reducing crop depredation by elk is through liberal hunting seasons in depredation areas. We have had several requests for elk to stock commercial game farms but these requests have been denied and no game farm permits for native ungulates are being granted until there are adequate regulations adopted for regulating commercial game farms.

ELK STATUS AND MANAGEMENT IN IDAHO

J.L. Thiessen

Idaho Fish and Game Department

Elk are found over about 50 percent of Idaho (41,250 square miles) with summer densities, in areas open to hunting, varying from about .4 to 3.0 per square mile. Elk habitat is located generally north of the Snake River Plains.

Elk populations declined nearly 50 percent from the late '50's to the mid '70's. Overharvest was the principal cause although habitat changes due to forest management practices and natural succession contributed. During the decline, seasons were long and general hunting for either sex allowed.

Long range management and policy plans for each big game species were developed in 1975. These plans were responsible for major changes in Idaho's deer and elk management programs. Hunting seasons were shortened, controlled hunts increased, some deer and elk seasons separated, midweek opening dates installed and sex-specific harvest regulations expanded. The general emphasis was to reduce hunting pressure on all elk and specifically on female elk. An objective was established to increase elk numbers from about 50,000 in 1975 to about 61,000 in 1980. It appears that this objective has been met or exceeded. The next five year segment (1981-85) of the elk management plan will undoubtedly display strategies for continued growth. A long range objective of realizing 87,000 elk in Idaho by 1990 appears obtainable without jeopardizing habitat.

A total of 71,775 elk tags was sold in Idaho in 1979. Non-residents purchased 7,800 of the 9,500 (quota) available. Twenty percent of the residents and 4 percent of the non-residents who purchased tags did not hunt. The average success of all residents who hunted was 8.5 percent and that of all non-residents who hunted was 16 percent.

Antlered only hunting is provided on an unlimited basis in 57 of 97 management units while general either-sex hunting is allowed for part of the season in 8 management units. Fifteen units are limited to controlled hunts only and 12 units have controlled units in addition to general seasons. General seasons vary from 5 to 68 days in length. Twenty-four management units are closed to all elk hunting.

General archery seasons are available in 39 management units and general or controlled muzzleloader seasons are available in six units.

One of the objectives in the five year elk management plan was to maintain post season ratios above 15-25 bulls per 100 cows depending upon the management unit. Prior to 1976, post season bull:cow ratios were high, varying from about 30-50 bulls per 100 cows depending upon the management unit. These ratios have been reduced in the past 4

years to about 20-40 bulls per 100 cows because of the heavy emphasis on bull harvest. The percent of males in the harvest for the ten year period between 1970-1979 was 53, 53, 53, 53, 57, 62, 84, 80, 80 and 82, respectively.

About 11 checking stations are operated annually in major elk producing areas to obtain data on kill location, age structure of the harvest, antler development and other physical parameters, as well as hunter success and attitudes. Approximately 1,300 elk were checked each year in 1978 and 1979.

Approximately 10,000 elk are counted and 8,000 classified each winter with the aid of helicopters. Post season cow:calf ratios vary between 25 and 60 calves per 100 cows depending upon the unit with most herds having ratios in the upper 40's or lower 50's. The average ratio has improved slightly since 1975.

Harvest surveys were conducted using mail-out questionnaires to 5 percent of the elk tag buyers until 1979 when the method was changed to a telephone contact questionnaire of 5 percent of the elk tag buyers. The principal benefits of the telephone techniques are 1) a precise number of hunters can be sampled and 2) non-response bias is eliminated. Costs of the two methods are similar. A high percentage (50-100 percent) of controlled hunt permittees are contacted via the telephone. Harvest for the ten year period 1970-1979 was 14,100, 11,000 9,300, 12,400, 8,700, 9,000, 4,100 6,400 7, 700 and 6,300 respectively.

MONTANA STATUS REPORT FOR ELK

Terry N. Lonner
Montana Department of Wildlife and Parks

In Montana the elk is a highly prized big game animal. Although elk occur on only 36,370 square miles or 28 percent of the state, in 1978 they contributed nearly 60% of the total license revenue from all hunting and trapping. During that same year, 643,604 hunter days were spent on elk hunting to bag 11,900 elk with a harvest success of 14%.

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 land and 25 percent private. Approximately 80 percent of the elk harvest occurs on public land.

The state has been divided into 7 administrative regions and all but one of these (southeastern Montana) has elk hunting. Last hunting season (1979) the regions with elk hunting were divided into 117 management units ranging from 3 to 33 per region. Elk hunting starts about September 10 with a general archery season and ends about mid-February with a late rifle hunt in the upper Yellowstone drainage near Yellowstone National Park. Over 90% of the elk harvest, however, occurs during the general hunting season that starts around October 20 and lasts for about 35 days or until near the end of November. Last hunting season the harvest from 16 of these 117 units was controlled by a permit only hunting and one unit had either sex hunting throughout the season. Fourteen units had antlered bull only hunting and the remaining 86 units had antlered bull hunting with the harvest of cows and calves controlled by permits, quotas, or abbreviated either sex hunting. In 1979, all hunting units except one were open to archery hunting from September 8 through October 14 for either-sex elk. This one exception did not open until September 15. In recent years two late hunts have been conducted in three major drainages - Yellowstone, Gallatin, and Madison near where they leave Yellowstone Park and enter Montana. These hunts start in December and usually end in late January-mid February. They are limited by permit and time period assignments. As a note of interest, two depredation hunts conducted this early winter received over 10,000 applications for 700 permits. About 6,200 applications were by letter for 500 permits and slightly over 4,000 applications were made in person at a National Guard Armory for the other 200 permits. Several non-residents from as far away as Arizona showed up to apply for this hunt.

Hunting season recommendations for commission approval are based primarily on 4 criteria; harvest results from hunter questionnaire surveys, winter and early summer classification and count flights, winter range forage evalutations, and public opinion.

The resident elk hunter has to pay $8.00 for an elk tag and an additional $1.00 for a conservation license. Another $6.00 must be paid to hunt elk with a long bow and arrow

during the pre-gun archery season. The non-resdient elk hunter must pay $225.00 plus $1.00 for a conservation license and this license must be purchased from the Fish, Wildlife and Parks office at the State Capitol in Helena on a first come, first served basis. This license includes 1 deer tag, an elk tag, black bear, and authorizes hunting for game birds and fishing. It also gives them the privilege to buy some special tags (grizzly bear, lion, archery stamp) and apply for others (either sex elk, sheep, goat, moose and antelope). Application for special licenses must be made by June 15, for both resident and non-resident.

Since 1950, estimated annual elk harvests have usually been sustained between 10,000 and 17,000. Elk management, including acquisition of important winter ranges, has received a high degree of Department emphasis and has been relatively successful. Most of the State's elk herds have stable or increasing populations. A total of about 160,000 acres in 16 different areas has been purchased at a cost of approximately $5 million through 1979. In addition we have another 66,300 acres leased for elk winter range in combination with the deeded acreage on these 16 units. The Department pays about $11,500 annually for leasing this land.

In recent years, hunting demand for elk has been continually increasing. The number of elk hunters reported afield in Montana has increased from 70,300 in 1971 to 86,636 in 1978. Although survey results are not in yet for 1979, total elk licenses sold were in excess of 100,000. Non-resident elk hunters reported afield increased from 9,750 in 1971 to 18,000 in 1975. In 1976 a 17,000 limit with an increased license fee was placed on non-resident elk licenses and for the first time, this quota was reached this past hunting season.

Our statewide objective for 1977 through 1982 is to provide 700,000 days of elk hunting annually at a hunting success rate of 16% with an average effort of 48 days per elk harvested. This means a sustained harvest goal of about 14,500 elk.

Research emphasis currently involves the winding down of an elk-logging-roads study and a study in the Missouri River Breaks. The Breaks study is in the final report writing phase and includes habitat relationships and elk-livestock inter-relationships. We have developed a population dynamics simulator called POSIM, but have only used it on a small scale basis in both research and management. Radio telemetry is being used on a rather broad scale to help us better understand seasonal distribution and movement patterns within several of our management units.

ELK STATUS IN OREGON

Paul Ebert

Oregon Fish and Wildlife Commission

A major effort was made to reduce hunter numbers in the popular elk hunting areas of the state by requiring hunters to select between a shorter first period hunt and a longer second period hunt when purchaing their elk tag. The hunter had to first select between Roosevelt and Rocky Mt. elk hunting before the hunt period was selected. Four units in western Oregon remained under the three-point regulation with permits required in the Saddle Mt. and Tioga units. These permits restricted hunters to the area for which they obtained a permit. The Chesnimnus and Snake River units in eastern Oregon were managed as limited entry areas and a three-point minimum bag remained in the Snake River unit.

Roosevelt elk hunters had to choose between a four-day first period hunt or a seven-day second period hunt. Forty-seven percent reported hunting the first period and 53 percent the second period. A total of 32,504 individuals hunted during the two periods and took 2,821 bulls and averaged nine percent success. Hunters averaged nine percent success during the first period and eight percent during the second period.

In the Saddle Mt. and Tioga permit entry three-point areas 7,767 hunters harvested 1,144 bulls and averaged 15 percent success. In addition to the general season harvest the 885 controlled damage permits generated a harvest of 404 Roosevelt elk and another 1,368 elk were taken by bow hunters in western Oregon. Thirty-four percent of the state's rifle elk hunters chose to hunt elk in the Roosevelt elk area.

Rocky Mt. elk hunters had to choose between a five-day first period and a nine-day second period. Fifty-five percent reported they hunted during the first period and 45 percent during the second period. A total of 55,704 individuals hunted during both periods and reported taking 6,244 bulls, averaging 11 percent success. First period hunters averaged 14 percent success and second period hunters eight percent success.

Limited entry hunters in the Chesnimnus averaged 23 percent success and in the Snake River 22 percent success. In addition to the general season harvest, 9,350 controlled antlerless permits generated a harvest of 4,674 elk and another 617 elk were taken by bowhunters in the Rocky Mt. area. Sixty-six percent of the state's rifle elk hunters chose to hunt in the Rocky Mt. area.

ROOSEVELT ELK HERD COMPOSITION

Year	Elk Classified	Bulls per 100 Cows	Calves per 100 Cows
1976	3,585	3	42
1977	2,811	6	38
1978	5,256	6	41
1979	3,810	9	36
1980	4,757	9	37

ROCKY MT. ELK HERD COMPOSITION

Year	Elk Classified	Bulls per 100 Cows	Calves per 100 Cows
1976	5,809	3	47
1977	4,595	7	47
1978	7,463	5	45
1979	7,442	7	38
1980	9,961	6	42

ROOSEVELT ELK POPULATION TRENDS

Year	Miles Traveled	Elk Observed	Elk Per Mile
	Summer Range Census		
1976	739	1,557	2.1
1977	628	1,330	2.1
1978	699	1,308	1.9
1979	597	1,249	2.1
1980	638	1,310	2.1

ROCKY MT. ELK POPULATION TRENDS

Year	Miles Traveled	Elk Observed	Elk Per Mile
1976	2,203	24,894	11.3
1977	2,044	21,341	10.4
1978	2,233	38,242	12.6
1979	2,374	27,487	11.6
1980	2,382	30,550	12.8

1980 UTAH ELK STATUS REPORT

Grant Jense
Utah Division of Wildlife Resources

A. HISTORY OF ELK MANAGEMENT IN UTAH

Elk herds were prevalent throughout the mountainous areas of northern and central Utah prior to settlement by white man. Unrestricted hunting following settlement eliminated most of the elk from its natural ranges by the turn of the century. Only the Uinta Mountains supported a native elk herd when Utah entered into the first interstate elk transplanting program.

Elk were given protection with closed seasons about 1898. To reestablish elk onto ranges where they were previously found, interstate elk transplants were started in 1912 and continued until 1925.

Elk received from Yellowstone National Park were released on the Fishlake, Oquirrh Mountains, Mt. Nebo, Logan Canyon and East Mountain on the Manti National Forest.

Sportsmen in Smithfield also obtained a few head in Montana and released them in Smithfield Canyon during this 13 year period.

Because of deteriorating range conditions and agricultural damage problems, the Board of Elk Control, later to be known as the Board of Big Game Control, was established to cope with problems of the rapidly increasing elk herds. The Board authorized the first elk hunt in 1925 on the Cache and Mt. Nebo.

Elk hunts in Utah were on a limited basis until 1967 when the Board of Big Game Control authorized the first "open bull" hunt. This type hunt was in force on five elk units during this initial year. Three additional units were added in 1968 and maintained in 1969; and in 1970, open bull hunting was extended statewide, except for the Heaston and Indian Peaks units. This open bull type hunt continued through 1979, with the exception of Mt. Dutton being limited to 25 permits and Pilot Mountain was closed to hunting.

Two new elk units were open to elk hunting for the first time in 1979. Twenty-five permits were available on the Boulder Mountain unit and 10 permits were issued on the Beaver Mountain unit.

Open bull permittees were initially restricted to purchase of a permit every fifth year only. In 1970, the waiting period was reduced so that a hunter could purchase a permit every third year. In 1971, it was reduced to every second year, and in 1972, the waiting period was completely removed.

A special archery open bull hunt was authorized for the first time in 1971 with an unlimited number of permits available. It has been held each year since 1971 concurrent with the archery deer season. An archer could not also purchase a regular open bull permit. One hundred fifty archery open bull permittees were randomly selected by a public drawing in 1979, and their permits were validated as hunter's choice.

Prior to 1972, elk hunting in Utah was restricted to residents only. The Board of Big Game Control in that year authorized the sale of 100 non-resident open bull permits. That same number was authorized each subsequent year until the 1977 season when 125 were authorized and sold. In 1979, the Board of Big Game Control removed the limit on non-resident open bull elk permit sales.

Since the inception of open bull hunting in 1967, hunters had been required to choose whether they would purchase an open bull permit or apply for a restricted permit. The open bull permit sales period was deliberately ended prior to the restricted permit application period, and thus did not allow unsuccessful applicants to purchase an open bull permit. This system had been designed specifically to limit the number of open bull hunters afield.

It is obvious from a comparison of open bull permit sales in 1977 with previous years that the system worked well. In 1977, the procedure was changed to require first the purchase of an open bull permit before a hunter was eligible to apply for a restricted permit. This change in procedure resulted in a very sharp increase in permit sales - from 17,652 in 1976 to 28,692 in 1977 (63%). This procedure was followed again in 1978 and resulted in 32,142 permits being sold, an additional 12% increase over 1977 permit sales. In 1979, a person was given the option of receiving or not receiving an open bull permit if not successful in drawing a restricted permit. It was believed that this procedure would reduce the number of open bull elk hunters. However, open bull elk permit sales increased to 37,645, another increase of 17%.

For the past five years, a mid-week (Wednesday) opening has been tried in order to spread out the hunting pressure. The first year or two, the Wednesday opening distributed hunting pressure somewhat; but since then, hunters have adjusted their vacation and work schedules for a Wednesday opening and they turn out in force. In effect, we now have a 4 to 5 day opening instead of a 2 to 3 day opening.

It appears that elk hunting in Utah is continuing to gain in popularity, even with the low success rate. Elk hunters must be finding more in hunting elk than just elk meat.

B. PRESENT STATUS

The present elk population in Utah is estimated to be 13,000 to 15,000 and increasing.

Two new herd units were hunted for the first time in 1979. Several smaller units are growing and showing potential for developing into sizesable herds.

The opportunity and interest for hunting elk in Utah is increasing.

C. HARVEST

	1977	1978	1979
Open bull permits sold	28,692	32,142	37,645
Hunter afield	27,166	30,783	34,654
Bulls harvested	2,285	2,923	2,313
Percent success	8	9	7
Restricted permit sales	1,872	2,020	2,020
Hunters afield	1,742	1,985	1,962
Elk harvested (bulls, cows and calves)	787	1,088	935
Percent success	45	55	48
Archery permit sales	784	918	1,526
Hunters afield	665	866	1,453
Elk harvested	51	82	97
Percent success	8	9	7
Total harvest	3,123	4,093	3,345
Percent success	11	12	9

D. TRANSPLANTS

An agreement was obtained from the BLM, and 50 head of elk were transplanted onto the Book Cliffs area of eastern Utah the past winter to supplement a small existing herd there.

During 1977 and 1978, 159 elk were moved from the Manti unit to Boulder Mountain. These elk have established and are increasing. This was the first transplant that has been approved by the U.S. Forest Service in Utah since the mid-1940's.

E. RESEARCH

At the advent of open bull hunting, there was concern expressed for the ability of yearling bulls to keep up the productivity of the herds in the event that the majority of mature bulls were harvested.

Studies were initiated on part of the Cache elk herd wintering on the Hardware Ranch. Yearling bulls and mature bulls were used as sires to determine the adequacy of yearlings as breeders. No significant difference was observed.

Prior to open bull hunting, yearling bulls in the harvest averaged 36% for the Cache herd unit. Since open bull hunting, yearling bull harvest has averaged 76%.

Rectal palpation and classification trend studies conducted on the Cache herd unit prior to and since open bull hunting have not shown any significant decline in the pregnancy rate of calf/cow ratio.

CURRENT ELK MANAGEMENT AND RESEARCH IN NEW MEXICO

Dusty Hunt

New Mexico Game and Fish Department

The Gila elk herd occurs in an area once inhabited by Merriam's elk (Cervus merriami), which were hunted to extinction about 1900. Rocky Mountain elk (Cervus elaphus) nearly disappeared from their range in Northern New Mexico at about the same time. In 1880, the Territorial Legislature attempted to restrict elk hunting to winter months; but because the law could not be enforced, only an estimated 60 Rocky Mountain elk remained in New Mexico by 1912. With protection and introduction of elk from Yellowstone, Rocky Mountain elk successfully reoccupied its former range as well as the range formerly inhabited by Merriam's elk. Since the reintroduction of elk into the Gila, the herd has steadily increased in number, and its range has expanded. The current herd is belived to be a vigorous, healthy population which suffers from only one severe mortality factor. Blindness due to Elaeophora schneideri significantly reduces calf survival in years when its vectors (several horse and deer fly species) are abundant.

The Gila elk study was initiated to develop baseline population dynamics data on vigorous elk. The study will also investigate ways of reducing the effect of Elaeophora on the herd; in the future this information will be applied to other herds in the state which appear to be losing their vigor. The following is a progress report of the first year's work.

Elk Capture. A total of 88 elk have been captured on the T-Bar study area near Reserve, New Mexico. Twenty-five have been captured at the Ft. Bayard study area near Silver City, New Mexico. Twenty-four radio collars are now functioning on the T-Bar; fourteen at Ft. Bayard. These two elk poplations separated by 60 airline miles, face similar environmental factors. Their difference is that the T-Bar herd is hunted, while the Ft. Bayard herd is not.

Five different methods were employed to capture elk. In areas where elk could be baited with alfalfa hay, salt, and sweet horse feed, "Clover Traps" were effective. When elk would not respond to bait, Pneudarts shot by workers on the ground were successful. The best drug response was obtained from 17-18 mg. of succinylcholine chloride. Palmer Darts shot from a helicopter gave good results when 4 cc M-99 combined with 5 cc Rompun were injected in adult elk. A 1500 ft. drive net, seven feet high with an eight-inch mesh, was used to capture elk in some cases.

Captured elk were weighed (when possible); an incisor was pulled for sectioning; age was determined by tooth wear and replacement; heart girth was measured; blood was taken for serology studies; general animal condition was noted; large I.D. ear tags and

either an I.D. collar or a radio telemetry collar were given each animal. Cows determined by rectal palpation to be pregnant received vaginal transmitters which were surgically implanted.

Numbers. Lincoln index estimated the T-Bar herd numbered 598 animals in 1978 and 1,104 in 1979. The increase can be attributed to sampling error and an increase in calf survival in 1979. Repeated surveys of the smaller, more restricted Ft. Bayard herd suggest there are about 200 animals.

Productivity. Conception rate of the hunted herd was determined to be 81% during 1979 and 50% thus far in 1980. The unhunted herd appears to have a 95% conception rate. All cows in which vaginal telemetry was implanted produced calves. Vaginal transmitters led workers to six newborn calves and provided location and time of parturition. It appears calving began between May 15-20 and was complete by July 1 on both study areas; with the majority of calves dropped during the last week of May. Eleven additional calves were captured and radio collared. Fifteen of the 17 calves captured were estimated to be less than one week old; the average calf weight was 44.5 lbs.

Age Structure. All elk observed during visits to the study area were recorded and classified as to sex and age. Annual winter helicopter surveys and hunter harvest data, however, probably provide better sex and age information than random observation of elk. During an aerial survey conducted on January 13, 1979, in which 328 elk were observed, 23 were spike bulls, 236 were adult cows, and 69 were calves. These data show a cow/calf ratio of 32 per 100 compared to 52 calves per 100 cows from ground observations. Ground-collected data probably show a more accurate picture of bull/cow ratios than aerial surveys. Mature bulls were missed during aerial surveys because they winter in different areas. An attempt was made to identify yearling cows from the helicopter, but they were not distinguishable from adults. If the number of spike bulls observed (23) represents approximately one-half of the yearling age group, then an estimate of 21 yearlings per 100 cows can be projected.

Hunter-harvested bulls were aged by tooth wear and replacement, and incisors were pulled to be aged by sectioning. Age distribution of bulls harvested in 1978 indicated 15% yearlings; 42% two-year olds; 34% three-four year-olds; 8% five-seven year-olds. No bulls aged 8 years or older were checked in 1978. In 1979, 3% of the bulls killed were yearlings; 42% were two-year olds; 35% three-four year-olds; 16% five-seven year-olds; and 3% were older than 8 years.

Sex Ratios. Sex ratios are proving to be difficult to obtain. During the warm season, elk primarily use the heavier timbered section of the study area, making it difficult to accurately classify and count the numbers of each herd observed. During the winter, when elk are more easily observed on the open winter ranges, adult bulls are not present with the herds. In the future, aerial surveys are planned during the rut, in hopes of better addressing this problem.

Causes and Rates of Mortality. Six mortality factors of elk have been identified on the T-Bar area: predation by coyote, hunter kill, illegal kill by hunters, collection of elk, elaeophorosis, and capture-related deaths. Of the six factors, predation hunter harvest, and elaeophorosis appear to be capable of seriously influencing population dynamics. Elaeophorosis appears to be the single most important natural mortality factor occurring in elk less than one year old. The greatest mortality appears to occur between 4-12 months of age. In 1978, 21 calves in their first year of life were found dead or totally blind from elaeophorosis on the T-Bar. Although calves dead from causes other than elaeophorosis were not found to make a relative comparison, it is believed this high number is significant. Mortality rates of elk were determined from the sample wearing telemetry collars: 13 adults, one calf born in 1978, and 11 calves born in 1979. Only four calves from the 1979 cohort died, for a mortality rate among calves of 36.4%. Three died from coyote predation (27.3%) and one from unknown causes (9.1%). Natural mortality on adult cows has not been recorded so far at the T-Bar, but lion predation has occurred at Ft. Bayard. Thus far in the study, elaeophorosis was confirmed to cause mortality only in elk less than one year of age. However, death is known to occur in older animals as well, but at a reduced rate. Many elk affected with elaeophorosis have been known to survive, as indicated by examination of elk trapped for this study, and hunter-killed bulls. It is possible that the survivors may be more susceptible to other forms of mortality than unaffected animals. Necrosis of the tissue on the muzzle and ear tips, as well as deformed antlers in bulls, are commonly seen in Gila elk. Winter weights of some of the calves which survived elaeophorosis were considerably less than those of unaffected calves. In October, the time when body weights are expected to be maximum, two blind calves suffering from elaeophorosis were necropsied and found in poor physical condition. After the first year, however, it appears that weights of affected animals are close to those of unaffected animals. Based on the information collected from the 88 trapped animals, evidence of elaeophorosis was recorded in 23% of the calves, 33% of one-year olds, 0% of two-year olds, 25% of three-four year-olds, and 9% of five-seven year-old animals; no 8+ year-old animals captured had been affected.

Because the potential for coyote predation upon elk calves could be great, a system was initiated of monitoring their relative abundance on the study area. The scent-post method, developed by the U.S. Fish and Wildlife Service, was selected for use. Ten, 10-plot transects were established along selected roads throughout the study area. These stations are read in January, June, and October. An index to the abundance of buffer species was also determined by counting rabbit and rodent visits to the stations. Since coyotes severely impact the survival rate of so many animals, their populations are now being monitored by this method throughout the state.

Habitat. The Ft. Bayard elk herd appears to be a resident population. A variety of vegetative communities are available, but the herd's habitat selection does not appear to follow well-defined patterns, based on current information. Habitat at Ft. Bayard ranges from an Upper Sonoran grassland to a pinyon (Pinus edulis)-juniper (Juniperus spp.)-oak (Quercus spp.) woodland to ponderosa (P. ponderosa) forest. Those communities are transversed by cottonwood (Populus fremontii) and Arizona alder (Alnus oblongifolia)-dominated, riparian communities. Elk are found in the major habitat types, but additional data will be needed to determine if their distribution is random.

T-Bar elk are observed to use definite winter and summer ranges. Summer range is on the western side of the study area, at higher elevations and with denser vegetation, while winter range is on the eastern side of the area in the more open grassland, at lower elevations. A definite feature of the winter range is large, open expanses of grassland where ponderosa pine-covered hills are part of the landscape. The average canopy cover of the winter range appears to be considerably less than that of summer range, but average ground cover of understory would be greater. Elk are observed during winter in close proximity to the open, grassland prairies, but few have actually been observed in the open terrain; they are usually associated with some cover. Specific sites used by elk during winter appear to be those which have abundant browse production as well as grass. Time of day also appears to greatly influence habitat type selection. During daylight hours, elk are consistently observed using two areas: the south-facing slopes among a series of east-west oriented canyons, and an extensive south-facing, open grassland prairie, cut by deep canyons covered with dense stands of mountain mahogany (Cercocarpus breviflorus), gray oak (Q. grisea), skunkbush (Rhus trilobata), and cinquefoil (Potentilla fruticosa). In both of these high-use wintering areas, mountain mahogany is used very heavily; gray oak to a less degree, and the use of other browse species is hardly noticeable. Some alligator-bark juniper (J. deppeana) occurs in the area and use on it appears light. Elk are observed on winter ranges from December through March, when

they begin to move up slope, to the heavier-timbered area 10 miles to the east. During summer months, elk can be seen in all habitat types, but most observations have been in densely-timbered spruce (Abies concolor)-fir (Pseudotsuga taxifolia) and ponderosa forests during the day and large, open parks at dusk, dawn, and during the night.

Calving Locations. Eleven calves have been captured on or near the T-Bar Allotment area. Three birth sites were identified by vaginal transmitters and the calves captured nearby. Five other newborns were captured probably very close to their birth sites. Of these eight calves, two were born in spruce-fir habitat, five in ponderosa habitat, and one in the ecotone between ponderosa and juniper habitat types. Birth sites of the remaining calves were not determined. It is difficult, at this time, to determine if elk select particular characteristics of vegetation for calving.

Nine of the eleven calf capture locations were in areas which had been logged in recent times; also young ponderosa trees had been mechanically thinned in much of the area where calving occurred. Two calves were located in such areas. No calves were found in areas which were being logged. Two calves were found within 100 yards of roads; one road supported a moderate amount of traffic, while the other was seldom used. Of the calves found, most appeared to have been born in areas with little disturbance from humans.

The T-Bar allotment consists of six pastures used for livestock management; cattle are present in three of the pastures during the spring. One of the three used pastures appeared to be more heavily grazed than the other two. All but two calves were born in pastures free from livestock use. One calf was known to have been born in a cattle-free pasture off the T-Bar area, but it later moved onto the Allotment in a pasture being rested. Cattle were never observed in the vicinity of newborn elk calves or nursery herds. However, after one month, single cows and calves were observed utilizing salt licks in the vicinity of domestic livestock.

Conclusion. The difficult organizational phase of the Gila elk study should now be complete. Considerable home-range and preliminary sex and age data has been accumulated. Numerous mortality factors have been identified; the relative importance of each can be evaluated with additional information. Future results, based on more than a single year's data, will provide better answers to the questions outlined in this presentation.

ELK MANAGEMENT ON A NEW MEXICO RANCH

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Vermejo Park Corporation
Raton, New Mexico

INTRODUCTION

Vermejo Park is a 494,000 acre (200,000 ha) privately-owned ranch in northeastern New Mexico. Elevations range from 6,000 ft. (1,830 m) to 13,000 ft. (3,960 m). Five major vegetation types are represented (Kuchler, 1964): gramma-buffalo grass; juniper-pinyon woodland; ponderosa pine-douglas fir; southwestern spruce-fir; and alpine meadows. Resident ungulates include elk (Cervus elaphus canadensis), mule deer (Odocoileus hemionus), and pronghorn (Antilocapra americana). Carnivores of importance include the mountain lion (Felis concolor), black bear (Ursus americanus), coyote (Canis latrans), and bobcat (Lynx rufus). A more complete description of the physiography of the area is given by Wolfe (1977) and Davies (1979).

Vermejo Park is operated both as a working cattle ranch and as a hunting and fishing resort. Guided hunts are offered for elk, mule deer, pronghorn, black bear, mountain lion, and wild turkeys (Meleagris gallopavo). Unlike many privately-owned hunting resorts, Vermejo Park is not a game farm. Wildlife is not kept in pastures enclosed with game-proof fences. All animals are completely wild and free-ranging, and all hunting is done in accordance with regulations established by the State Game Commission.

Hunting Program

The majority of the hunting opportunity at Vermejo is provided by the elk herd, estimated at 4,000 - 6,000 animals. This represents approximately 20 percent of New Mexico's elk population (New Mexico Department of Game and Fish, unpublished data). During the six hunting seasons, 1974 - 1979, 2,668 sportsmen harvested 1,959 elk (1,147 bulls, 737 cows, 75 calves) for a success rate of 73.4 percent. Since 810 of these hunters were participating in cow only hunts, the success rate on bull elk was 61.7 percent. Of significant interest is the fact that 42.4 percent of all bulls harvested were 6 x 6 or larger. For comparison, only 12.2 percent of the bulls checked from the White River herd in Colorado, 1961 - 1972, were of this size (Boyd 1970, Boyd and Lipscomb, 1976). Both the success rate and the percentage of trophy-class bulls is greater than is generally observed on public land elk hunts.

Elk hunting provides the ranch with over one-half million dollars of revenue per year. Three types of hunts are offered: the Trophy Hunt (1980 cost = $4,000/hunter); the General Bulls Hunts (1980 cost = $2,200/hunter); and the Post-Season Cow Hunts (1980 cost = $100/hunter). All hunters, except those participating in the post-season cow hunts, are required to stay in one of the three fully staffed hunting lodges, and to be accompanied by a ranch guide. The price of the bull elk hunts includes the landowner's trespass fee, lodging, meals, guides, and horses. Since the post-season cow hunts are a herd management tool, they are operated differently than the bull elk hunts. As a method of encouraging participation in the cow hunts, hunters are allowed to camp on the property, are not required to hire a ranch guide, and pay only a minimal trespass fee.

Elk Research and Management

An important distinction between Vermejo Park and most "game ranches" is the fact that Vermejo is actively involved in applied wildlife research and management. A study of elaeophorosis (elk blindness caused by the nematode Elaeophora schneideri) was recently completed (Davies 1979), and a long-range population ecology study of the Vermejo Park elk herd is currently in progress (Wolfe, unpublished data).

The goal of the current study is to develop an elk management plan that will result in the maximum sustainable yield of trophy bull elk. Research methods include the following procedures:

(1) Helicopter surveys are flown each winter to obtain post season sex and age ratios, estimate the minimum elk population, and map winter elk distribution.

(2) Elk are trapped in Clover box traps during January, February, and March. Captured animals are collared and ear-tagged. Radio locations and visual sightings of I.D. collared animals provide information concerning the movements and distribution of the elk herd. The survival rate of collared elk will assist in determining age specific mortality rates.

(3) Each year one hundred permanent pellet-group transects are counted to monitor population trend.

(4) Blood samples taken from trapped elk are examined for 5 hematologic characteristics and 20 blood chemistry characteristics. Viral and bacterial serological tests are also performed. These studies aid in evaluation of the health and nutritional status of the herd.

(5) Necropsies are performed on all sick, injured, or dead elk observed. Necropsy results are evaluated with the assistance of the Wild Animal Disease Center

at Colorado State University. The significance of disease in the population dynamics of the herd will be evaluated.

(6) Specific antler measurements (number of points, antler weight, length of main beam, circumference at the base) are taken from all hunter-killed bull elk. Data on antler quality and age is compared so trophy bulls can be defined in demographic terminology.

(7) The age of hunter-killed elk is estimated by tooth wear and replacement (Quimbly and Gaab 1957), and counting the cementum annuli in the root of a central incisor (Low and Cowan 1963).

(8) Uteri from hunter-killed cow elk are examined to estimate the conception rate. Ovaries from non-pregnant cows are examined microscopically in an attempt to determine the cause of the reproductive failure.

(9) Kidney fat is measured in hunter-killed cow elk (Riney 1955). Annual variation in kidney fat indices is helpful in evaluating habitat quality and the nutritional status of the herd.

(10) Data collected in this study will be evaluated by simulation modeling. Computer analysis will be used to estimate sex and age specific harvest rates that will maximize the production of trophy bull elk, and at the same time keep the herd within the carrying capacity of the habitat.

Results

A complete discussion of the results of the elk research at Vermejo Park is beyond the scope of this paper. There are, however, several research findings pertinent to the subject of trophy elk management on private lands.

Most hunters questioned at Vermejo Park indicated that the main reason they were willing to pay $2,000 - $4,000 for an elk hunt was the high success rate on trophy bulls. Therefore, it appears that the opportunity to maximize income from the elk resource increases as the number and quality of trophy bulls in the herd increases.

Data from this study indicates that 91 percent of the 6 x 6 bulls harvested at Vermejo are at least 4 years old. Maximum antler development occurs between the ages of 6 and 9 years. Bulls with the largest antlers are usually 8 or 9 years old. Bulls less than 6 years old, even though they may be 6 x 6, tend to have small, light antlers. Therefore, in order to produce the greatest number of trophy bulls, the herd should be managed to maximize the number of bulls in the 6-9 year age classes. This departs from the traditional approach to game management of maintaining young age-class herds

which provide maximum harvestable surpluses. When large numbers of trophy bulls are desired, older age-class herds with higher bull to cow ratios are necessary.

The percent of 6 x 6 bulls in the harvest has decreased from 52.3 percent in 1976 to 37.3 percent in 1979. The primary reason for this decline is that each year, more bulls are removed from the 6-9 year age classes than are entering those age classes. In addition to high hunting mortality on the 6-9 year old bulls, increasing numbers of young bulls were also harvested. The percent of bulls less than or equal to 3 years old in the harvest has increased from 30 percent in 1976 to 46 percent in 1978. (1979 age data is not yet available). This results in a vicious circle. As the number of mature bulls decreases, more hunting mortality is inflicted on the younger bulls. An increased mortality rate on the younger bulls will ultimately decrease the number of bulls surviving and entering the 6-9 year age classes, and eventually even fewer trophy bulls are available. As this cycle continues, the age structure decreases until it approaches a young age structured population, with few trophy animals, that is typical on public lands throughout the west.

The solution to this problem is to reduce the number of bulls removed from the population each year. This can be accomplished by two methods: a) reduce the number of hunters, or b) place a minimum size limit on the bulls. Correlation of age and antler point data indicates that approximately 95 percent of all bulls with antlers smaller than 5 x 5 are less than 3 years old.

Beginning with the 1980 hunting season, Vermejo Park will reduce the number of bull elk hunters by approximately 12 percent, and impose a 5 x 5 minimum size limit on bull elk. With these restrictions, the 1980 bull harvest is calculated at 145 animals, a 24 percent reduction from the 1974 - 1979 average of 191/year. This should reverse the trend of declining numbers of trophy bull elk in the herd.

In contrast to the need for reducing the bull elk harvest, low pregnancy rates (Table 1) and a high percentage of old cows in the population (Table 2) suggested the need for an increased cow harvest. The average antlerless harvest, 1974 - 1979, was 135/year (range 72 - 268). However, 50.6 percent of the total antlerless harvest occurred during the 1978 and 1979 hunting season. The increased antlerless harvest is a result of special post-season cow hunts recommended by Vermejo Park, and approved by the New Mexico State Game commission. A total of 447 hunters participated in the 1978 and 1979 cow hunts.

Discussion

Can operations similar to Vermejo Park be successful in other areas? There are several constraints to the development of wildlife enterprises on private lands (Teague 1971):

(1) Many sportsmen believe fee-hunting is an unfair commercialization of the public's wildlife.

(2) Most resource agencies fail to accept the landowner as a full partner in wildlife management.

(3) Antiquated game laws and public misunderstanding restrict realistic game harvests in many areas.

These constraints are particularly relevant to elk management on private lands in the west. Many western sportsmen are accustomed to vast areas of public lands, and the idea of paying landowners a trespass fee for hunting privileges is unacceptable. However, both sportsmen and state game departments must realize that if landowners can profit by maintaining healthy wildlife populations on their properties, then they are more willing to follow land management practices favorable for wildlife rather than production of other crops. Good game management on private land usually improves wildlife populations on surrounding public lands, and will result in better hunting on those lands. Other benefits of wildlife enterprises on private lands are discussed by Teague (1971).

As public lands become more crowded, the quality of the hunting experience diminishes. Serious elk hunters then become more willing to pay for the opportunity to enjoy their sport on uncrowded private lands. The demand for quality elk hunting definitely exists. However, the development of successful hunting operations on private lands will depend upon cooperation and understanding between landowners, sportsmen, and state game departments. An important fact to remember is that elk management goals on private lands may differ from the goals generally established for public lands. By working together to develop practical management plans for private lands, sportsmen, landowners, and the wildlife will all benefit.

Acknowledgements

Financial support for the population ecology study was provided by Vermejo Park Corporation, Kaiser Steel Corporation, and the Camp Fire Conservation Fund. The assistance of these organizations is greatly appreciated.

Table 1 Pregnancy Rates of Hunter-Killed Cow Elk at Vermejo Park, New Mexico, 1974-1979.

YEAR	NO. EXAMINED*	No. GRAVID	PERCENT GRAVID
1974	51	36	70.5
1975	32	27	84.4
1976	49	40	81.6
1977	50	37	74.0
1978	98	68	69.4
1979	197	176	89.3

* Total number examined includes yearlings. Yearlings composed less than 5 percent of the sample.

Table 2. Ages of Hunter-Killed Cow Elk at Vermejo Park, New Mexico, 1974-79.

AGE CLASS	NUMBER	PERCENT
Yearling	37	8.2
2 1/2	29	6.5
3 1/2 - 7 1/2	216	48.0
8 1/2+	168	37.3
Total	450	100.0

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Abstract Only

IMPLICATIONS OF A COMPREHENSIVE GAME DAMAGE LAW ON COLORADO ELK MANAGEMENT

Bob Hernbrode

Colorado Fish and Game

Colorado has had Game Damage Statutes since 1933 but since the enactment of HB1235 in 1979, we now have the most comprehensive game damage statutes in the U.S. In order to implement this new law, 46 pages of regulations were passed by the Wildlife Commission.

The Wildlife Cash Fund is directly affected. Damage claims for the winter of 1978-79 have approximated $400,000. Based on current estimates of damage claims potential, costs of materials and equipment, and labor costs, the average impact is projected to be $1.5 million, but could approach $3 million with a bad winter. Wildlife management services will be adversely impacted, as a greater portion of field personnel's available time will be spent investigating and handling big game damage claims.

The Division will be under considerable pressure to quit our aggressive goals of increasing elk herds in light of damage that occurs as a result of these increased populations.

STRATEGY FOR ELK MANAGEMENT DURING A PERIOD OF INTENSE OIL AND GAS ACTIVITY

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Abstract

Conditions during a period of intense oil and gas development in west-central Alberta are described. The probable impact of this industrial activity on elk habitat utilization, seasonal distribution and movements as well as its influence on hunting pressure is discussed. Harvest and land-use strategies for effective elk management within this developmental framework are examined. Possible solutions to conflicts and future research needs are proposed.

Acknowledgements

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INTRODUCTION

Elk (Cervus elaphus) management in the foothills of west-central Alberta historically has been limited to occasional habitat and population inventories and establishment of annual hunting seasons. Prior to the onset of intensive industrial activity and access development this approach probably was adequate. Relatively inaccessible range, extensive muskeg areas and the unavailability of sophisticated all-terrain vehicles kept hunting pressure to a minimum in most areas. However, the discovery of a major oil and gas field in the vicinity of the Pembina River during the fall of 1977 quickly and dramatically changed the situation. Intense exploration and subsequent development produced many hastily planned roads which in conjunction with a vast network of seismic lines resulted in almost unlimited access to critical elk winter range concentrated within and adjacent to the creeks and river valleys of the Pembina River drainage.

Prior to the "Pembina Boom" (July 1977) the provincial government introduced "A Policy for Resource Management of the Eastern Slopes". The policy outlined those activities considered to be compatible with wildlife management in areas of critical importance. Subsequently, the referral system for land-use applications was redesigned to include wildlife field staff. Government biologists in the region reviewed each proposal and submitted mitigative recommendations. The success and failure of various land-use strategies largely was a function of the implementation of special guidelines for activity within wildlife range. This paper describes the potential and real impacts of unmitigated development and proposes a management strategy designed to ensure maintenance of elk populations within a developmental framework.

ENVIRONMENTAL SETTING

The study area has been described as the lower foothills zone (Rowe 1972). Elevations, vary from 823 metres (2,700 ft.) in the east to 1,402 metres (4,600 ft.) in its western section. A series of major rivers flow in an easterly direction from the Rocky Mountains.

The climate is seasonally variable and is characterized by short, cool summers and long, cold winters. Annual precipitation totals 53 centimetres (Rowe 1972).

Muskeg plateaus, pine (Pinus contorta) and poplar (Populus tremuloides and P. balsamifera) ridges are the most common phytogeomorphic features between the river valleys. Moose (Alces alces), elk and deer (Odocoileus hemionus and O. virginianus) are the common ungulate species. Although elk can be found throughout the area in the summer, wintering animals concentrate along the creek and river valleys during this

critical period (approx. December 1 - April 30). The period of concentration probably is influenced mostly by weather and the subsequent availability of food. As snow accumulates, elk increasingly seek the relatively available forage provided by grassy meadows, willow flats (Salix sp.) and south-facing poplar and mixed wood ridges (Table 1).

PROBLEM DEFINITION

Elk are thought to be more susceptible to disturbance and harassment than other ungulates inhabiting the region. "For example species in which individuals have high life expectancies, low reproductive rates, a retention rather than dispersal of juveniles, and which inhabit widely dispersed patches of stable habitat, the alienation from available habitat is likely to be most severe, as are probably other effects of disturbance," (Geist 1971 p. 420). Morgantini (1979) indicated that the results of his study suggested that learned avoidance of human activities by hunted elk could prevent them from optimizing their distribution and habitat selection.

As a result of heightened elk response to disturbance and escalating developmental pressure within critical range, management interest in disturbance-related behavior also dramatically increased. This escalating developmental pressure is best exemplified by the intense geophysical (seismic) exploration which occurred during an eight month period in the Pembina River Valley which is critical to wintering ungulates. Developmental (drilling) activity began subsequent to the exploration phase and soon reached a spacing density in some areas of one wellsite per 32 hectares (80 acres)(Fig. 1). The next step was development of gathering systems and construction of pipelines. The cumulative effect of simultaneous exploration, development and transportation of oil and gas resources markedly altered the landscape. The problem was further complicated by limitations of manpower and funding and land management in critical areas by personnel not trained in the wildlife disciplines. Furthermore, the inability to respond quickly through legislative changes hampered managers in their attempts to ensure compatibility between oil and gas acitivity and wildlife management and counterbalance the various influencing factors. The net result was thought to have been a reduction in total elk numbers and a decrease in productivity resulting from displacement of animals from primary range.

Avoidance of an area by elk could have been a function of any/or all of the following factors:

1. Visual stimuli provided by the intense vehicular activity associated with seismic programs and drilling rigs as well as the drilling rigs themselves (extending high above the forest canopy).

Table 1. Winter habitat utilization (1978-1979) by elk within the Edson region as indicated by aerial surveys (N=259).

Habitat Type	% of elk observed in habitat type	% of surveys conducted in habitat type[a]	Utilization Index[b]
Poplar	32	10	3.20
Mixed	29	11	2.63
Willow flats	24	19	1.26
Muskeg	5	17	0.29
Conifers	10	42	0.23

a Includes one percent (1%) of surveys flown over water bodies.

b Percent of elk observed in habitat type ÷ percent of surveys conducted in habitat type.

Description of Habitat Types

Poplar: overstory dominated by poplar (Populus sp.)

Mixed wood: overstory dominated by poplar and spruce and/or pine.

Willow flats: grassy meadows associated with willow (Salix sp.)

Muskeg: poorly drained areas with sparse overstory of blackspruce (Picea mariana) and understory of bog birch (Betula pumila).

Coniferous: overstory dominated by lodgepole pine (Pinus contorta) and/or white spruce (Picea glauca).

(Photo by C.W.B. Stubbs)

Fig. 1. Aerial photograph of a fully developed gas field in an area that historically provided good habitat for ungulates.

2. Auditory stimuli from drilling rigs, explosives used for collecting seismic data, helicopter support, and all vehicles associated with oil and gas activity.
3. Olfactory stimuli from any of the above.
4. Learned response by associating any/or all of the above stimuli with hunting or other forms of harassment.
5. Physical changes to habitat (e.g. roads, wellsites, campsites).

Note: To make matters worse, the infamous "Amoco Blowout" occurred during the winter of 1977/78 along the banks of the Pembina River. This probably resulted in a concentration of human activity unequalled at any other wellsites in Alberta. Unfortunately, it was near the center of this critical elk winter range.

Secondary impacts also are an important determinant of the overall effect of oil and gas activity on elk. Increased access undoubtedly resulted in steadily rising hunting pressure. However, escalating access and industrial activity were not counterbalanced with adjustments in hunting seasons. This may implicate the cumbersome process required to change hunting regulations and illustrates the need to react quickly to changing land-use developments.

Although statistical analyses were not available, increased and uncontrolled access probably resulted in dramatic increases in both legal and illegal hunting pressure. Prior to intense development, extensive muskegs and the lack of all-weather roads minimized the elk harvest. However, with the proliferation of all-weather roads and the increase of people (associated with the oil and gas industry) in the area during hunting season, an increase in harvest would be expected. A reduction of elk in response to increased access has been documented in other areas (Thiessen 1976; Leege 1976).

Compulsory registration of elk kills in Alberta (implemented in 1975) has provided site-specific kill data and confirmed the occurrence of increased harvests. Figures 4-6 illustrate the locations of elk kills in relation to access. As new access developed into river valleys, elk harvests increased. Figures 7 and 8 illustrate this increase.

MANAGEMENT STRATEGIES - PROPOSED SOLUTIONS

The quick onset and intensive nature of oil and gas activity in the west Pembina field was unprecedented in Alberta. Furthermore, wildlife biologists had previously placed little research emphasis on the impact of human activity (other than hunting and perhaps logging) on ungulate populations (Tennessen 1979). Consequently, provincial managers had to extrapolate widely and were heavily dependent on their professional creativity to develop mitigative guidelines for industrial activity in critical elk range. Regulations appropriate to the timing, intensity and spatial distribution of industrial

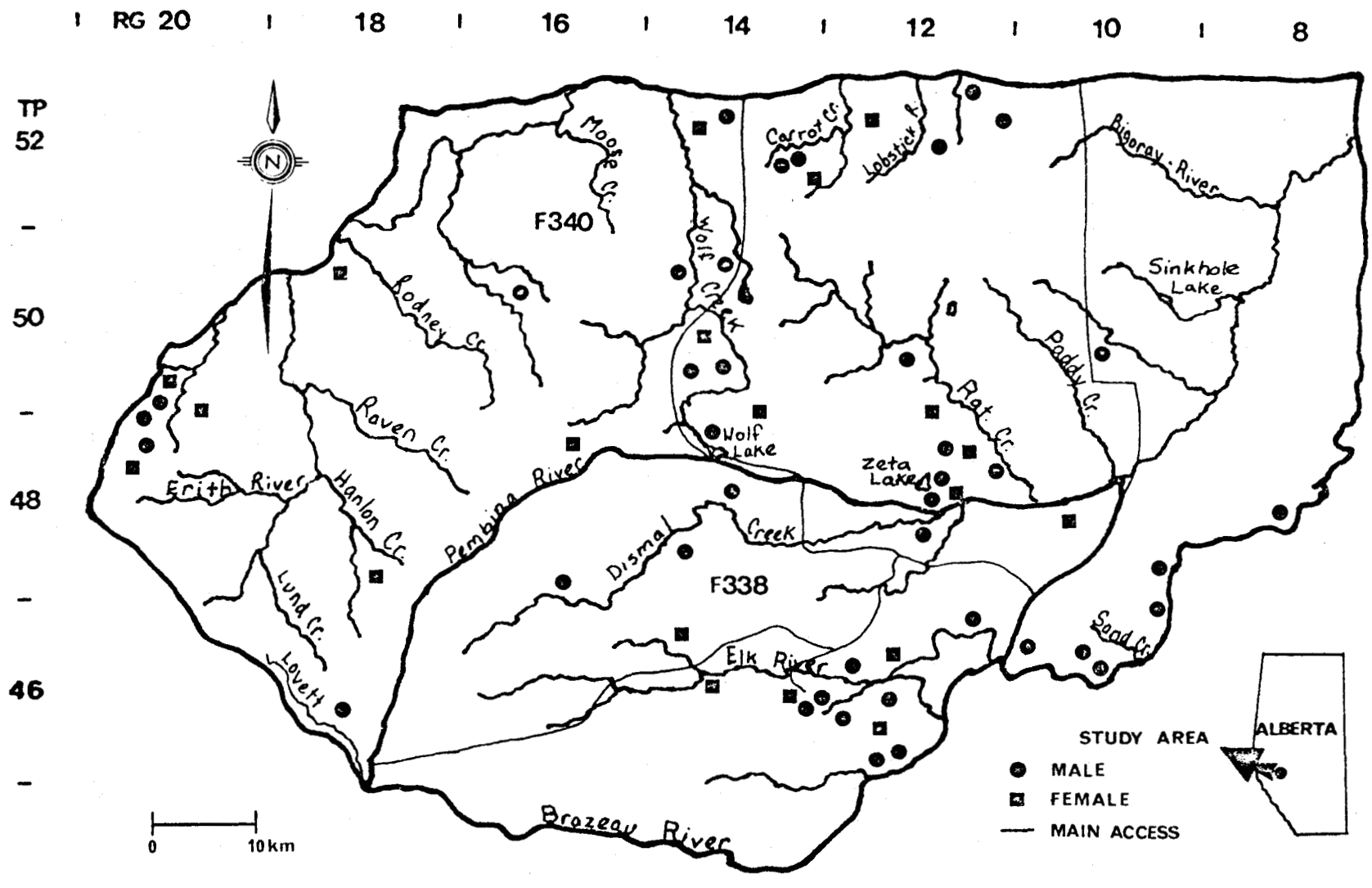

Fig. 2 Distribution of elk harvested in W.M.U.'s F 338 and F 340 during 1975.

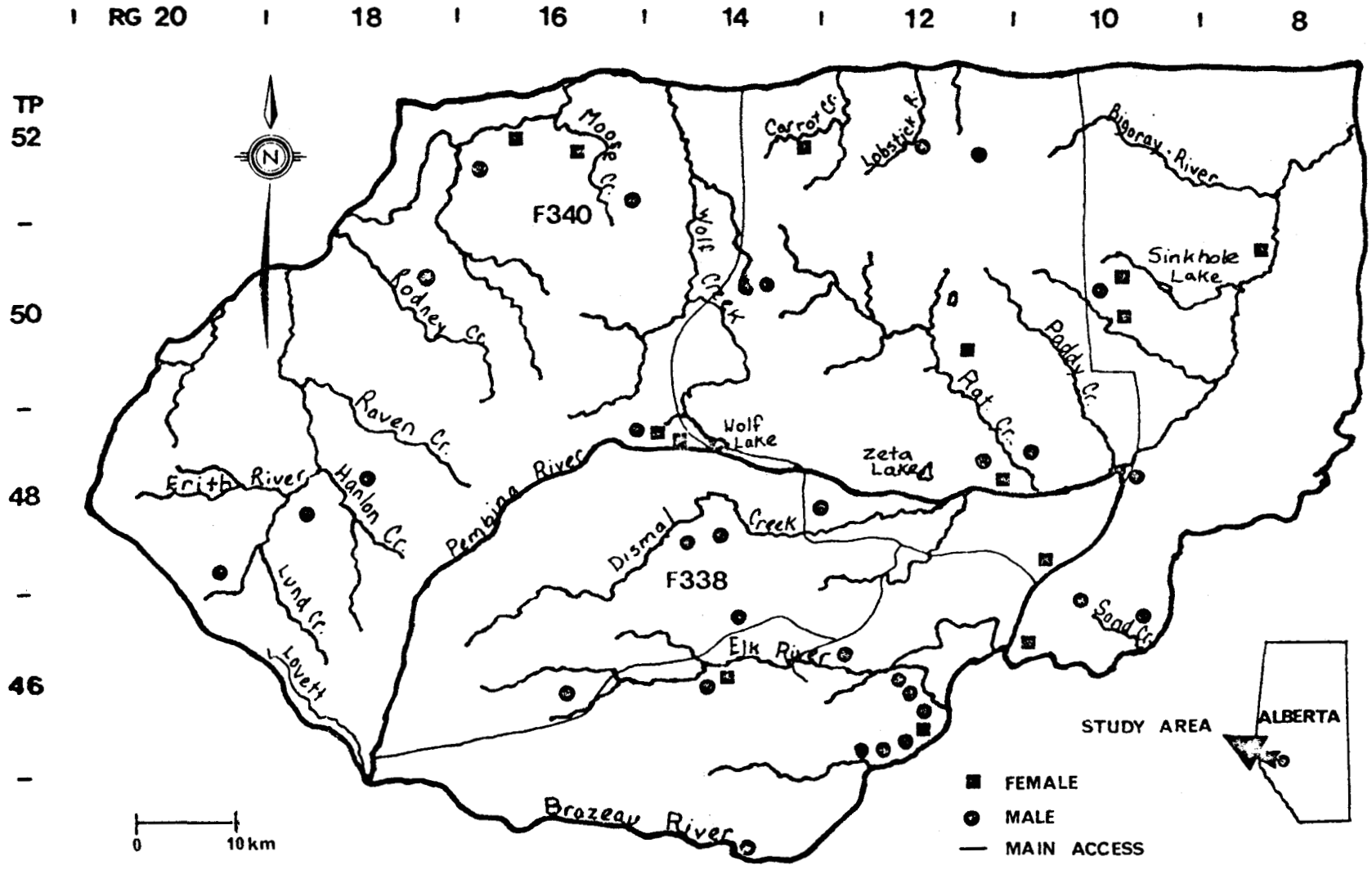

Fig. 3 Distribution of elk harvested in W.M.U.'s F 338 and F 340 during 1976.

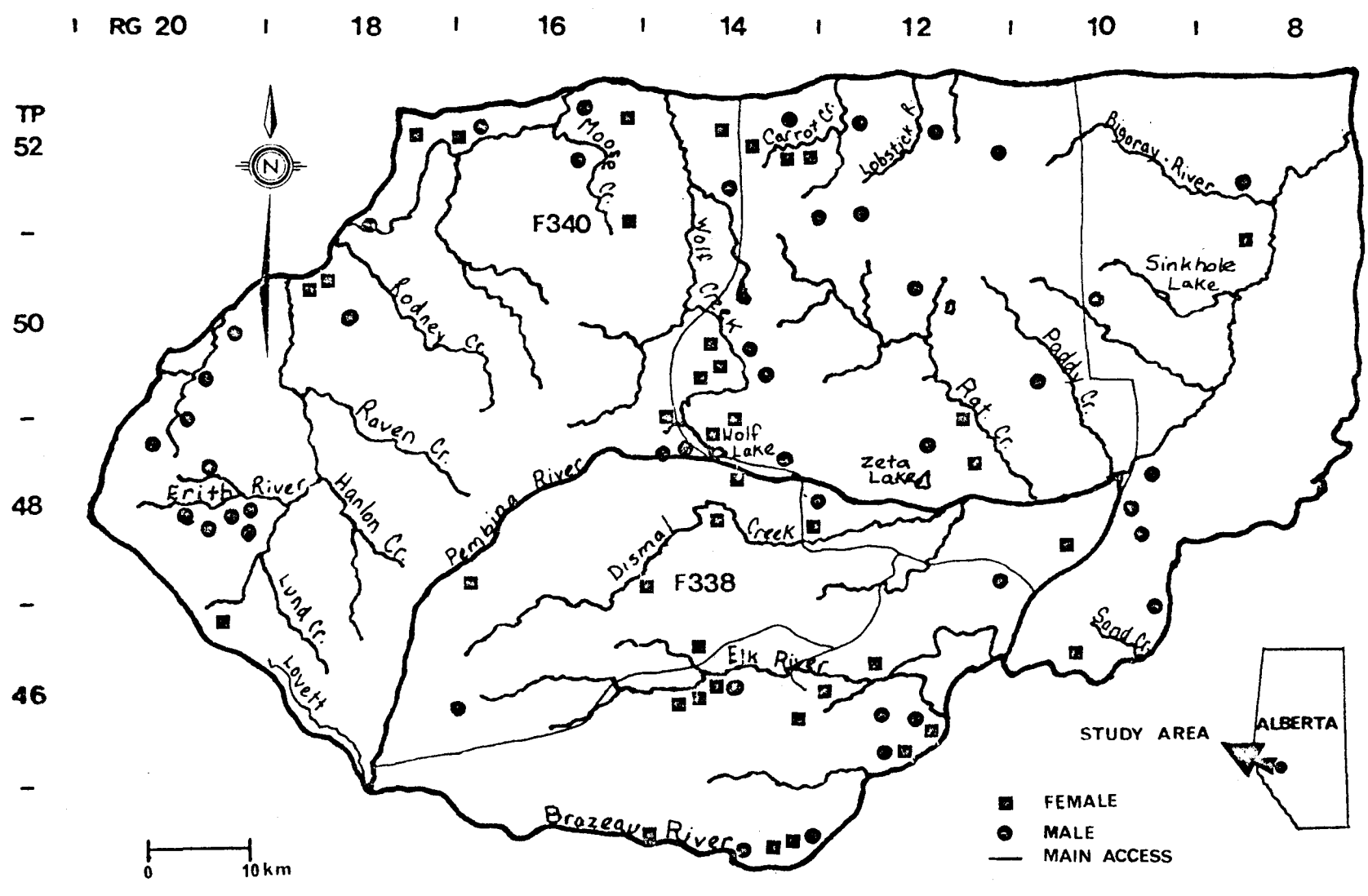

Fig. 4 Distribution of elk harvested in W.M.U.'s F 338 and F 340 during 1977.

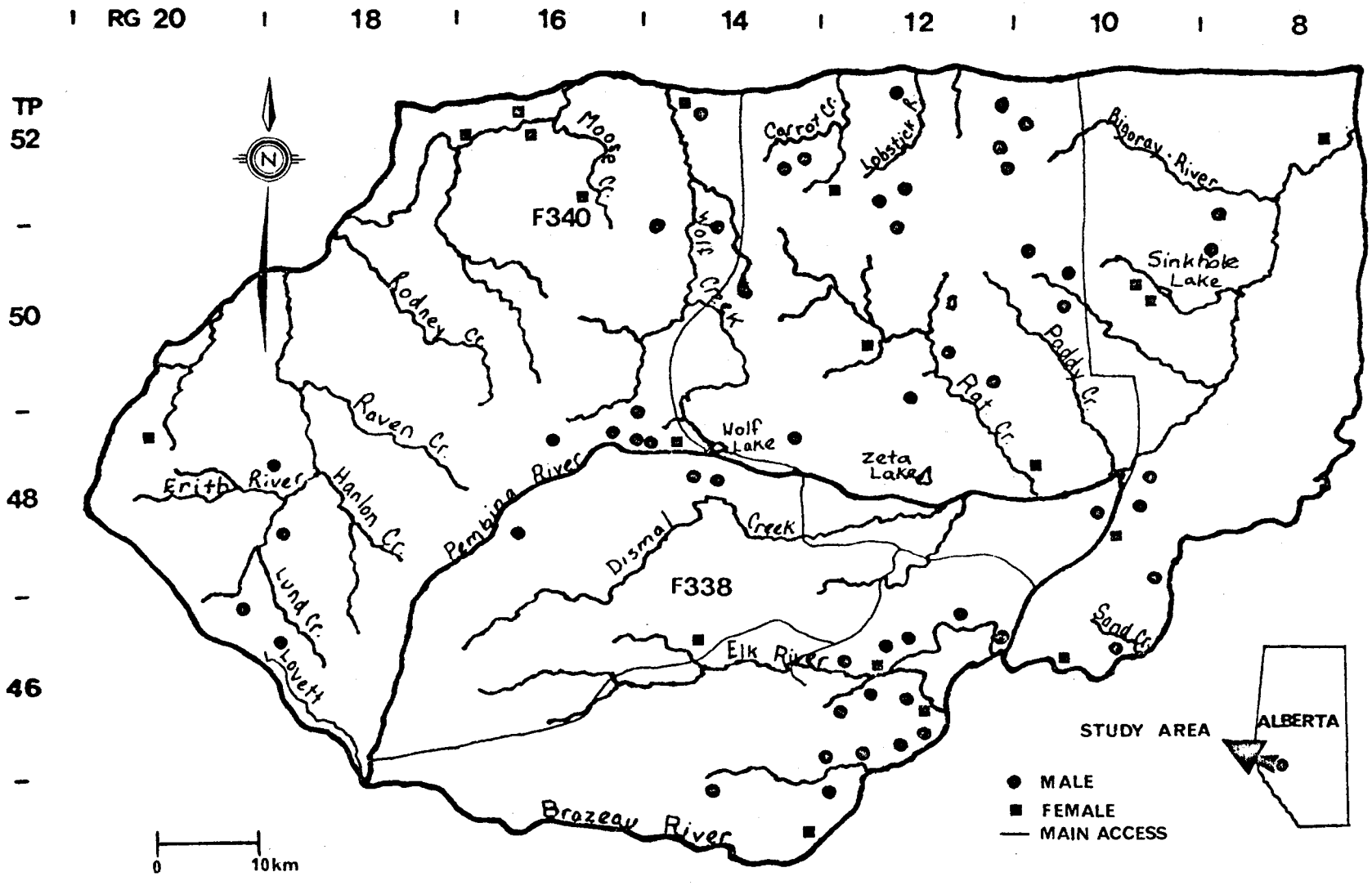

Fig. 5 Distribution of elk harvested in W.M.U.'s F 338 and F 340 during 1978.

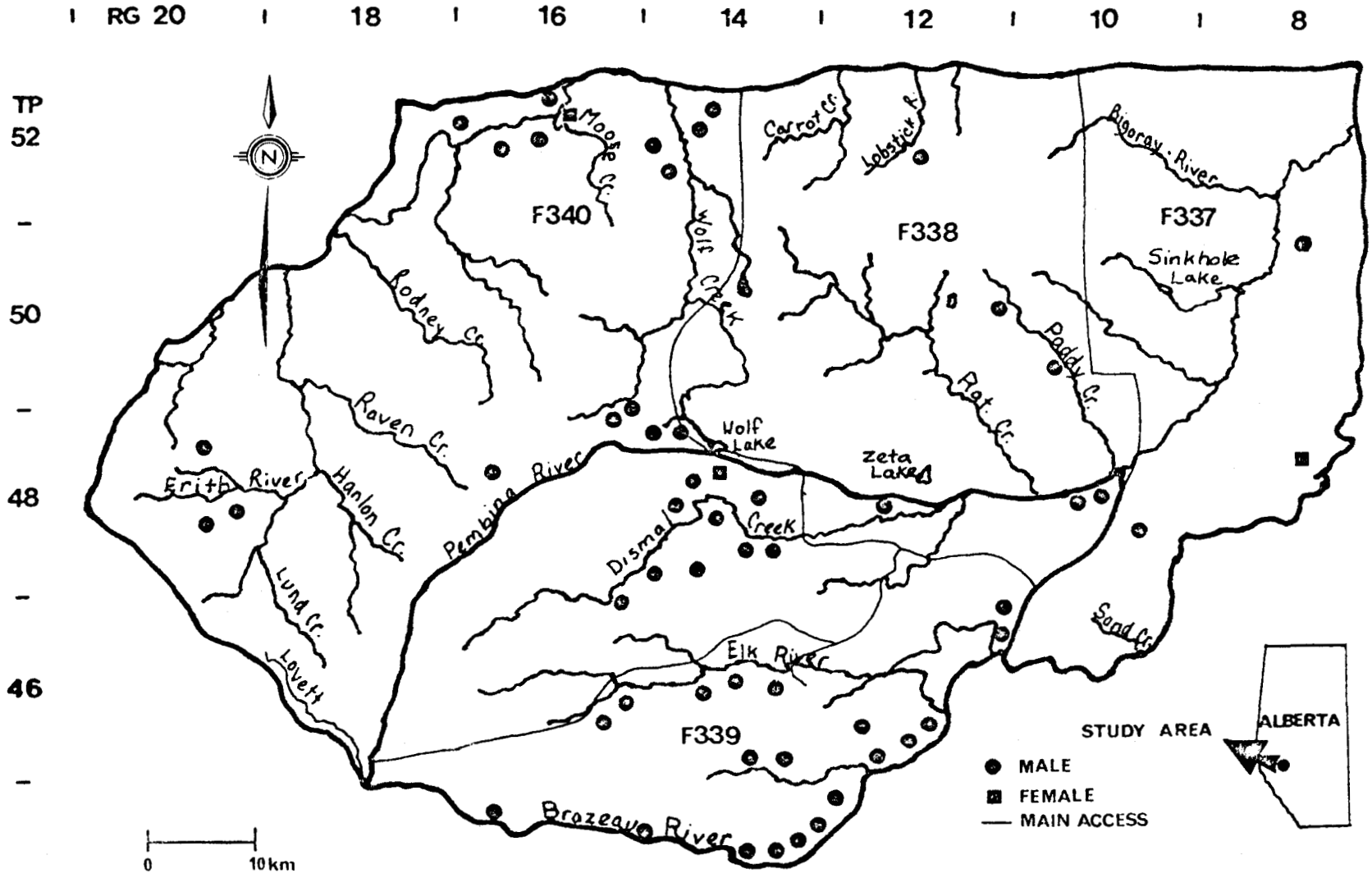

Fig. 6 Distribution of elk harvested in W.M.U.'s F 337, F 338, F 339 and F 340 during 1979.

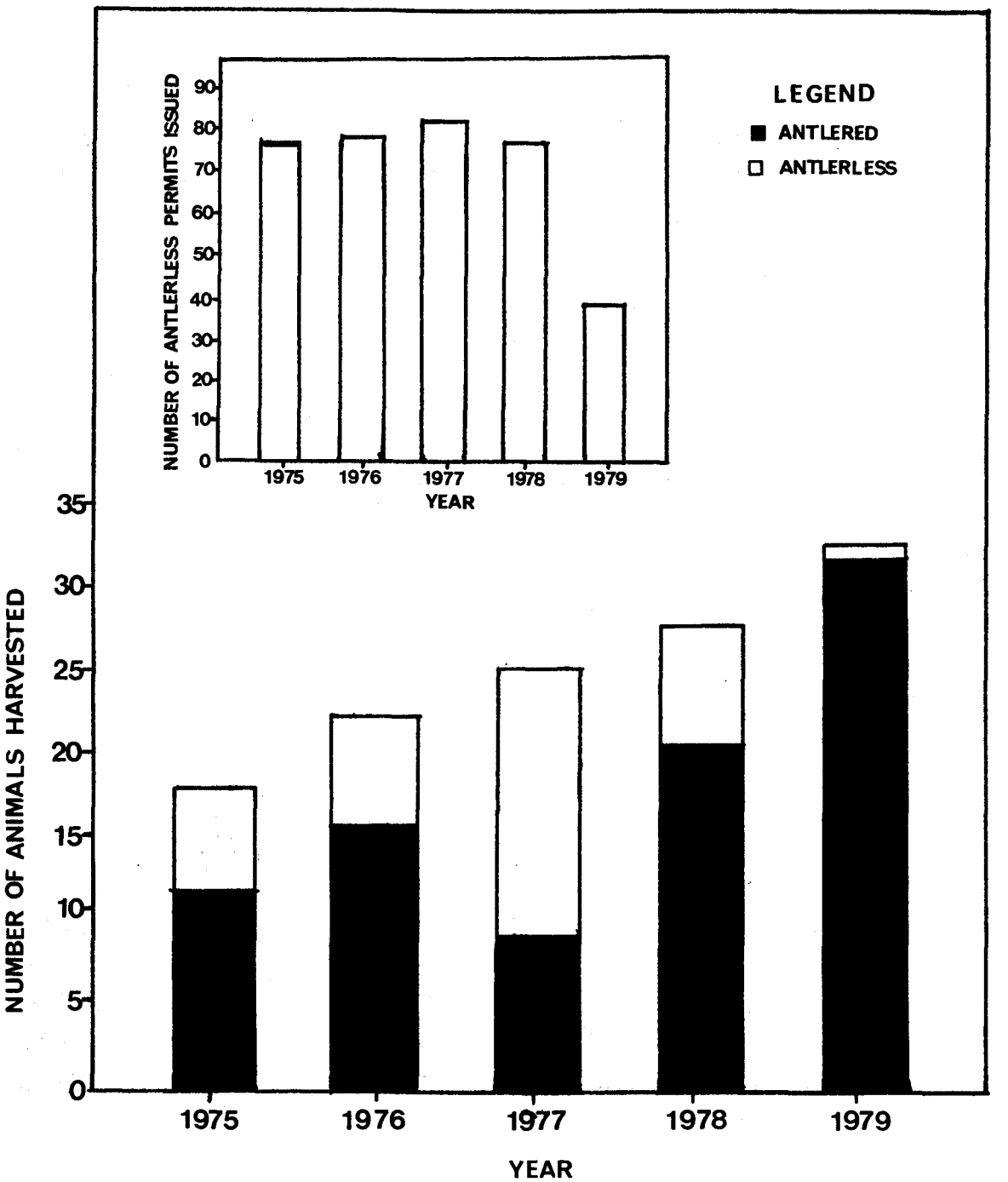

Fig. 7. Yearly elk harvest in W.M.U. F 338 (1975-1979).

Note: W.M.U. F 338 was designated as F 339 in 1979.

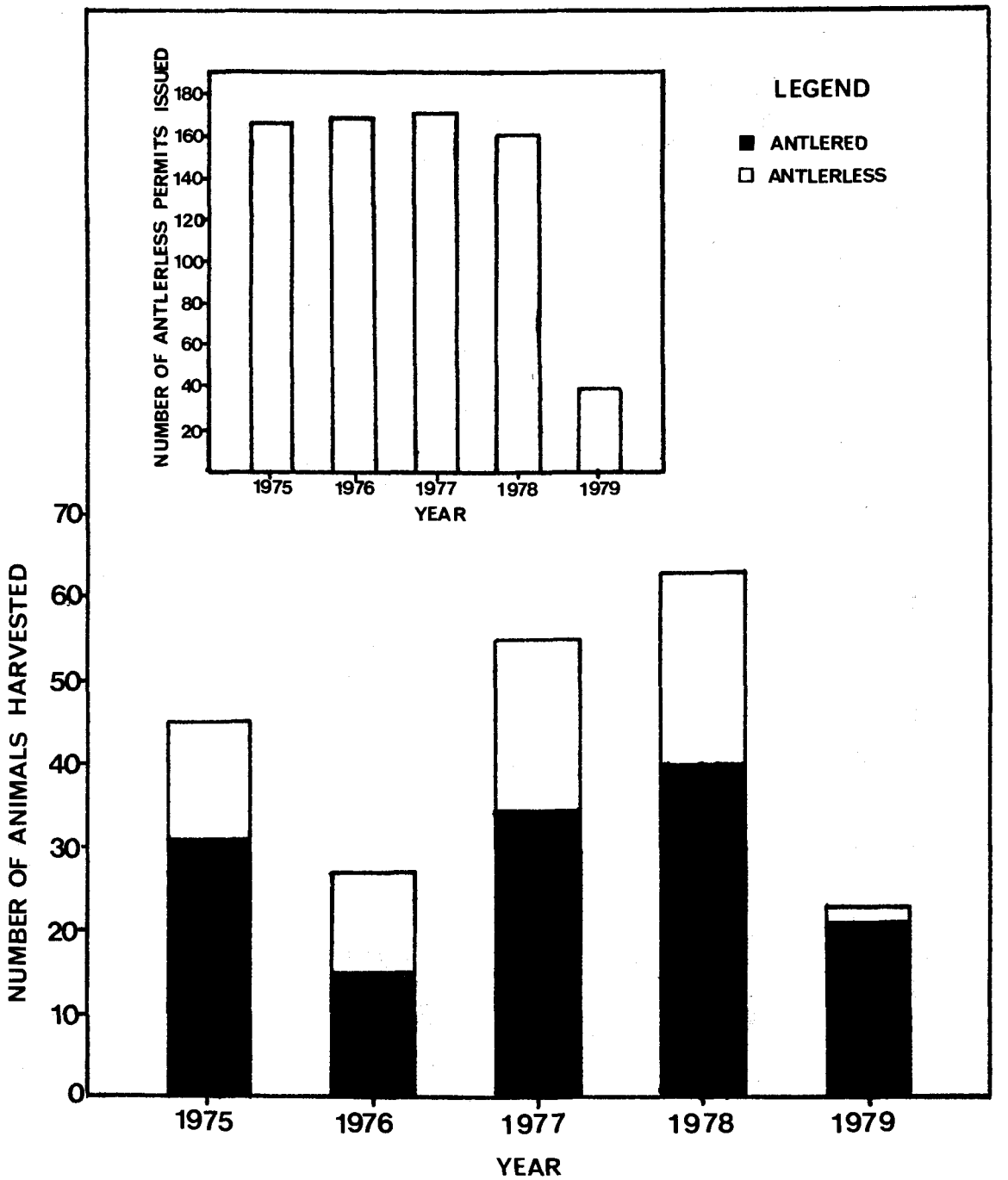

Fig. 8 Yearly elk harvest in W.M.U. F 340 (1975-1979).

Note: F 340 was divided into 3 W.M.U.'s in 1979.
Total elk harvest illustrated for 1979 is for all units.

programs were developed. Additional guidelines attempted to modify programs to make them more compatible with wildlife management. In some instances, and especially where large programs affected sensitive species or habitats, biological monitoring programs were a prerequisite for Fish and Wildlife approval. Guidelines were applied to geophysical exploration, wellsite construction and development of oil and gas fields (e.g. access and pipeline construction).

1. Seismic Activity (Exploration)

The vast majority of regulations concerning seismic lines are applied by the Alberta Forest Service and they largely concentrate on soil erosion, stream siltation and timber salvage. However, the Fish and Wildlife Division recently became involved in the processing of land-use applications within critical wildlife areas in an attempt to reduce the negative effects of industrial activity.

One serious consideration in reviewing seismic proposals was the timing of activity. Much of the geophysical exploration in west-central Alberta had been targeted for winter largely because of wet summer conditions. However, this directly contradicted wildlife management strategies designed to minimize unnecessary and negative shifts in energy balance during winter when both the physical condition of animals and the quality of their range (absolute and relative) decline (Moen 1973). Furthermore, disturbance may disrupt traditional herd use of critical winter range (Telfer 1978) and force animals into marginal habitats. Consequently, activity between December 1 and April 30 has been discouraged as a general rule. Nonetheless, each individual application was reviewed on a site-specific basis and according to animal distributions, weather and the overall level of industrial activity in a given year. It is generally accepted that high snowfalls increase dependence on, and activity within wintering areas (which also may be used for calving in some instances). Furthermore, the impact of seismic activity probably is cumulative and where one program might be easily tolerated, numerous seismic projects create considerable impact from line-clearing, explosions, machinery, vehicles, campsites and concentrated human activity. Consequently, shared collection of seismic data may be one solution.

Another problem was avoidance of roads by elk. This has been documented by numerous researchers (e.g. Hershey and Leege 1976; Marcum 1976; Perry and Overly 1976; Ward et al. 1976; Rost and Bailey 1979) and effectively causes range discontinuity. This may be attributed to vehicular activity, lack of protective cover along roads (visual harassment) and physical barriers resulting from steep cutbanks or high snowberms.

Although seismic lines only would be classified as primitive trails, the level of activity in some instances approached that of secondary roads. Furthermore, subsequent

recreational use compounded the problem. Consequently in order to minimize habitat loss and the development of an uncontrolled and dense network of access, seismic lines were restricted to minimum spacing between lines of 0.8 km (1/2 mile) for conventional programs (defined as 8 m right-of-way and accessed by vehicle) and 0.4 km (1/4 mile) spacing for portable methods (defined as 3 m right-of-way and accessed by foot with helicopter support). However, a complicating factor in this choice is the uncertainty whether the greater access provided by conventional methods is more of a problem than the helicopter support used during portable operations.

Disguising the whereabouts of seismic lines also can greatly assist in reducing the pressure from recreational use, particularly along conventional lines. However, the practice of placing completed lines into the public domain and thereby increasing hunting pressure by virtue of greater access probably creates the greatest potential danger to local populations. Therefore, portable programs often were favored because of their restricted access after program completion. The most serious consequences of unrestricted access are believed to be abandonment of traditional range and overharvests.

Several other guidelines (regulations) placed on conventional programs can assist in resolving the access problem. Line-of-sight diverts ("dog legs") were required every 360 m, on either side of existing access and ridge tops (Fig. 9). This should reduce the incidence of wounded animals resulting from long shots by hunters in areas of extended visibility along straight seismic lines. Furthermore, the reduced disturbance should allow increased foraging by elk along undisturbed seismic lines.

The most obvious method used to eliminate access was to block seismic lines at their intersection with all existing access. Several methods exist and include piling debris onto completed lines (most commonly used) or cross ditching. However, despite the clear benefits for wildlife management this procedure has not been consistently followed. Perhaps the two major reasons are pressure from recreational groups for unlimited, uncontrolled access and the competitive exploration policies of the oil and gas industry. Rather than share information collected in a sensitive area, companies prefer the exclusive information approach and individually collect their own data in an overlapping fashion in the same areas and often along the same seismic lines.

Perhaps the most sophisticated approach to ensure compatibility between wildlife management and the oil and gas industry was to implement biological monitoring programs. The basic function of the monitor was to ensure that operating conditions are followed as prescribed (and thereby minimize the negative impacts) and to design mitigative guidelines for further activity in the area based on an evaluation of the

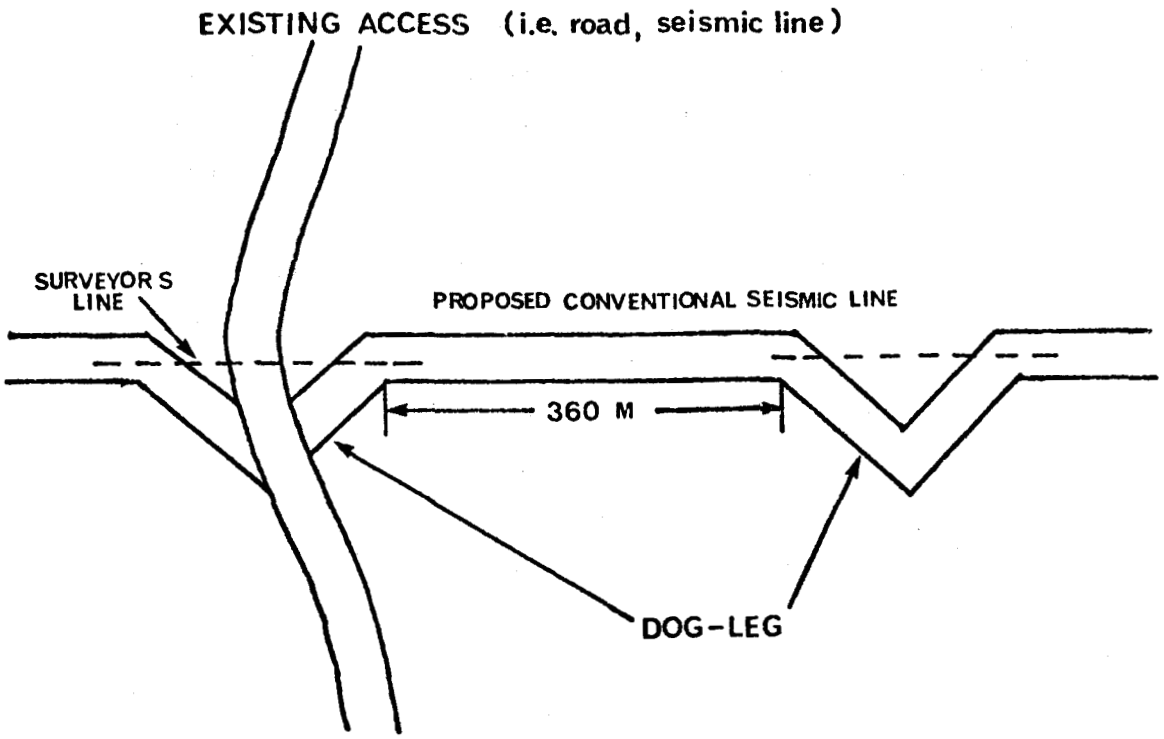

Fig. 9. Illustration of "dog-leg" technique used to reduce line-of-sight on seismic lines.

program's impacts. The success or failure of the program was largely a function of surveys (ground and air) conducted prior to, during and after the industrial program and the authority of the monitoring biologist to adjust field operations as required to ensure compatibility on a site-specific basis. Although communication problems have developed because of the involvement of subcontractors (Horejsi 1979) this approach has been successful both in resolving field problems and developing a continually improving set of operational guidelines.

2. Wellsite Development (Construction and Operation)

Many of the regulations required for seismic programs also were applied to wellsite construction and operation (e.g. timing restrictions, access control and monitoring programs). However, drilling programs represent a much more intensive (albeit more localized) and longer term activity and, therefore, require additional guidelines. Although, each wellsite proposal was reviewed on a site-specific and species specific basis, wildlife managers also must anticipate the long-term implications of development in the area and often do not have sufficient time or information to provide mitigative guidelines.

Access remains a serious problem and may be of greater concern because of the "permanent" nature of roads associated with producing oil and gas wells. In addition, high grade roads which provide better recreational access are required for the transportation of heavy drilling equipment and supplies.

Associated and subsequent developments such as maintenance activities, campsite locations, pipeline construction and corridors also must be considered. Finally, the decision largely is a function of animal distributions and seasonal requirements, the locations of roads and wellsites and the length of time required to complete the drilling program.

The key guidelines applied to reduce the impacts of wellsites and associated access are:

1) Careful choice of road alignments to avoid passing too close to or through critical areas (Collins et al. 1978).
2) Provisions of buffers sufficient to reduce harassment and allow continued use of important range. The importance of buffers to elk patterns of habitat use has been amply documented (Black et al. 1976; Ward 1976).
3) Relocation of wellsites and campsites proposed in seasonally important areas (e.g. natural clearings used during winter) into adjacent and less sensitive sites such as dense timber stands. Directional drilling can be of particular importance when the program extends beyond the recommended December 1

cutoff date for industrial activity in critical wintering areas. However, under extenuating circumstances (e.g. loss or breakage of drilling pipe) or if conditions permit; limited, closely controlled extensions have been granted. Nonetheless, every attempt has been made to avoid program commencement at a time when it is obvious that considerable winter activity will be required and conflicts may be unavoidable.

4) Construction of roads and wellsites when elk are absent from an area or at least during those periods when they are less sensitive to disturbance.

Under circumstances when wellsite development and access construction have been approved during winter or in highly sensitive areas additional conditions have been applied including:

1) Introduction of a manned, locked gate restricting access to individuals not associated with the program. This has provided considerable benefit in minimizing secondary impacts from hunters and recreational vehicle users.
2) Restrictions on the recreational use of firearms, snowmobiles (and other recreational vehicles) by company and service personnel in the program area and within sensitive zones. Illegal harvests by oil and gas industry personnel have been documented in the region (G. Chantel pers. comm.).
3) Transportation of as much material required for the program onto the site by December 1 and limiting removal of equipment prior to May 1. This effectively reduces unnecessary vehicular activity.
4) Limiting snow berm accumulations along roads (similarly along seismic lines) to 50 cm. In addition construction of roads with steep cutbanks have not been permitted. Both conditions reduce their physical barriers to movements.
5) Implementation of core travel times (e.g. during mid-day 1,000-1,500 hrs) so that vehicular traffic is heaviest during periods when elk are less active and animal movements are reduced.
6) Introduction of aircraft corridors outside of the sensitive areas and establishment of minimum overflight heights of at least 250 m unless taking off or landing.
7) Closure of roads into sensitive areas upon completion of industrial programs. Roads should be revegetated with suitable browse species to enhance ungulate use.

In essence, our approach was first to eliminate unnecessary (but, nonetheless, harmful) factors associated with oil and gas developments. Subsequently, we attempted

to modify programs to reduce their direct impacts on local wildlife populations. Only when it was obvious that conflicts could not be resolved was total program rejection recommended.

3. Oil and Gas Field Development

Identification of a producing oil and gas field typically has been followed by development of collecting systems, processing plants and pipelines. Major concerns are associated with the location of these facilities and their construction schedule.

The approach to facility location was similar to that used for access and wellsite construction. Pipeline and particularly industrial plant location in elk winter range has been strongly discouraged. Furthermore, an attempt is made to locate these facilities within timbered areas and thereby separate industrial sites and key elk habitats by suitable buffers.

Pipelines are perhaps easier to manage if the appropriate guidelines are followed. Construction projects during periods when elk are absent from the area or are less sensitive to disturbance are preferred. However, conflicts may arise with fisheries management and attempts to minimize stream sedimentation. In deference to fishery management considerations and water quality protection standards every attempt has been made to schedule construction when moderating snow conditions allow animals to move into other areas and simultaneously when ice and stream flow reduction is sufficient to address fisheries concerns. Consequently, alignments which avoid critical areas and movement corridors have been encouraged as much as possible.

4. Hunting

It is widely accepted that failure to control access and/or adjust hunting seasons to offset increased industrial pressure can result in declines in the size and distribution of elk populations (e.g. Thiessen 1976; Leege 1976). Even in areas of controlled access adjustments may be required particularly if access is not removed after program completion. Development of these contingency plans has been recommended because subsequent developers may successfully have agreements to reclaim roads set aside or because the manned, locked gates are removed without reclamation.

Portions of two wildlife management units (W.M.U.) are located within the West Pembina Oilfied. In 1979, in response to increasing harvests and a general decline in animals observed, the Alberta Fish and Wildlife Division instituted more conservative hunting seasons in the area. (Management Unit F 340 was divided into three smaller and more manageable units, F 337, F 338 and F 340). The two most accessible and heavily impacted units (F 337, F 338) were restricted to a two week hunting season which represented a substantial reduction from the 70 day average season characteristic in the

area from 1966 to the present. In addition, antlerless elk authorizations were eliminated in W.M.U.'s F 337 and F 338 and were substantially reduced in Units F 339 (formerly F 338) and F 340 (Figs. 7 and 8). These changes predictably resulted in lowered harvests in Units F 337, F 338 and F 340. However, harvests in F 339 simultaneously increased. Although adequate data is not yet available, it is assumed that hunters (many from the nearby city of Edmonton) traditionally active in Management Units F 337 and F 338 (or the equivalent area in the pre-1979 W.M.U. F 340) chose to relocate into F 339 rather than be restricted to a two week season. Further changes will be recommended to ensure wider distribution of hunter activity and thereby establish seasons which local populations can tolerate during industrial development. Despite the benefits of reductions in season length more innovative and sophisticated modifications in harvest strategies are required. Permit hunts (authorizations) based on increased inventory data should maintain male and female harvests at an acceptable level regardless of industrial development of increased access (this approach does not preclude adjustments as required to offset habitat disturbance or loss). In addition, authorization systems allow for quicker and more precise changes in response to rapidly changing developmental activity.

Establishment of temporary sanctuaries also has potential benefits. Under this scheme, hunting would be prohibited during periods of intense industrial activity and major emphasis would be placed on mitigating land-use conflicts. However, in areas of intensive and long-term development, permanent sanctuary status may be the only suitable method to maintain remaining elk popualtions. Schultz and Bailey (1978) found that unhunted elk were disturbed very little by human activity. Consequently, not only would continued hunting further destabalize elk populations but, it also could maintain their heightened response to disturbance and thereby exacerbate land-use problems (Tennessen 1979). The continued avoidance by ungulates of areas of human activity several years after hunting closures has been documented (Batcheler, in Geist 1971; Douglas 1971).

DEVELOPMENT OF MANAGEMENT STRATEGIES AND RECOMMENDED RESEARCH

In areas of minimal access and industrial or recreational pressure elk populations can be capably managed on the basis of periodic surveys and collection of trend data. However, with the onset of intense land development activity and associated access populations can not be effectively managed without regular surveys to determine the size and distribution of elk populations and their changes in response to developmental activity. However, this approach will require a major (philosophical) change in

government commitments to widllife management. Without the means to collect the required data on elk populations and distributions, harvest, habitat alteration and land-use pressures and the ability to quickly alter mangement strategies in response to this information elk management will remain (at best) a crude attempt to apply general information to site-specific circumstances and often after the fact. Management strategies must be based on real data if they are to be successful and must be able to respond quickly to changing situations. To respond after large-scale changes in populations, habitats and activity patterns more often than not has been futile.

Appropriate research progams should concentrate on evaluating elk response to various industrial and recreational activities and developing mitigative guidelines. Many of the negative impacts are more a result of needless practices and activities associated with development than the program itself. However, this should not be misconstrued to mean that the problem is superficial. Attitudes, largely reflected in actions, are the most difficult factors to alter. Not only must industry change its often indifferent attitude toward wildlife management but government policies which overlook or encourage incompatible practicies should be reviewed.

From a scientific perspective research should concentrate on the types and consequences of disturbance and associated animal reactions. Heart-rate telemetry is one method to measure immediate response and should be further evaluated. Several studies have had promising results (MacArthur et al. 1979; Ward et al. 1976). In addition, direct observation studies of disturbance also should be continued. Perhaps one outcome of these research programs will be the design of low-impact methods for exploration and development of oil and gas resources. Irregardless, both industry and government should immediately review current industrial practices and undertake intensive population and habitat inventories in an attempt to ensure successful elk management within a developmental framework.

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THE MUSKWA-LIARD ELK HERD
AN HISTORIC AND ECONOMIC PERSPECTIVE

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One of the most northern native elk (Cervus elaphus nelsoni) herds in North America is located in a remote roadless area west of the Alaska Highway, in northeastern British Columbia. Concentrated in an area between the 58 and 59th degrees of latitude, isolated segments of the herd have been reported within 30 miles of the Yukon border (Gullickson pers. comm.). B.C. Fish and Wildlife Branch estimates (Harper, unpub, 1972) and more recent aerial censuses of the area (Peck, 1980), indicate a thriving population, thought to exceed 4,000 animals.

The area inhabitated by elk in northeastern B.C. is on the eastern slope of the Rocky Mountain Front Ranges and adjacent foothills that are drained by easterly flowing tributaries of the Muskwa and Liard rivers, which by way of the MacKenzie system eventually reach the Arctic Ocean. The specific segment of the elk herd that I am investigating is on one of the northern tributaries of the Muskwa, the Tuchodi river, but in general my comments will apply to elk throughout the area, which will be referred to as the Muskwa-Liard herd.

In terms of topography, a tremendous west to east elevational gradient exists in the area, with peaks exceeding 2,900 metres in the core of the mountains, giving way to valley bottom elevations of less than 800 metres in the foothills some 60 km eastward. This elevational difference, and the west to east valley orientation create conditions that facilitate the development of periodic chinook winds on this lee side of the mountains. As a result, the foothill region is favoured with an unique climate, characterized by moderate temperatures and low precipitation. The relatively snow free west and south facing slopes, in turn, provide critical wintering areas for elk and other ungulates (Silver, 1976).

The vegetational character of lower elevations in the area, have been described within Krajina's (1969) boreal black and white spruce (Picea mariana and P. glauca) biogeoclimatic zone (Annas, 1977), while the upper elevations fall within the subalpine spruce-willow birch (Picea-Salix-Betula) zone (Pojar, 1976). Fire has had a tremendous influence in determining a rich and diverse vegetational mosaic. Hansen (1950) notes that "fire has played an important role in the past as well as in the present. Practically all stages of succession can be seen along the Alaska Highway". Annas (1977) suggests a

characteristic fire frequency of 70-120 years. Large hot wild fires appear to have burnt much of the area in the early 1900's resulting in remnant spruce stands restricted primarily to valley bottoms and moist north facing slopes. Upland south and west facing slopes are characterized by stands of aspen (Populus tremuloides) and balsam poplar (P. balsamifera). Associated shrubs include a variety of willow (Salix spp.), buffaloberry (Sheperdia canadensis), labrador tea (Ledum groenlandicum), shrubby cinquefoil (Potentilla fruiticosa), and rose (Rosa spp.). Recent prescribed fires on upland sites have stimulated considerable Populus regeneration, and where repeated, produce prolific grass/forb communities. Characteristic graminoids include hairy wild rye (Elymus innovatus), northern brome (Bromus pumpellianus) and a number of bluegrasses (Poa spp.), and fescues (Festuca spp.). Abundant forbs include fireweed (Epilobum augustifolium), lupine (Lupinus spp.) and a host of vetches (Astragulus and Oxytropis spp.).

The remote location and relative obscurity of the Muskwa-Liard elk herd has led to a documented record of their existence that is sketchy at best. Therefore in addition to historical accounts, government records and files, a number of local informants intimately familiar with the area were contacted and interviewed. These informants included guide-outfitters, trappers, natives, Fish and Wildlife and Forest Service personnel, and bush pilots.

Precontact with the whiteman, these northern Rocky Mts. were inhabitated by the nomadic Sekanni Indians, of Athabascan lineage (Jenness, 1937). Remants of their presence still exist in the form of an occasional old axed stump and a few campsites, suggesting that they were still hunting on the tributaries of the Muskwa in the early 1900's (Henry, 1934). An elderly native lady recalled the burial of a "Great Chief" on upper Gatho Ck. when she was a child (D. Peck pers. comm.). Apparently, the abundant wildlife attracted these early indigenous hunters to the area, but the low native densities reported by Jenness (1937) suggest that it must have been a tough and meagre existence. The effect that these early natives had on their environment can only take the form of speculation at the moment, although there is considerable evidence available from an ethnological study of related tribes in Alberta to the effect that these early natives could have set fires to enhance their hunting opportunities (Lewis, 1977).

The Peace River, some 150 miles south of the Muskwa region, provided a navigable canoe route through the Rockies for the early explorers, and much of the early history is in relation to it. Alexander MacKenzie in 1789, and Simon Fraser in 1806 passed through the area in their quest for a route to the Pacific Ocean, and both gave comment to the abundant wildlife on the eastern slopes of the mountains. MacKenzie (1801) and his

journal reported that "Elk (moose), stag (wapiti), and buffalo were so common along the Peace River as to make the country resemble a barnyard." Fraser (1806) noted that the indians got plenty of animals "...that is, moose and red deer by chasing them with their dogs on the crusts." The fur traders that followed continued to comment on the "... red deer that were peculiar to this quarter" (MacDonald, 1872). Harmon (1820) reported that "... throughout the whole course, from this fall (Vermillion) nearly to the Rocky Mountains, at a little distance from the river, on each side, there are plains of considerable extent, which afford pasture for the red deer or elk."

It appears however, that at some point in the mid-1800's, elk disappeared from the banks of the Peace River. There is some possibility that they accompanied the wood buffalo in the hide and pemmican trade promoted by the Hudson's Bay Co. (Hewitt, 1921), but there is also considerable evidence that a severe winter, or series of them decimated the herds. Wm. Ogilvie, Dominion Land Surveyor, reported that "... the explanation given is that a heavy fall of rain occurred in one of the winter months, about twenty-five years ago (cira 1866), which completely saturated the snow, which was frozen, and converted into an immense cake of ice, and the buffalo and all animals that graze and do not browse were nearly exterminated." Hewitt (1921), reports that over 14 feet of snow fell one winter in the mid-1800's. A government treaty expedition in 1899 noted that "... in reference to the herds of buffalo and elk seen by MacKenzie (1789) and Simpson (1828)... the existing tradition is that some sixty years ago, a winter occurred of unexampled severity and depth of snow, in which all the herds perished and never recovered their footing on the upper river" (MacFarland and Mair, 1908). Preble (1908) indicated that the elk that formerly ranged on the plains of the Peace River were extinct over part of its range. (i.e. along the Peace River in B.C.).

During the 1800's, very few whitemen had ventured into the Muskwa-Liard region, but one isolated report of elk on the Muskwa drainage, cira 1850 is available. Richardson (1851) commenting on the mammalian fauna of the north, notes that "... the wapiti is not known on Slave River or Lake, but further to the west it ranges as far north as the east branch of the River of the Mountains, where Mr. Murdoch MacPherson informs me he has partaken of their flesh." (River of the Mountains = Liard, the east branch = the Ft. Nelson or Muskwa). During the early 1900's, first a few trappers, and then surveyors and mapmakers began to find their way into these more remote regions, and reports of a small band of elk on the tributaries of the Muskwa began to filter back to civilization. It appears, therefore, that elk in these mountain valleys had survived the factors that decimated the Peace River herds and were maintaining themselves as a viable population.

The early trappers and surveyors apparently killed a number of elk in the region for camp meat (Rand, 1946). One of the first permanent trappers on the Tuchodi River, cira 1926 - 27, recalled that he used to burn the sidehill off in front of his cabin so that he would have a redy supply of elk meat over the winter (Al Larson, from pers. comm with Don Peck). The Provincial game warden, A. Bryan Williams, claimed knowledge of the elk herd in northeastern B.C. (Rand, 1946), but it was not until Sheldon (1932) reported their existence in the B.C. Journal of Mammalogy that the herd gained official recognition.

The interest of the scientific community were soon aroused, and specimens collected on Gatho Ck. (Prairie River), by the Harry Snyder expedition in 1935, found their way to the National Museum of Canada (Rand, 1946). The same year, the provincial game commission expressed an official interest in the herd, and sent a game warden (W.L. Forrester) to investigate. He reported back a herd of some 200 animals, all in good condition (Rand, 1946). The occasional mention of the elk herd by game commission reports into the 1940's, suggested that the elk were holding their own at an estimated 150 animals, and were being protected by a closed season.

The completion of the Alaska Highway during the Second World War, provided the first all season vehicular access into this northern part of the province. With this improved access and renewed postwar economic confidence, the guide outfitting business began to expand in the mountainous regions west of the highway. Elk were occasionally sighted, primarily on the Tuchodi and Gatho Ck. drainages, and although the occasional one was taken for camp meat, their low numbers seemed to warrant the continued closed season (Don Peck, pers. comm.).

Throughout the 1950's, these guide outfitters hunted where they pleased, roaming through the area with their pack strings, with periodic rendezvous on the Alaska Highway, or at remote lakes to change hunters. Towards the end of the decade, however, they began to think about organizing their industry, an effort which culminated in exclusive guiding rights in specific areas alloted to each individual guide outfitter in 1961 (Hannaford, 1977). With this security, a number of guide outfitters established permanent basecamps in the mountains, and obtained grazing rights for their horses in the vicinity. In an effort to improve these ranges for horses, each spring found the outfitter out trying to burn off some of the south facing hillsides in his area. Considerable opposition to the outfitter burning program was expressed by the Forest Service in the initial years but the regions remoteness, a few sympathetic rangers, and the eventual realization that there were really no valuable timber being destroyed, led to quite a substantial area being burnt. In recent years, the Forest Service, through its

mandate of managing grazing rights in the region, are allowing prescribed burning on a permit basis.

Along with establishing some pretty good horse pasture, the burning seems to have had quite a positive effect on the elk population. A bull only season was initiated in 1961, restricted to two weeks, with elk on the moose tag on either/or basis. By 1964, elk warranted their own tag, and a lengthy season was established, which has cumulated in the three month bull, and two to three week cow season in effect today (B.C. Fish and Wildlife Branch files). As this started out as an unofficial program there was unfortunately no official monitoring of the elk response to burning, although local guide outfitters estimate that there has been a tenfold increase in elk numbers since the 1950's (Garry Vince pers. comm.).

The guide outfitter prescribed burning program has traditionally been at the individual's discretion, that is in deciding the when, what, where and how to burn. Burning is primarily in the spring and is generally restricted to the drier west and south facing slopes. Moist valley bottoms, rocky outcrops, and north slopes act as natural fire breaks at this time of the year (late April-early May). Simple ignition techniques, utilizing horseback and matches are characteristic, although in recent years, aerial ignition has been touted as a possible solution to the limited lite-up time available.

The area that has been intentionally burnt in the last twenty years is substantial. A portion of virtually every south facing hillside, along at least four of the major drainages has been burnt at least once, and more often two to three times in the past twenty years. Elk concentrations and distribution correspond fairly well with the areas that have been recently burnt. The general burning strategy followed has been to initially burn an area, to top kill the existing Populus stands, and then subsequent burning at three to four year intervals. Fires are relatively small, restricted to the 100-200 ha. of a hillside, but under certain conditions may get quite a bit larger, such as a major fire on the upper Muskwa that burned an estimated 7,000 ha. in 1977 (G. Vince, pers. comm.).

Elk appear to have responded to the burning programs by an expansion in range and a substantial increase in numbers. Current investigations into the population response, and habitat use of these elk in relation to fire are still in the preliminary stages, but the initial data suggests extensive use of recently burnt areas. Elk have been osbserved on burns within a month of a fire, and winter concentrations on burned over hillsides are particularly evident. In the face of a complete complement of predators (i.e. wolves, bears, etc.) the herd appears to be quite productive, with preliminary overwinter composition counts indicating 50-60 calves/100 cows (Peck, 1980).

The harvest data for the past fifteen years indicates that there has been a steady increase in harvest since the original season, which may reflect similar population trends, as well as increases in the number of hunters (Table 1). Currently, in excess of 200 animals are taken annually in the area. Harvest data has been differentiated between resident (i.e. of B.C.) and non-resident hunters, as the data has been collected by two different methods, and will be considered separately.

The non-resident figures have been compiled from analysis of the compulsory guide outfitter reports, and is the actual harvest taken by the guide outfitter clientele. As all non-residents require the services of a guide outfitter by law, these data represent the total non-resident harvest. This harvest is restricted primarily to "trophy" class bulls (98% of kills, 1964-79, N=1011)(B.C. Fish and Wildlife Branch files). Age data collected on the Tuchodi river harvest for the 1977-79 hunting seasons has been analyzed for 1977 and 1978. The mean age of bulls taken approaches six years (5.76). Over 65% of the animals harvested had a 6 x 6 rack or better, (N=70), and the success ratio for non-resident elk hunters was close to 100% (Peck, 1980).

This makes the area very attractive to the non-resident elk hunter, and as a result the guide outfitters can and do ask a considerable price for their elk hunts. Whereas in the early 1960's elk hunts were available for $500 to $1,000, they now run from $2,000 - $3,000 (guide outfitters pers. comm.). Therefore the 100+ non-resident elk harvested annually in northeastern B.C. represent $200,000 to $300,000 in terms of guide outfitter fees. Licensing, transportation and a variety of costs would significantly increase this total.

The resident harvest data, in the form of reported and estimated harvest, is based on the B.C. Hunter Sample, and although there is some question of its accuracy, general trends can be extracted. Until quite recently, the resident take made up a relatively small portion of the total harvest. This reflects the inaccessibility of the area to the resident hunter, and a general lack of knowledge as to elk distribution in the area. However, recent improvements in riverboat technology, in the form of inboard jets, have made the rivers more accessible to the resident hunter. Dramatic increases in the number of hunters, and subsequently in the harvest has been reported in recent years (B.C. Hunter Sample). The 1978 estimated resident harvest equalled the non-resident harvest, and indications are that it exceeded the non-resident harvest in 1979. Little reliable data on the composition of these kills are available, although it is assumed that they are primarily bulls, taken early in the season, when high water facilitates access. Characteristically low water during the October cow season restricts access, and subsequently harvest. Placing an average value on the resident harvest is difficult, but $1,000/animal harvested should at least be a minimum figure.

Rough computations of the preceding values, indicates that the northeastern B.C. elk herd brings in at least 1/4 to 1/2 a million dollars annually. Quite a valuable resource, in light of the cost of a few matches!

What does the future hold for the Muskwa-Liard elk herd? Preliminary provincial elk management objectives include increasing elk numbers in traditional habitats, and in line with management as a game species, increasing harvest (to a maximum of 10% of the herd). Controlled burning is recognized as a viable prescription to enhance elk habitat (B.C. Fish and Wildlife Branch 1979).

Harvest trends in northeastern B.C. suggest a continued increase in the proportion of the harvest that will be taken by resident hunters. Concurrently the attractiveness and quality of hunting for the non-resident will decline. The possibility of alleviating future conflicting resident/non-resident harvest demands by an expansion of the burning program beyond the areas that have traditionally been burnt by guide outfitters is one alternative that warrants investigation.

Table 1. Elk Harvest North Eastern B.C.

Year	Non Residents	Residents Reported	Estimated (Residents)
1979*	103	N/A	N /A
1978	100	71	102
1977	92	47	N /A
1976	93	40	77
1975**	88	20	47
1974	76	4	19
1973	79	27	144
1972	73	8	27
1971	75	11	30
1970	63	8	47
1969	62	9	25
1968	54	1	3
1967	40	8	25
1966	27	N/A	N /A
1965	16	N/A	N /A

* Unit 7-42, 7-47, 7-50, 7-51 (1976 - 1979)

** Old G.M.A. 27 (1967 - 1975)

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REPRODUCTIVE RATES, AGE STRUCTURE AND MANAGEMENT OF ROOSEVELT ELK IN WASHINGTON'S OLYMPIC MOUNTAINS

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INTRODUCTION

Four years ago the Game Department recognized that work should be done on the Olympic Peninsula Roosevelt Elk (Cervus elaphus roosevelti) herds. The biological work was to be basic, was to involve department personnel and the public, and was to have practical management application. This report summarizes some of that work.

Present and future demands on the Roosevelt Elk resource and a declining habitat base requires better understanding of elk populations and their ecology and continuing improvement of management systems. This report concerns studies of important population characteristics and effects of human use of elk populations. Habitat is discussed as it relates to population characteristics brought about by interactions of human use of elk populations.

Study Goals and Objectives

Management is decision making. Good decisions require basic knowledge of the population, its habitat use and condition, and human influences. A goal of these studies was to improve the information base on which population management was based. A result has been an improved system of arriving at recommendations for population management.

Specific objectives for the studies were as follows:

1. Determine sex and age composition.
2. Determine age-specific productivity of females.
3. Analyse the elk harvest for temporal distribution, composition, etc.

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My wife Nancy contributed field assistance, encouragement, patience and a good deal of understanding. My daughters Jennifer and Barbara surrendered some of daddy's time.

STUDY AREA

Located on Washington's Olympic Peninsula, the study area occurred in three counties: Clallam, Jefferson, and Grays Harbor (Fig. 1). Information on pregnancy, lactation, age composition, hunter pressure, and harvest characteristics was collected from the following Game Management Units: 600 Ozette, 607 Soleduck, 612 Goodman, 615 Clearwater, 618 Matheny, 639 Humptulips, 636 Skokomish, 648 Wynoochee, 645 Hoquiam, and 651 Satsop. Information on sex and age composition was collected from these Game Management Units and from a small area located approximately 12 miles within Olympic National Park. This area has been well described by Jenkins (1977).

The major study area, on the western side of the Peninsula, varied in elevation from near sea level to about 4,000 feet. Generally, the terrain is lowest and most gentle in the west. Elevations increase to the east, as does steepness of the terrain. Glaciation has significantly influenced topography of this area, creating broad U-shaped river valleys. Abundant precipitation, varying from 80 to 160 inches per year on the study area, has contributed to steepness of the terrain through down-cutting by rapid streams. Most precipitation (about 80%) occurs from October through March in this marine climate (Raedeke, 1980). Most precipitation is received as rain below about 1,000 feet, rain and snow between 1,000 to 2,500 feet, and as snow above 2,500 feet. Winter conditions and lowland snowfalls are highly variable in occurrence and severity.

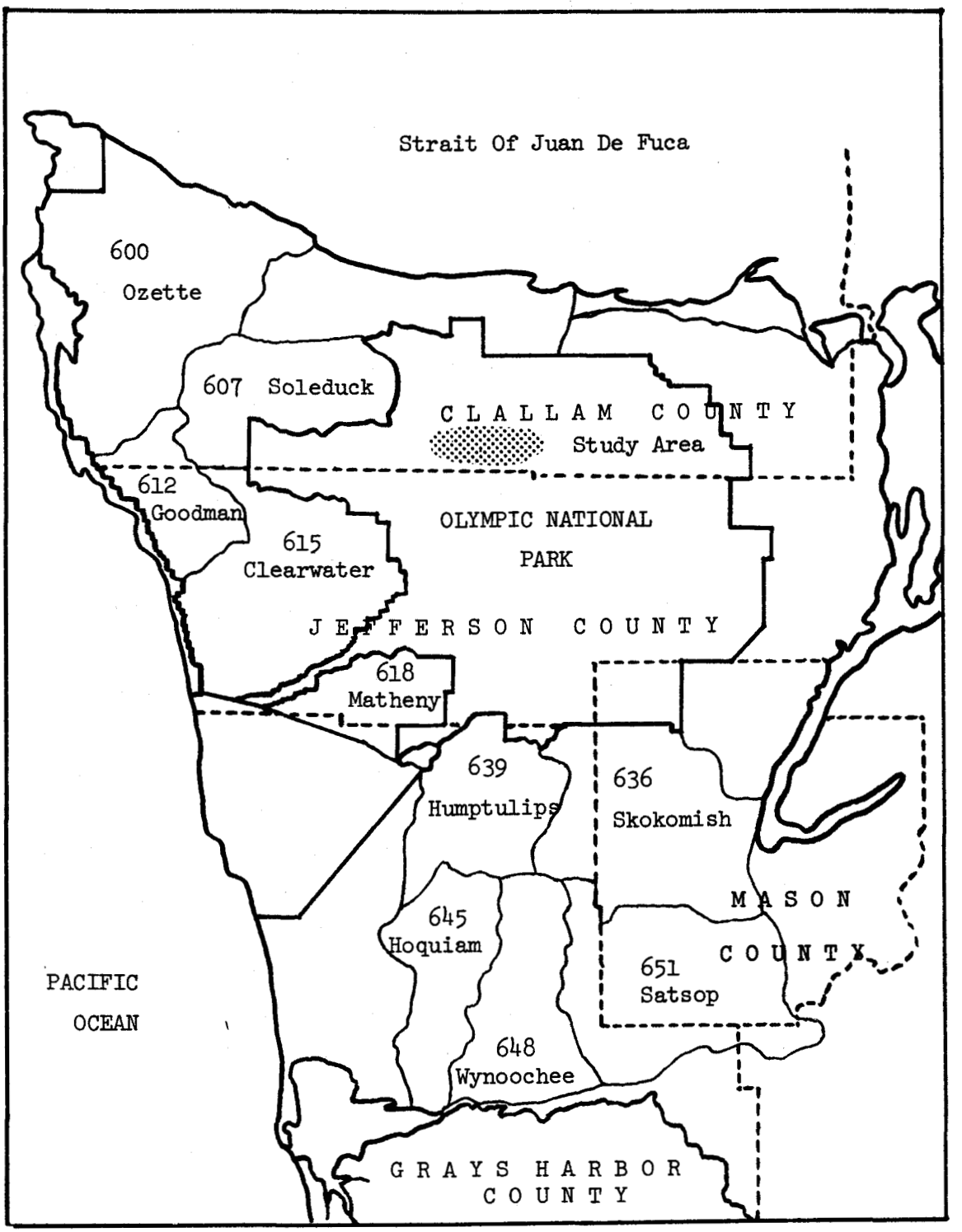


Figure 1. Study areas, counties, and Game Management Units from which information was collected on the Olympic Peninsula.

Franklin and Dyrness (1973) recognize four major vegetation zones for western Washington; all of which are present within the study areas. The coastal zone, dominated by Sitka Spruce, Picea sitchensis, occupies the broad western coastal plain. The Western Hemlock, Tsuga heterophylla, zones is most extensive. Moving eastward and increasing in elevation, the Abies amabilis zone dominates. In the highest elevations of the major study area, and in much of the Olympic National Park study area, Mountain Hemlock, Tsuga mertensiana dominates.

Land ownership varies within the study area. Large tracts are owned and managed by private timber companies. Extensive state forests also occur here. Parts of three districts of Olympic National forest are included within the study area. The central core of the Peninsula is occupied by Olympic National Park. National Park lands and other lands adjoin in such a manner as to create extensive boundary areas (Fig. 1).

Roosevelt elk are native to the moist forests of Washington's Olympic Peninsula. Since recorded history for this area, there have always been significant Roosevelt elk populations here. The Peninsula was the Roosevelt Elk stronghold during market hunting days early in this century. In fact, this population has served to restock or establish Roosevelt Elk in western Washington and in other Pacific Northwest coastal forests (Troyer 1960:15:Batchelor, 1965:1). In 1909, Mount Olympus National Monument (now Olympic National Park) was created solely for the purpose of protecting elk and deer within its boundaries (Raedeke, 1980:37). Despite the areas obvious importance to the subspecies, most studies of Roosevelt Elk populations on the Peninsula, have been surveys of elk populations DeGraaf (1941), Jones (1953), Morgenroth (1909), Morgenroth (1921), Murie (1935), Newman (1958), Pautzke, Lauchart, and Springer (1939), Skinner (1936), Smith (1918), and Springer (1939). Schwartz (1936), (1938), (1939), and Schwartz and Mitchell (1945) reported on a more exhaustive study of Olympic Peninsula elk populations, their biology, range conditions, and management. Brent (1967) summarized some population management practices on the Olympic Peninsula.

METHODS AND MATERIALS

Productivity

Collection of Reproductive Materials

Ovaries, uteri, udders, and mandibles or primary inscisors were collected from cow elk killed by hunters within the study area. In 1976, collection kits were mailed to each permittee prior to the opening of hunting season. This method followed closely that used by Kuttel (1975:4, 7-8). In 1977, 1978, and 1979 collection materials were distributed

only to interested Game Department field personnel working within the study area. This method proved less expensive, more productive, and had the benefit of exposing department personnel to the research, some basic reproductive biology, and exposing more hunters to the project.

Prior to the hunting season, each cooperator was supplied with adequate sets of the following materials:

1. A letter describing what was needed and why (Fig. 2).
2. Pre-numbered (permanent ink) labels and tooth envelopes (with corresponding numbers) for primary inscisor teeth, mandibles, and ovaries, uteri, and udders (Fig. 3).
3. A pair of pliers for pulling primary inscisor teeth.

Field personnel patrolling hunting areas located freshly killed animals and collected necessary materials while interviewing the hunters. Date of kill, sex of animal, location and other pertinent information were recorded (Fig. 4). Udders were examined at the kill location when possible, lactation status was recorded on a Big Game Field Check form, along with the corresponding sample number, and the udder was discarded (Fig. 4). Additionally, primary inscisors were collected at established checking stations within the area. Location of the kill was obtained and attempts made to collect ovaries, uteri, and the udder. Reproductive materials collected this way were matched to inscisors or mandibles by sample numbers. Reproductive tracts (uteri and ovaries) were frozen at the Bogachiel Rearing Ponds or Aberdeen Steelhead Hatchery or preserved in 10% Formaldehyde for later examination.

Most reproductive materials and teeth were collected during the November general season. None were collected earlier than November 1. A smaller number were collected during extended damage or late hunts (November through January 31) and a few were collected from illegal kills found in February, March and April.

Evaluation of Reproductive Materials

Udders were examined when collected by cutting them open and scraping the internal tissue with a knife blade. Presence of milk on the blade indicated lactation, which was assumed to indicate production of a calf during the previous calving season. Many different personnel performed this examination.

Uteri were microscopically examined internally for embryonic or fetal development indicating pregnancy. When small membranes were found but no embryonic development was visible, a 4X hand lens was used to detect the embryonic tissue.

STATE OF WASHINGTON
Dixy Lee Ray
Governor

DEPARTMENT OF GAME
Region 6
P.O. Box 44
Aberdeen, WA 98520

Figure 2. Letter describing needs and collection methods for elk age structure and reproductive materials.

October 25, 1978

TO: Elk Study Cooperators

FROM: Jack Smith, Game Biologist II

SUBJECT: Elk Information needs for 1978 season.

As you are all aware, the elk season is almost upon us. What you may not be aware of is that this may be the last season for collecting those messy elk reproductive tracts and udders (three cheers). The very simple tooth collections will continue as an annual part of our management program, however.

Because this is the last year, I'd like to make it the best also. That is only possible with your continued, valuable assistance.

Enclosed are the plastic bags for collecting the female reproductive tract and udder from cow elk. A tag with wires is included for labeling the samples in the plastic bags. The two center inscisor teeth should also be collected and placed in the numbered envelope provided. Again this year, please record the sample number(s) on the Successful Big Game Field Check form. Also, if you cut open the udder (milk bag) and scrape it, you can simply record on the Field Check whether the cow was lactating (milk present) or not lactating (milk not present). If you do not want to cut the udder open, please include it in the plastic bag. These samples are especially valuable if we have the reproductive tract, information on lactation status, and the two center inscisor teeth for aging.

Again, we need the two center inscisor teeth (unbroken) from bull elk older than yearlings (1 and one half years). Any bull with a full set of 8 large inscisors qualifies. Single envelopes are enclosed for these also. Please record the total number of points from each antler on your field check. (5-6 or 5 x 6) This we are correlating with age.

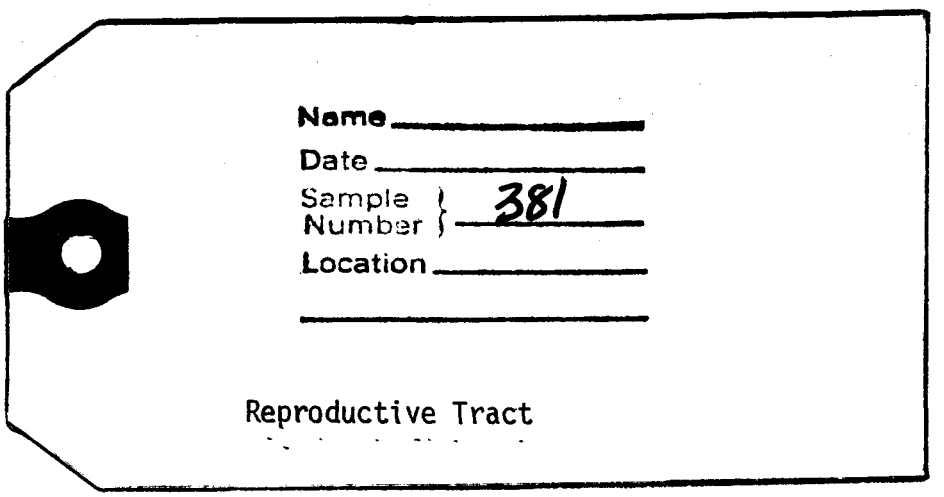
Lastly, please ask the successful hunter whether he plans to have the elk commercially cut or do it himself. Record a yes-or no on the back of the field check. If he answers yes, please include the name of the locker plant and city where its located. This may help us find new lockers and will let us get a preliminary harvest estimate for the needs of administration.

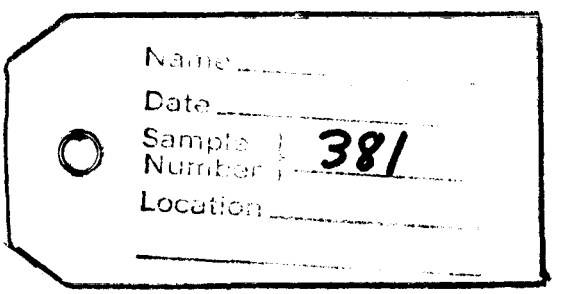
As in past years, Al Rasmussen and Kelly Lund will be assisting in these collections. Kelly will be working the Humptulips-Wynoochee areas and Al will be in the Forks area. I will be working the Forks area and the Matheny Unit during the first 3 or 4 days of the permit season and in the Humptulips-Wynoochee area the last 1 or 2 days. If you can't get to a gut pile or illegal kill please note the exact location and pass the information to Kelly Lund, Al Rasmussen or myself as soon as possible. Ravens make short work of exposed gut piles and the stench from decaying illegal kills can even make a demented biologist sick!

Thanks for your help guys. See you during the season.

JS:j

Figure 3. Prenumbered tags and tooth envelope for primary inscisor teeth and/or mandibles, and ovaries, uteri, and udders.





Mandible

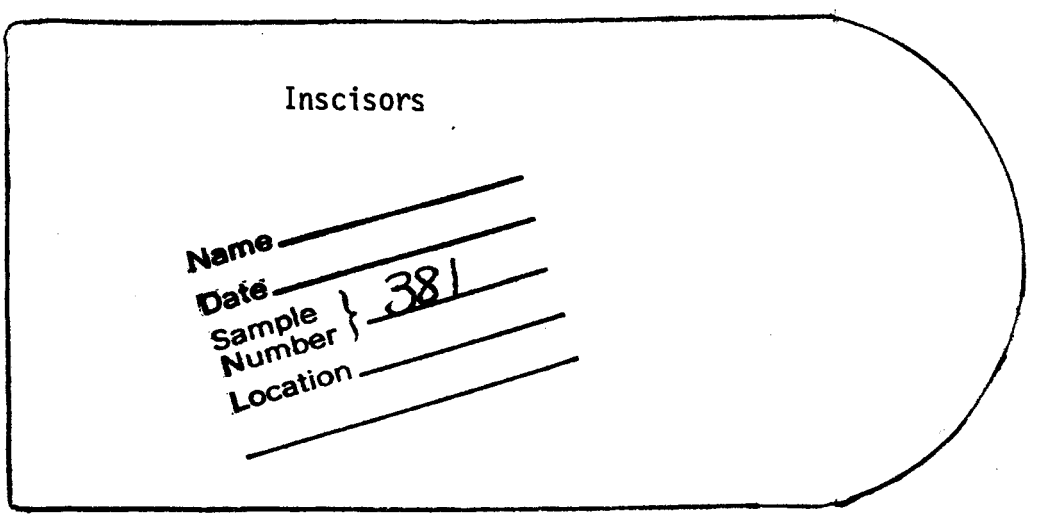


Figure 4. Sample number, lactation status, and other information recorded on Successful Hunters Field Check Form.

SAMPLE NUMBER 712

SUCCESSFUL HUNTERS FIELD CHECK

Hunter's Name BILL STINGER

Address 1412 NEWBERRY, ELMA

Deer or Elk Tag No. W15623

Date of Kill 11-11-78

AREA WHERE KILLED

Game Management Unit 600 - OZETTE

Local Area COLBY CREEK - 5024 spur

County CLALLAM

SPECIES KILLED

Mule Deer .....

Black-tailed Deer .....

White-tailed Deer .....

Elk X

Other .....

SEX OF ANIMAL

Male .....Buck ..... Bull .....

No. of Points .....

Fawn or Calf .....

Female ....Doe ..... Cow X

Fawn ..... Calf .....

Approximate age (if known) 2½+

Recorded by SMITH-117

LACTATING

Herd Composition

Elk composition counts were conducted in both study areas from September 1 to October 15 while elk were actively rutting. Animals seen were classified into four groups: Branched antlered bull, spike bulls, cows, calves. Only groups thought to be completely counted have been included in the analysis. Bulls were classified by antler presence and form, cows and calves were differentiated on the basis of size, coloration of pelage (calves tend to have a more orange and darker rump patch), and the length of the nose or muzzle (calves have a proportionately shorter nose than older elk)(Kuttel, 1975).

Portions of both study areas were covered by vehicle or on foot, whichever was appropriate, during early morning and evening hours. 7x35 binoculars and a 15x-60x variable powered spotting scope were used to classify elk seen.

Age Structure and Analysis

General age structure information was derived from composition counts. This includes the actual relationship between yearling and older bulls, as well as the actual composition of calves in the population.

Age structure information for older animals was derived from those mandibles and primary inscisors collected during the November through January elk seasons. In the field or at check stations, elk ages were determined into three classes: calf or $\frac{1}{2}$ year old, yearling or $1\frac{1}{2}$ year old, and $2\frac{1}{2}$ or older elk. The tooth replacement method was used here (Swanson 1951; Quimby and Gaab 1957). Primary inscisors and when possible the mandibles were collected from the $2\frac{1}{2}$ or older age group. Age determinations of $2\frac{1}{2}$ or older elk were made by the cementum annuli technique (Matson 1975, 1976, 1978). Root tips were cleaned, cut at 5-7 mm and sent to Matson's (Box 308, Milltown, Montana 59851), where they were sectioned, permanently mounted, and assigned respective ages.

Corrections in age structure information were made to adjust calf and yearling classes. All calves and yearlings were aged at check stations by tooth replacement. Because teeth from older elk were collected for age determination at a later date, age determinations were obtained for only a sample of the actual number of older animals coming through a check station (some hunters would not give up the teeth, some were lost, some broken in processing, etc.). Therefore, correction factors were used to adjust calf and yearling classes of males and females in proportion to the incomplete sample obtained from older individuals as indicated by check station data. For example, data on

female calves was corrected by determining a ratio of cow elk older than calves examined at check stations to the number of cows older than calves for which ages were determined, and multiplying by the number of female calves checked, as follows:

$$\text{corrected numbers of female calves} = \frac{(\text{cows older than calves, ages determined}) \times (\text{calves checked})}{(\text{cows older than calves examined})}$$

Differences between study areas and years were statistically tested using the Chi-square statistic. All tests were made at the $\simeq = .05$ probability level unless otherwise indicated.

Locker Forms (Fig. 5, A Record of Kill Left at Storage Plant) were used to determine distribution of the harvest over time.

RESULTS AND DISCUSSION

Productivity

Pregnancy and Lactation Rates

Uteri from 198 cow elk older than calves collected during the 1976, 77, 78, and 79 hunting seasons were analysed. The number of uteri examined by year were as follows: 1976 - 45, 1977 - 51, 1978 - 46, and 1979 - 63.

Pregnancy and lactation rates are summarized in Table 1 and Figs. 6 and 7. Rates of pregnancy were not significantly different between the $3\frac{1}{2}$ - $7\frac{1}{2}$ and $8\frac{1}{2}$ - $13\frac{1}{2}$ age groups ($\chi^2 = 0.05$, 1 d.f., $\simeq = 0.5$). Differences in pregnancy rates between the $2\frac{1}{2}$ year old group and the combined $3\frac{1}{2}$ - $13\frac{1}{2}$ year old group were highly significant ($\chi = 25.5$, 1 d.f., $\simeq = 0.01$). A lower pregnancy rate occurred in $14\frac{1}{2}$ - $20\frac{1}{2}$ year old cow elk than in $3\frac{1}{2}$ - $13\frac{1}{2}$ year old cows and the difference was highly significant ($\chi^2 = 8.4$, 1 d.f., $\simeq = 0.01$).

Trainer (1971 : 25) indicated a lower pregnancy rate for Roosevelt elk cows 11 years old and older (0 of 8 were pregnant). My study indicates that female fertility declines very significantly with age after a cow elk reaches 13 years of age. The age difference (Trainer 1971: 11 years vs this study : 14 years) where a decline in pregnancy rate becomes noticeable may be attributable to the two aging methods used. Trainer (1971) used tooth replacement and wear while cementum annuli was used for adult animals in this study. Kuttel (1975) compared tooth replacement and wear with cementum annuli and reported that the wear and replacement technique tended to underestimate ages of Roosevelt elk older than $2\frac{1}{2}$ years. Keiss 1969:79 concluded that cementum annuli method appeared more accurate than the wear-replacement method for estimating age in Rocky Mountain Elk. As more "known age" Roosevelt Elk are evaluated the accuracy of cementum annuli vs. replacement and wear can be further evaluated.

Figure 5. A Record Of Kill Left At Storage Plant form used to determine legal harvest distribution over time.

STATE OF WASHINGTON
DEPARTMENT OF GAME

№ 46552

Place above number on carcass tags.

RECORD OF KILL LEFT AT STORAGE PLANT

—COMPLETE IN DETAIL—

Complete information must be recorded below before leaving game at storage plant.

NAME STEVE BACKSTER

STREET 13 GARDEN LANE CITY FORKS ZIP 98764

DATE OF KILL 11-15-79 DEER OR ELK TAG NUMBER W114603

LIST AREA WHERE KILLED

Specify

1

Game Management Unit.. 618 / MATHENY
(Number / Name)

Name of Local Area..... HIGLEY PEAK - D Road

County Where Killed..... JEFFERSON

CHECK SPECIES KILLED

2

Black-tail Deer ☐ Mule Deer ☐

White-tail Deer ☐ Elk ☒

Other Species.....

CHECK SEX KILLED

3

Antlered ☒ Antlerless ☐

GAME CODE, STATE OF WASHINGTON

WAC 232-12-190: It shall be unlawful for any person to accept for storage, smoking, freezing or other processing any game animals, game birds or game fish, or parts thereof, without such animals, birds or fish, or parts thereof, having attached thereto a tag showing the owner's name and address or a seal or tag issued by the Department.

3

GAM 68 (Rev. 10-77)

Table 1. Combined Pregnancy and Lactation rates of Cow Elk collected in the Olympic Mountains study area during the 1976-77 1977-78, 1978-79, and 1979-80 Hunting Seasons.

Age	Number Pregnant		Number Uteri Examined		Percent Pregnant		Number Lactating		Number Udders Examined		Percent Lactating	
½	0		7		0.0		0		6		0.0	
1½	0		25		0.0		0		22		0.0	
2½	10		29		34.5		3		24		12.5	
3½	13		22		59.1		9		16		56.2	
4½	21		25		84.0		15		21		71.4	
5½	15	64	19	91	78.9	70.3	13		16		81.2	
6½	6		13		46.2		8	50	11	64	72.7	78.1
7½	9		12		75.0		11		11		100.0	
8½	5		10		50.0		3		5		60.0	
9½	6		7		85.7		5		6		83.3	
10½	3		3		100.0		2		2		100.0	
11½	5	26	8	36	62.5	72.2	3	13	6	22	50.0	59.1
12½	5		6		83.3		2		6		33.3	
13½	2		2		100.0		1		2		50.0	
14½	0		0		---		0		0		---	
15½	3		6		50.0		5		6		83.3	
16½	2		4		50.0		1		3		33.3	
17½	1	6	3	17	33.3	35.3	2	8	2	14	100.0	57.1
18½	0		2		0.0		0		1		0.0	
19½	0		1		0.0		0		1		0.0	
20½	0		1		0.0		0		1		0.0	
Total	106		205		51.7		83		168		49.4	
Total w/o ½	106		198		53.5		83		162		51.2	
Total w/o 1½	106		173		61.3		83		140		59.9	
Total w/o 2½ and under	96		144		66.7		80		116		69.0	

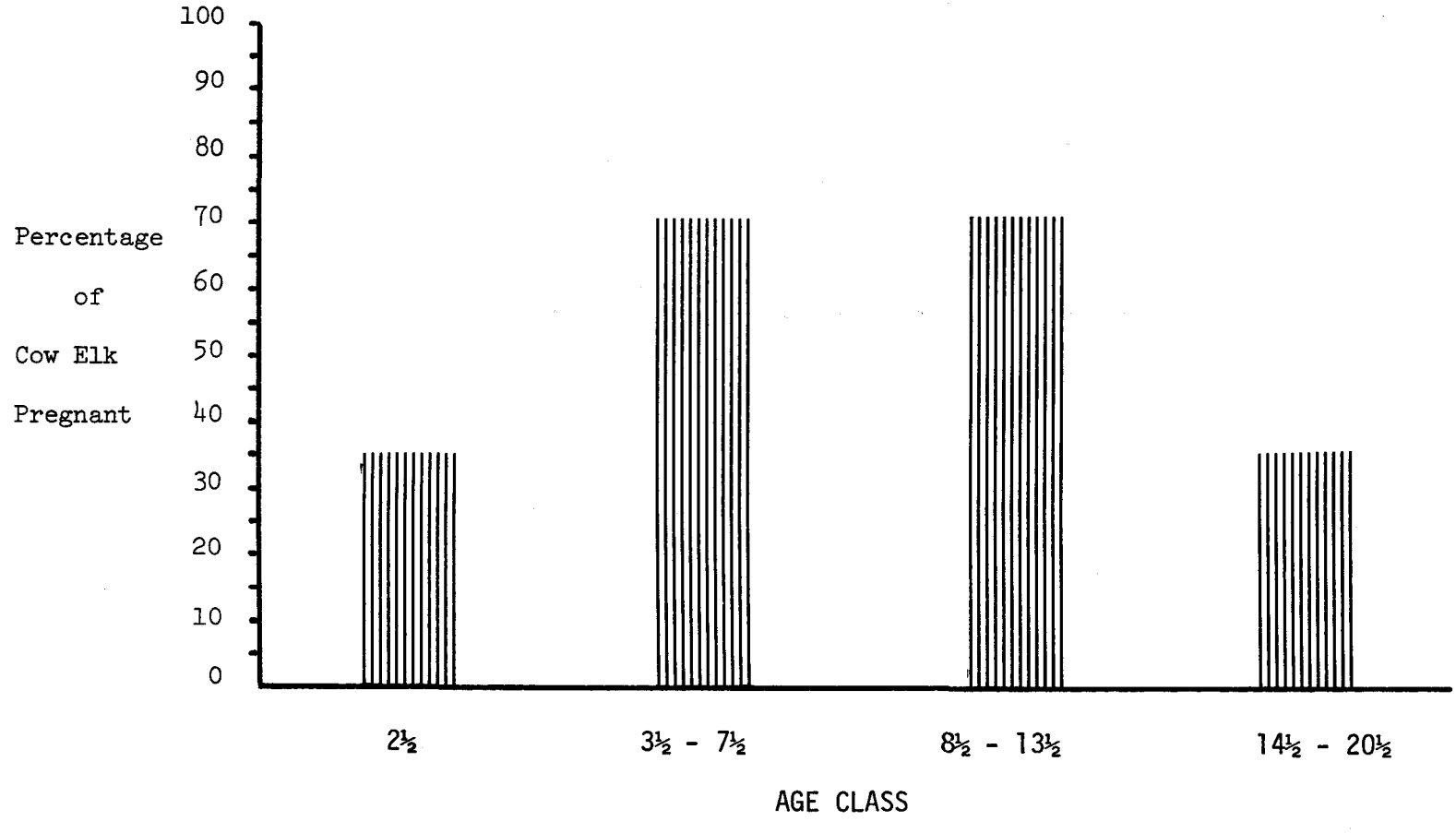


Figure 6. Pregnancy rates of four cow elk age groups collected in the Olympics study area during four hunting seasons, 1976 - 1979.

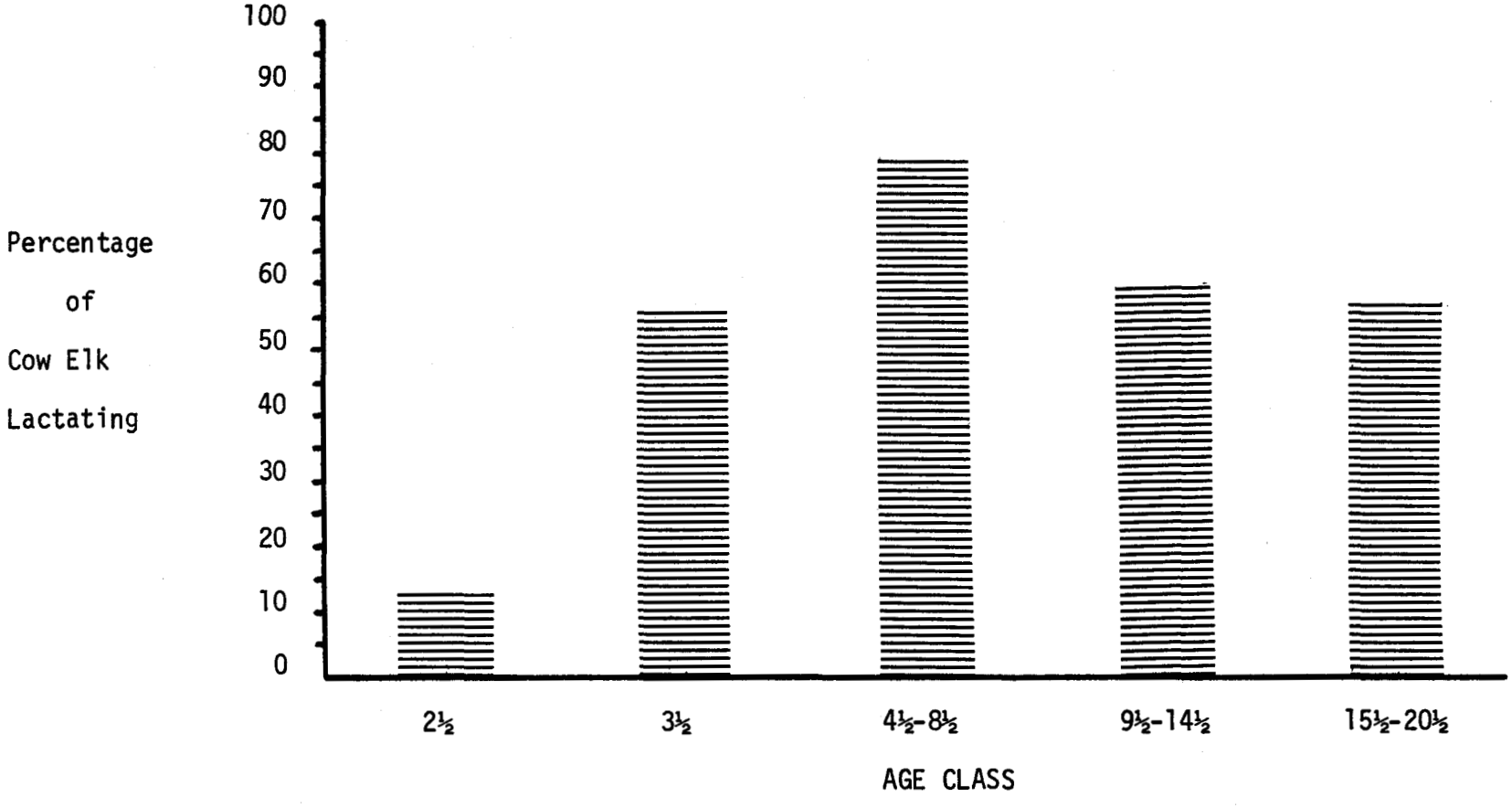


Figure 7. Lactation rates of five cow elk age groups collected in the Olympics study area during four hunting seasons, 1976 - 1979.

Another possibility is that weather factors influenced condition of female elk to the point that older females were more productive than they would have been under more adverse conditions. In other words, improved body condition may have allowed 13 year old cows to breed at the same rate as 11 year old cows. Some observations would support this. During February and March of 1976 and 1977 on the Olympic Peninsula, cow and calf elk were observed wintering above 3,000 feet elevation on ranges normally considered as summer range. Lack of snow at this elevation during these winters may have contributed to better food supply and better condition of the cows, which may have enhanced their productivity (Trainer 1971). However, Flook (1970:36) reported a significantly lower reproductive rate in female Rocky Mountain Elk between 14 and 19 years old, compared with younger adults.

Lactation rates also seemed to decline with increasing age of the cow elk although there was no significant difference in lactation rate (χ^2 = 0.019, 1 d.f., $\simeq$ = 0.5) between the $9\frac{1}{2}$ - $14\frac{1}{2}$ age group and the $15\frac{1}{2}$ - $20\frac{1}{2}$ year age group. Additionally, no significant difference between the $4\frac{1}{2}$ - $8\frac{1}{2}$ and $9\frac{1}{2}$ - $20\frac{1}{2}$ age groups were found (χ^2 = 4.38, 1 d.f., $\simeq$ = 0.05). (These age groups correspond to the $3\frac{1}{2}$ - $7\frac{1}{2}$, $8\frac{1}{2}$ - $13\frac{1}{2}$, and $14\frac{1}{2}$ - $20\frac{1}{2}$ year old groups used in pregnancy rate calculations).

It appeared there was not good agreement between pregnancy rate information and lactation rate information. However, the discrepancies indicated increased with decreasing sample size and there were no significant differences between pregnancy and lactation rates for corresponding age groups: 3 - 8 (χ^2 = 1.18, 1 d.f., $\simeq$ = 0.2), 9-14 (χ^2 = 1.07, 1 d.f., $\simeq$ = 0.2), and 15 - 20 (χ^2 = 1.48, 1 d.f., $\simeq$ = 0.2).

Lactation information is considered to be less reliable than pregnancy information in this study because determinations were made by many field people and reported to me leaving additional opportunity for error in field examination and translation of data. However, these discrepancies could be attributed to sample size alone as there were no consistent trends or bias evident.

To further examine the relationship of age to fertility in Roosevelt elk, a composite of pregnancy rates combined with lactation information for the previous year was constructed (Table 2). No significant difference in fertility rate between the $3\frac{1}{2}$ -$7\frac{1}{2}$ and $8\frac{1}{2}$ - $13\frac{1}{2}$ age group was evident (χ^2 = 0.86, 1 d.f., $\simeq$ = 0.5). A highly significant difference in fertility between the $3\frac{1}{2}$ - $13\frac{1}{2}$ and $14\frac{1}{2}$ - $20\frac{1}{2}$ year old female elk was evident (χ^2 = 8.88, 1 d.f., $\simeq$ = 0.01). Pregnancy/lactation rate declined from 73.5 percent in the $3\frac{1}{2}$ - $7\frac{1}{2}$ group to 67.2 percent in the $8\frac{1}{2}$ - $13\frac{1}{2}$ group and further to 45.2 percent in the $14\frac{1}{2}$ - $20\frac{1}{2}$ age group.

Table 2. Composite of Pregnancy rates combined with previous years lactation information (10½ year old cow lactation rates added to 9½ year old cow pregnancy rates)

Age	Number Preg. Or Lactating		Total Examined		Percent Pregnant or Lactating	
½	0		29		0.0	
1½	3		49		6.1	
2½	19		45		42.2	
3½	28		43		65.1	
4½	34		41		82.9	
5½	23	114	30	155	76.7	73.5%
6½	17		24		70.8	
7½	12		17		70.6	
8½	10		16		62.5	
9½	8		9		88.9	
10½	6	39	9	58	66.7	67.2%
11½	7		14		50.0	
12½	6		8		75.0	
13½	2		2		100.0	
14½	5		6		83.3	
15½	4		9		44.4	
16½	4		6		66.7	
17½	1	14	4	31	25.0	45.2%
18½	0		3		0.0	
19½	0		2		0.0	
20½	0		1		0.0	
Total	189		367		51.5	
Total w/o ½	189		338		55.9	
Total w/o 1½	186		289		64.4	
Total w/o 2½	167		244		68.4	

Of 25 yearling elk examined within the study area, none were pregnant (Table 1). However, 3 of 24 2½ year-old cows were lactating, indicating pregnancy as a yearling. Considered together (Table 2), this information indicates a 6.1 percent pregnancy rate in yearling elk in the Olympics study area. While cow elk normally breed for the first time in their third rutting season after birth (2 years, 4 mos. old Muire, 1951), yearling pregnancy is well documented. Studying Roosevelt elk in Pacific and Wahkiakuim counties of Washington, Pierson 1963:7 found that 8 of 25 2½ year old cows checked were lactating indicating a 32 percent pregnancy rate as yearlings. Kuttel (1975:17) found that 5 percent of yearling cows successfully bred in his Willapa Hills study area and Trainer (1971:25) reported 3 of 25 yearlings pregnant (12 percent). Evidence of yearling pregnancies in Roosevel elk was presented by Batchelor (1963).

There is a possibility that some yearling cows may mature late in the rutting season and be bred later than most older elk. This is indicated by the 12.5 percent lactation rate for 2½ year olds and the 0 percent pregnancy rate for yearlings found during this study (Table 1). Further evidence is provided by a yearling cow elk road-killed on state highway 401 near Naselle on 6 February 1977. This animal was pregnant. The date of conception, determined from back-dating from kill date using fetal forehead-rump length, was determined to be 25 December 1976. Trainer (1971) and Kuttel (1975:22) suggested that some elk when breeding for the first time experience a delayed estrus. Further data accumulation will be necessary to evaluate the significance of late breeding in yearling Roosevelt elk females.

Thirty-four and one-half percent (10 of 29) 2½ year-old cows were found to be pregnant while 56.2 percent (9 of 16) of 3½ year-old cows were lactating (Table 1, indicating pregnancy as 2½ year-olds). These data may be further indication of delayed estrus during the first reproductive cycle. Delayed estrus during the first reproductive cycle may also explain the 4 spotted calves observed by Al Rasmussen and myself during late September composition counts within Olympic National Park in 1977.

Kuttel (1975:17) reported a 71 percent pregnancy rate among 2½ and older cow elk collected during the general elk season. In the Olympics, pregnancy rate of cows 2½ or older was 61.3 percent over the four years reported on here. Trainer (1971) reported slightly fewer than 50 percent of Roosevelt elk cows 2½ years or older were pregnant.

Table 3 presents information on the numbers and percentages of pregnant cow elk that were also lactating. Minimally, 75½ percent of cows 3½ through 7½ years old were pregnant two years in a row. For cows 2½ years or older, 67.0 percent were pregnant two years in a row. This compares with a 48 percent pregnancy rate for cow elk 2½ years old and older that were also lactating, in Oregon (Harper 1971), and an 83.3 percent lactation rate for pregnant cow elk in this age group studied in Washington's

Table 3. Lactation rates of Pregnant Cow Elk Harvested in the Olympic Mountains during the 1976-77, 1977-78, 1978-79 and 1979-80 Hunting Seasons.

Age During Nov. - Jan.	No. Pregnant Elk With Known Lactation Status Collected		No. Pregnant Elk Lactating		Percent Pregnant Elk Lactating	
2½	7		1		14.3	
3½	8		5		62.5	
4½	17		11		64.7	
5½	13	53	11	40	84.6	75.5
6½	6		4		66.7	
7½	9		9		100.0	
8½	3		2		66.7	
9½	5		4		80.0	
10½	2	22	2	15	100.0	68.2
11½	5		3		60.0	
12½	5		3		60.0	
13½	2		1		50.0	
14½	0		0		0.0	
15½	3		2		66.7	
16½	2		0		0.0	
17½	1	6	1	3	100.0	50.0
18½	0		0		0.0	
19½	0		0		0.0	
20½	0		0		0.0	
Total	88		59		67.0%	
Total w/o 2½	81		58		71.6%	

Willapa Hills (Kuttel 1975). These are conservative estimates assuming that some cows could have been pregnant again during the 6-8 months prior to their death. These data do not support the notion that adult female Roosevelt elk breed every other year (Fig. 8).

Although not statistically significant (χ^2 = 0.42, 1 d.f., $\simeq$ = 0.5) a smaller percentage of $8\frac{1}{2}$ - $13\frac{1}{2}$ year old cows were pregnant and lactating than $3\frac{1}{2}$ - $7\frac{1}{2}$ year old cows. Further, a smaller percentage of $14\frac{1}{2}$ - $20\frac{1}{2}$ year old pregnant cows were lactating compared with $3\frac{1}{2}$ - $13\frac{1}{2}$ year old cows. Because of small sample size, these differences were not statistically significant (χ^2 = 1.49, 1 d.f., $\simeq$ = 0.2).

Older cows may have a decreased ability to breed in consecutive years because of poorer ability to maintain the physical condition necessary to maintain a pregnancy. This inability to breed in consecutive years may be due not only to age but to a lack of micro-or macro-nutrients in the diet or to inadequate food energy or protein levels in the diet. To a degree these factors are all influenced by elk density.

Comparative pregnancy rates for adult cows indicate a decrease in pregnancy rate from 1976 to 1979 (Table 4, Figure 9). This was probably not due to a decline in condition of the animals range. Population estimates indicate that the population of elk within the study area was at a historically high level, but was less than 10 percent greater in 1979 than in 1976. Harvest rates have increased recently in an effort to alter female age structure. Other influences on this pregnancy rate will be discussed in a following section.

Herd Composition

Inside Olympic National Park

Table 5 summarizes information derived from counts done in late September on the High Divide during 1976, 1977, and 1979. The 1978 trip resulted in no observations of elk although 1 group was heard. Conditions for observation were impossible. Rain, wind, fog, and snow for three successive days aborted any opportunity to observe elk.

In 1976, most observations were made of a single group of 176 elk. This group was completely counted twice, once by Kurt Jenkins and once by myself and Al Rasmussen. Both counts were similar and a mean is presented in Appendix Table 5. Parts of this large group were counted repeatedly over a three day period.

Observations in 1977 were made over a wider area than in 1976 following the pattern of distribution of many smaller groups of elk. Weather conditions were favorable. One hundred thirty-seven (137) elk were classified compared to 179 in 1976. The study area was much drier with little snow left on the High Divide, and fewer elk were on the ridge than in 1976.

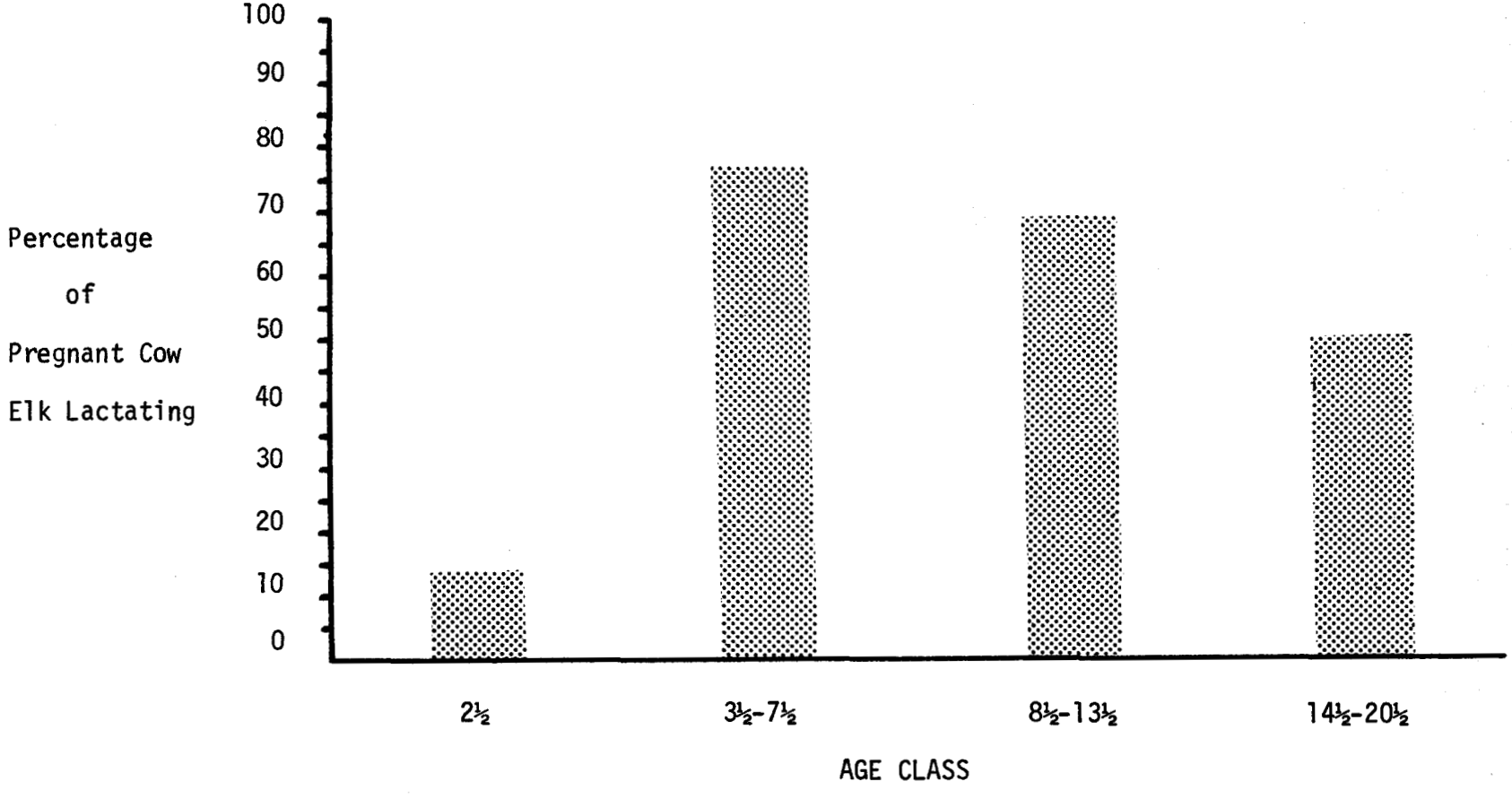


Figure 8. Percentage of cow elk, in four age groups, determined to be pregnant for two consecutive years, Olympics, 1976 - 1979 hunting seasons.

Table 4. Comparative rates of Pregnancy of Cow Elk older than 3 years in the Olympic Mountains study area, 1976 through 1979.

	1976	1977	1978	1979
Pregnant	24	28	18	26
Not Pregnant	7	11	13	17
Total Adult Uteri Examined	31	39	31	43
Percent Pregnant	77.4	71.8	58.1	60.5

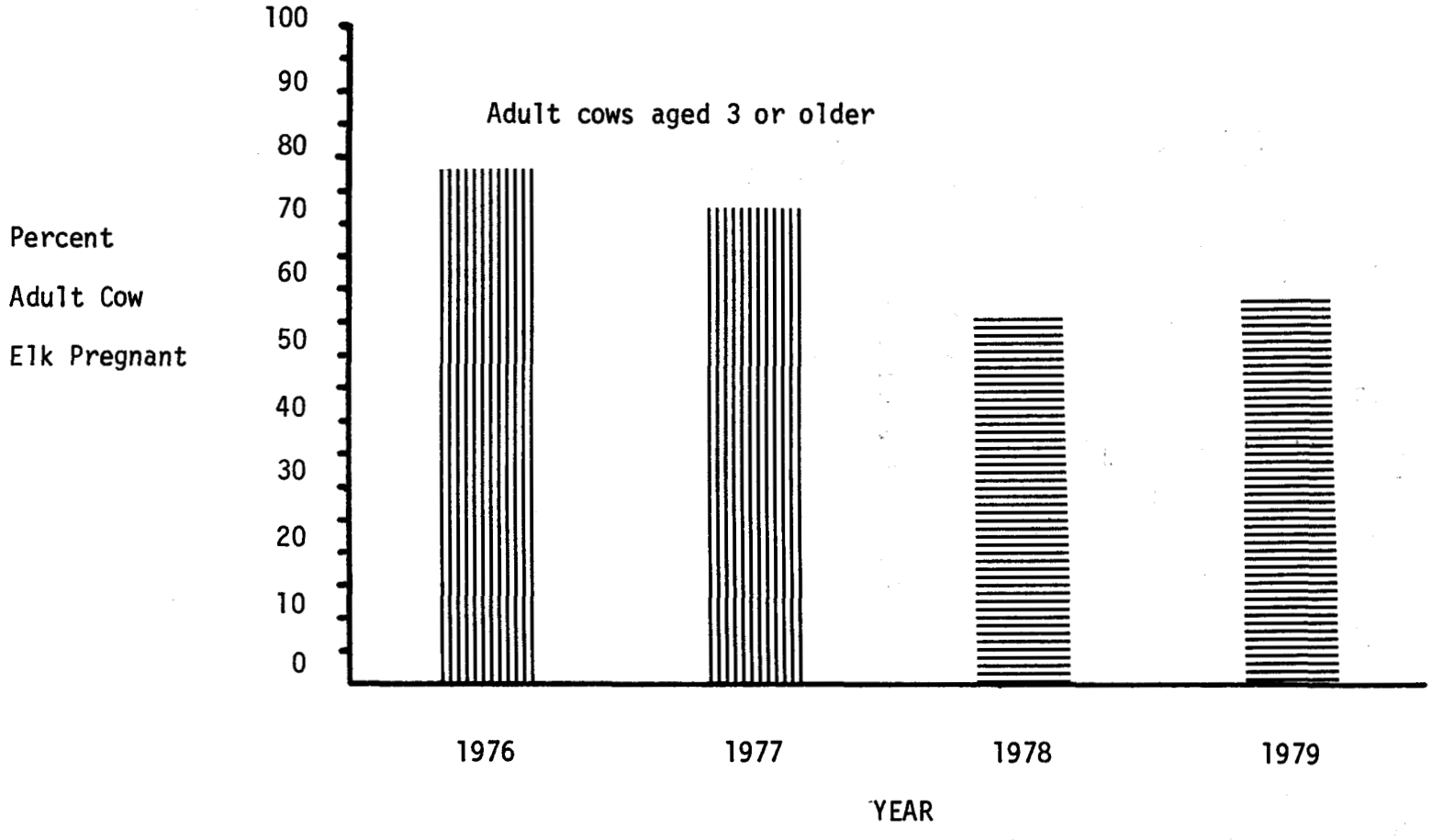


Figure 9. Rates of pregnancy of adult cow elk collected in the Olympic Mountains during the 1976 - 1979 hunting seasons.

Table 5 Branched Antlered Bull : Spike Bull : Cow : Calf ratios on the High Divide O.N.P. Area during 1976, 1977 and 1979.

Year	Number of Groups	Number of Elk Classified	Branched Bull :	Spike Bull :	Cow :	Calf
			Numbers			
1976	2	179	24	15	102	38
1977	7	137	26	16	69	26
1979	10	91	12	4	53	22
Total	19	407	62	35	224	86
			Ratios			
1976	2	179	23.5	14.7	100.0	37.3
1977	7	137	37.7	23.2	100.0	37.7
1979	10	91	22.6	7.5	100.0	41.5
Combined	-	-	27.7	15.6	100.0	38.4
			Percent Composition			
1976	2	179	13.4	8.4	57.0	21.2
1977	7	137	19.0	11.7	50.4	19.0
1979	10	91	13.2	4.4	58.3	24.1
Total	-	100.0	15.2	8.6	55.1	21.1

During the 1979 counts, only 91 elk were enumerated on all the High Divide during a 4 day period. The ridge was very dry; elk were widely scattered in smaller groups than during 1976 and 1977. Good weather gave excellent coverage of the study area, but elk were difficult to observe because of a greater affinity for cover. The same phenomena occurred on managed timberlands outside the park. Elk seemed to be less active and spent more time in heavy cover during daylight hours than in previous years.

Table 6 presents classifications, ratios, and percent composition of elk observed in the O.N.P. study area. Group size declined in each successive year. Most of this variation is probably due to the timing of observation in relationship to the stage of the rut. Drach, pers. comm., studying rutting behavior on the high divide, found that group size was largest at the beginning of the rut, but declined as rutting activities intensified. Compsotion observations were unaffected by differences in group size, however, because the habitat allowed enumeration of most elk using the ridge.

Ratios of elk sampled within O.N.P. for the years 1976, 1977, and 1978 were not significantly different (χ^2 = 6.83, 6 d.f., P>.66). Because of this, data were combined to compare with ratios obtained outside O.N.P.

Outside Olympic National Park

Pre-season elk herd composition counts for the Olympic study area outside Olympic National Park are summarized in Appendix Tables 8 - 11. Table 6 presents numbers classified, bull : cow : calf ratios, and composition of elk observed outside Olympic National Park.

There were no significant differences in the ratios between years for herd classification counts conducted outside the Park, (χ^2 = 9.76, 9 d.f., P = 0.63), even though there was sizeable variation in some of the ratios. For this reason data outside the park for 1976, 1977,and 1979 were combined for comparisons inside Olympic National Park.

Table 7 and Figure 10 summarize data regarding the percentage of elk groups classified during the rut that had a branched antlered bull in the group. There was no significant difference between the percentage of groups having a branched-antlered bull comparing 1976 and 1977 ruts or comparing 1978 and 1979 ruts. However, there was a highly significant difference (χ^2 = 6.06, 1 d.f., P>.99) when the percentage of elk groups with a branched antlered bull during rut was compared for 1976 - 77 versus 1978 - 79. Not only did fewer rutting elk groups have a branched antlered bull, but the proportion decreased over these years (Figure 10, Table 6). The ratio of adult bulls to cows also decreased during this time from about 1 to 8 to approximately 1 to 16.

Table 6. Classification Summary and Bull : Cow : Calf Ratios for Elk observed in the Olympic Peninsula Study Area outside Olympic National Park.

Year	Number of of Groups	Number of Elk Classified	Branched Bull :	Spike Bull :	Cow :	Calves
			Numbers			
1976	14	372	18	33	217	104
1977	12	310	14	40	168	88
1978	19	377	11	34	233	99
1979	15	161	6	13	104	38
Total	60	1220	49	120	722	329
			Ratios			
1976	14	372	8.3	15.2	100.0	47.9
1977	12	310	8.3	23.8	100.0	52.4
1978	19	377	4.7	14.6	100.0	42.5
1979	15	161	5.8	12.5	100.0	36.5
Combined	60	1220	6.8	16.6	100.0	45.6
			Composition			
1976	14	372	4.8	8.9	58.3	28.0
1977	12	310	4.5	12.9	54.2	28.4
1978	19	377	2.9	9.0	61.8	26.3
1979	15	161	3.7	8.1	64.6	23.6

Table 7. Percentages of Elk Groups classified outside O.N.P. during the rut that had a Branched-Antlered Bull with the group.

Year	No. Herds	With A Branched Bull	Without A Branched Bull	Percent with a Branched Bull
1976	14	10	4	71.4
1977	12	9	3	75.0
1978	19	9	10	47.4
1979	15	5	10	33.0

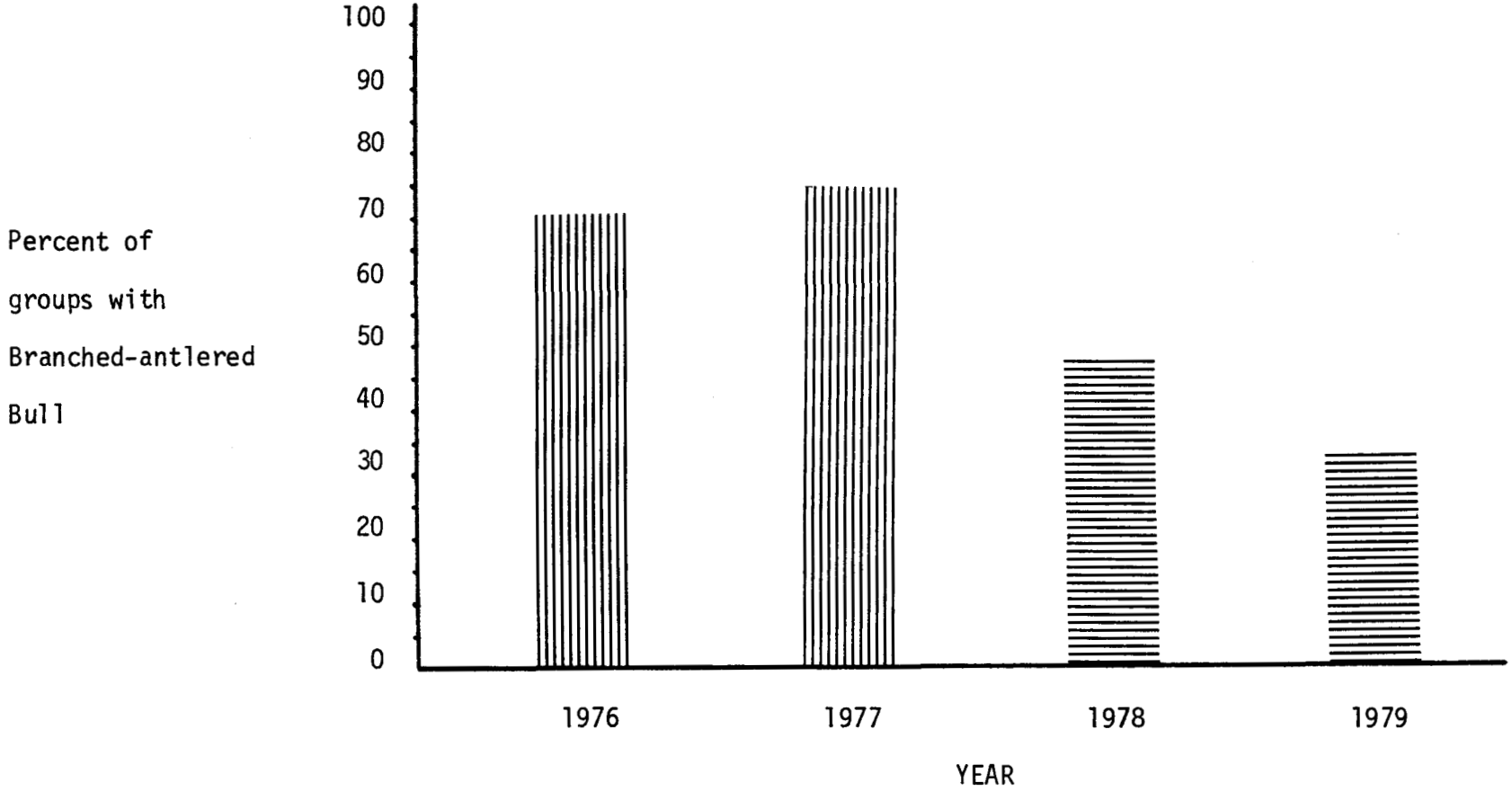


Figure 10. Percentages of elk groups classified which contained at least one branched-antlered bull elk, Olympics, 1976 - 1979 rutting periods.

Elk herd composition during the rut was compared between study areas to establish differences between a hunted and an unhunted elk herd. Chi-square tests indicated highly significant differences in composition inside and outside the Park during these three years (χ^2 = 61.8, 3 d.f., P>0.99). As might be expected Branched-antlered bull : cow ratios were very much higher inside Olympic National Park than outside the Park (χ^2 = 52.1 1 d.f., P>.99). Branched-antlered bull : spike bull ratio was also higher inside the Park than outside (χ^2 = 30.9, 1 d.f., P>.99). These differences were attributed to differences in hunting and poaching mortality. It is important to note, too, however that even in the unhunted elk groups bull:cow ratios were only 43.3 : 100.0 (Table 5). Flook (1970:21) reported a bull:cow ratio of 37:100 for the mountain parks of Canada. Assuming a 113 male:100 female sex ratio at birth (Flook 1970:15), this would indicate much higher male than female mortality even without significant hunting mortality. Mortality during rut and because of the rut (body condition), and differences in wintering elevations were proposed to explain this apparent higher male mortality rate in Rocky Mountain Elk (Flook, 1970:27,35).

Cow : calf ratios were higher in the hunted elk groups than in the unhunted elk groups within Olympic National Park, although the difference was not statistically significant (χ^2 = 1.43, P = 0.77). This difference may or not not be due to hunting related changes in elk density, age structure, or range relationships. Elk density in relation to available forage, and forage quality should be more suitable outside Olympic National Park than inside and better productivity should occur outside the Park. Knight (1970:62) concluded that an increase in herd production could probably be achieved by increasing the harvest rate in Rocky Mountain elk he studied.

Differences in cow : calf ratios between these areas may not reflect actual differences in pregnancy rates but rather in summer calf survival rates (Knight 1970:63). This seems a more reasonable assumption than different pregnancy rates. However, changes in female age structure probably accounts for at least part of this observed difference. Investigation into pregnancy rates of elk within Olympic National Park could prove or disprove this assumption.

Mean bull : cow : calf rations, 1976 - 79, outside the park were 23.4 : 100.0 : 45.6 compared to 43.3 : 100.0 : 38.4 within Olympic National Park, 1976, 77 and 79 respectively. Kuttel (1975 : 28) reported a bull : cow : calf ratio of 24.6 : 100.0 : 50.4 during 1974 rut in the Willapa Hills. A pre-season bull : cow : calf ratio of 37 : 100 : 46 was reported by Brown (1967a) for Roosevelt elk in Southwest Washington during 1961 and 1962. Schwartz 1938:61 classified 7,049 elk during 1936, 1937, and 1938 on the Olympic Peninsula. These data, collected throughout the year, indicated a bull : cow :

calf ratio of 14.3 : 100 : 28.6. Bulls were probably underestimated significantly because of their solitary behaviour during much of the year. Schwartz and Mitchell (1945) reported an average cow : calf ratio of 100 : 61 during 1936, 1937, and 1938 on the Olympic Peninsula based on July - August counts. These data indicates a sizeable problem with calf mortality during those years. July - August counts could be expected to show higher cow : calf ratios because of limited opportunity for mortality on calves and because of samplying problems due to formation of "nursery herds" (Harper 1967).

Age Structure and Analysis

Analysis of harvest data for antlerless elk and discussions with hunters during permit seasons indicated that selection for and against harvest of calf ($\frac{1}{2}$) and yearling ($1\frac{1}{2}$) antlerless elk was occurring. Table 8 summarizes age structure information for 377 antlerless elk harvested during the 1976-1979 hunting seasons. Calves were harvested in the ratio of 100 cows : 14 calves while their occurrence in the pre-season population was 100 cows : 45.6 calves, indicating a high selection against shooting calves. Harvest data also indicated a selection against shooting $1\frac{1}{2}$ year old cows as fewer of this age group were harvested than either $2\frac{1}{2}$ or $3\frac{1}{2}$ year old cows, while it is likely that more yearlings occurred in the population than $2\frac{1}{2}$ and $3\frac{1}{2}$ year old cows, respectively. No selection bias was evident for cows $2\frac{1}{2}$ years and older.

Chi-square tests were done to test age structure differences between years. No significant differences were found between 1976 and 1977, and 1978 and 1979, respectively ($P>0.38$ and $P>0.20$). Data for 1976 and 1977, as well as 1978 and 1979 were grouped. A chi-squared test comparing these grouped data indicated a significant shift in age structure toward younger age structure in 1978 and 1979. ($\chi^2 = 14.98$, 9 d.f., $P = 0.98$). This shift follows an increase in antlerless harvest rate in 1977. Mean age of cow elk older than calves declined from 7.4 in 1976 to 5.4 in 1978 then increased slightly to 5.7 in 1979 (Table 11).

Figure 11 shows distribution of female ages by year and for all hunting seasons combined. A relatively old female population age structure is depicted. Values of 33.5, 26.5, and 23.0 percent were calculated for the percentages of adult female elk older than 7, 8, and 9 years, respectively. The mean age of these adult females was 7.5 years. Similar values reported in the literature are presented in Table 12. Age distribution data from the Olympics correspond to reported values from lightly hunted, over populated populations reported, Cheatum and Gaab (1952) for the North Yellowstone elk herd, by Geer (1965) for the Gallatin River elk herd in Montana, and by Knight (1970) for the northern portion of the Sun River elk herd in Montana (which normally ranges within the

Table 8. Antlerless Age Structure For Elk Harvested in the Olympic Mountains Study Area, 1976 - 1979.

Year Class	1976	1977	1978	1979	Total	Percent Of Total
½	6**	10**	17**	12**	45**	11.9
1½	6*	10*	14*	12*	42*	11.1
2½	7	7	26	20	60	15.9
3½	6	7	22	14	49	13.0
4½	5	10	12	15	42	11.1
5½	3	7	11	4	25	6.6
6½	2	3	5	7	17	4.5
7½	4	4	7	5	20	5.3
8½	1	5	6	4	16	4.2
9½	4	1	2	1	8	2.1
10½	0	3	1	2	6	1.6
11½	1	1	3	5	10	2.7
12½	3	3	1	3	10	2.7
13½	3	0	1	1	5	1.3
14½	1	0	0	0	1	0.3
15½	1	3	2	0	6	1.6
16½	2	1	1	1	5	1.3
17½	1	1	2	1	5	1.3
18½	1	0	1	1	3	0.8
19½	1	0	0	0	1	0.3
20½	0	0	0	1	1	0.3
Total	55	74	125	105	377 (Includes 18 male calves)	99.9
Mean age w/o calves	7.4	6.1	5.4	5.7	5.8	

* Corrected numbers.

** Corrected numbers, bull calves included.

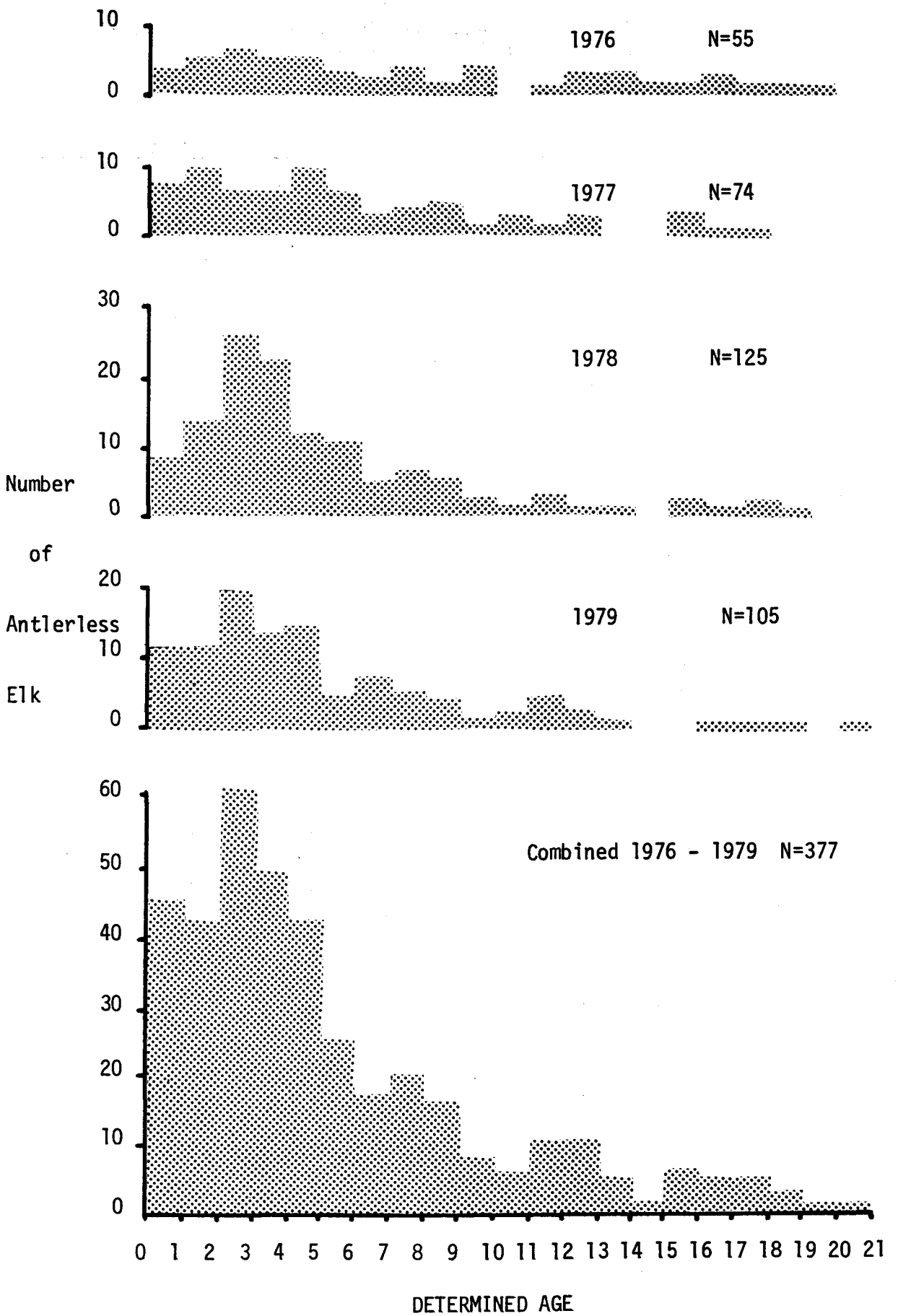


Figure 11. Antlerless age structure for elk harvested from November through January in the Olympic Mountains Study Area, 1976 - 1979 (Includes 18 bull calves).

Table 9. Some Parameters of Population Age Structure for Adult Female Elk and Adult Female Red Deer, three years of age and older, as reported in the literature (Adapted from Smith 1974 : 118).

Subspecies and Author	Location	Mean Age	Percentage of Sample 7 yrs.	8 yrs.	9 yrs.	Number in Sample
Wapiti (C.e. nelsoni)						
Greer (1965)	Yellowstone Nat' Park	6.5[a]	30.2	----	13.2	53
Greer (1967)	Yellowstone Nat' Park	6.3[b]	33.7	20.4	13.3	130
Cheatum & Gaab (1952)	Yellowstone Nat' Park	8.3[b]	52.7	43.0	25.8	186
Greer (1965a)	Montana	7.7[a]	41.2	----	23.7	58
Knight (1970)	N. Sun River, Montana	6.7	32.0	24.0	----	50
	S. Sun River, Montana	5.2	12.2	6.1	----	82
Boyd (1970)	Colorado	4.5	3.6	2.3	----	315
Wapiti (C.e. roosevelti)						
Harper (1971)	Oregon	---	14.5	----	----	186
Kuttel (1975)	Willapa Hills, Washington	6.6[c]	25.0	19.3	13.6	88
This study, 1976-1979	Olympic Mts., Washington	7.5	33.5	26.5	23.0	230
Red Deer						
Caughley (1971a)	Grebe River, New Zealand	----	18.8	10.4	6.0	250
Smith (1974 : 118)	Wapiti Area, New Zealand	6.5	33.3	24.6	18.3	666

a Adjusted (See Smith 1974 : 118)

b Distribution partially estimated (See Smith 1974 : 118).

c Calculated from age distribution data presented by Kuttel (1975)

Table 10. Antlered Age Structure For Elk Harvested in the Olympic Mountains Study Area, 1976 - 1979.

Year Class	1976	1977	1978	1979	Total	Percent Of Total
1½	72*	104*	127*	80	383	76.6
2½	13	25	23	16	77	15.4
3½	2	5	4	0	11	2.2
4½	3	2	3	0	8	1.6
5½	1	1	0	0	2	0.4
6½	0	2	3	0	5	1.0
7½	0	2	2	1	5	1.0
8½	0	1	0	0	1	0.2
9½	0	0	0	0	0	0.0
10½	0	0	2	1	3	0.6
11½	0	1	0	0	1	0.2
12½	0	0	0	0	0	0.0
13½	0	1	0	0	1	0.2
14½	1	0	0	0	1	0.2
15½	0	0	0	0	0	0.0
16½	0	2	0	0	2	0.4
Total	92	146	164	98	500	100.0
Mean age without calves	2.0	2.4	2.0	1.8	2.1	

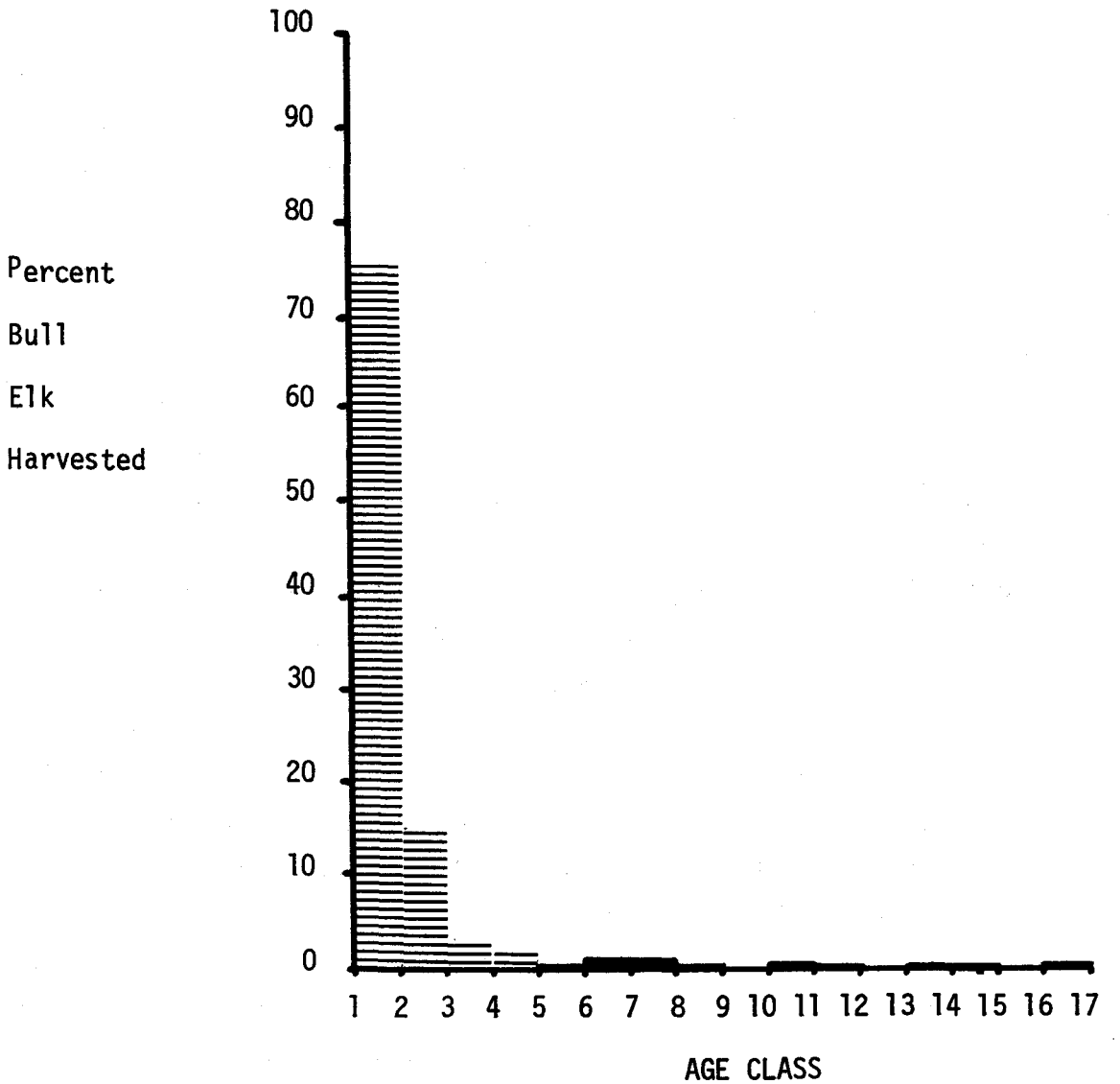


Figure 12. Distribution of bull elk harvest by age class in the Olympics, 1976 - 1979 hunting seasons.

Sun River Game Preserve during the hunting season). More heavily hunted populations of Rocky Mountain elk reported by Knight (1970) for the south Sun River elk herd and by Boyd (1970) for the White River elk herd in Colorado contrast markedly with the Olympic elk in age distribution.

Female age distributions from the Olympics were older than those reported by Harper (1971) for Western Oregon or by Kuttel (1975) for the Willapa Hills of Washington. These were the only other Roosevelt elk age distributions located during this study. Age distribution was slightly older, but comparable to that reported by Smith (1974) for the Wapiti area of New Zealand.

Three $18\frac{1}{2}$ and $19\frac{1}{2}$ and a $20\frac{1}{2}$ year old cow were harvested during this study. These animals approach the known maximum age or life span for female elk in wild populations. Flook (1970) reported a 21 year old female Rocky Mountain elk. This is the oldest reported female from a wild elk population to date. Reports of oldest females from other populations of Rocky Mountain elk were 16 years (Greer 1965), and 18 years (Boyd 1970, and Picton 1961). Kuttel (1975), reported three female Roosevelt elk from the Willapa Hills herd to be $16\frac{1}{2}$ years old when harvested.

Age distribution of bull elk harvested in the Olympic Mountains is shown in Table 10 and Figure 12, respectively. Since these elk are harvested under a "visible antlers" law, there is no selective bias for one age group over the other under the law. However, bulls over three years of age are considerably more difficult to hunt because of their solitary nature combined with climatic factors and vegetation characteristics of preferred escape cover. Therefore, bulls older than 3 years are not represented in the harvest in proportion to their occurrence in the pre-season population. Branched-antlered bull to spike bull ratios were 30.5 : 100 in the harvest and 40.8 : 100 in pre-season counts indicating a greater vulnerability to hunting of spike bulls compared to branched-antlered bulls. Additionally, 66 percent of the branched-antlered bull harvest consisted of $2\frac{1}{2}$ year old bulls. This age class is also very vulnerable to harvest, when compared to $3\frac{1}{2}$ and older bulls, because of a tendency to remain with the cow and calf groups, much the same as do yearling bulls. For these reasons, bull harvest data was not used to represent age distribution of bulls in the population, but rather age distribution of bulls in the harvest. Weather factors play a significant role in harvest of $3\frac{1}{2}$ and older bulls. These may negate any trends evident in age distribution of bull elk. For these reasons, statistical differences are not considered to be biologically meaningful here.

The mean age of 500 bull elk harvested during the 1976 through 1979 hunting seasons was 2.1. Of this harvest, 76.6 percent was comprised of yearling bulls, 15.4 percent $2\frac{1}{2}$ year old bulls, and 8 percent bulls older than 3 years.

Two bulls were determined to be 16½ years old when harvested. Murie (1951) reported a tagged bull killed at 25 years of age, while Picton (1961) and Flook (1970) reported maximum ages of 13 and 14 years, respectively, for wild Rocky Mountain bull elk. Kuttel (1975) reported a maximum age of 5½ years, and a mean of 1.9 years for Roosevelt elk bulls harvested in Washington's Willapa Hills during this study.

Harvest Distribution

Throughout 1976-1979, bulls have been harvested during a November general season of 14 or 15 days. Some additional legal bull harvest has occurred in the study area during a limited area, December archery season and during several limited area, permit damage seasons. Bull harvest during these special seasons, however, has generally been less than 1 percent of total bull harvest.

Antlerless harvest has occurred during a 5 day permit season falling somewhere between the third and twelfth days of the general bull elk season except in the Clearwater unit, (Figure 1). Success rate in harvesting an elk by a permit holder generally runs 45 to 55 percent in the study area. In the Clearwater unit, antlerless harvest has been during a December archery season. Some additional antlerless harvest has occurred in limited permit, agricultural damage seasons. Generally, late permit seasons have accounted for less than 10 percent of antlerless harvest.

Bull elk harvest distribution over time is represented in Figure 13. Similar data for 1975-1978 indicate that through the entire study, bull harvest patterns have been very consistent. From 1975 through 1979, approximately 40 percent of the bull harvest has occurred opening day, regardless of whether it opened on Sunday or Monday. About 15 percent of the bull harvest generally occurred on the second day and by the fourth day of the season, 70 percent of the bull harvest had occurred. Generally, harvest on the last 10 or 11 days makes up 30 percent of the total with from one to 7 percent occurring on any one day. Most often, 2 to 4 percent of the bull harvest occurred on any one of the last 10 or 11 days of the season.

Management Implications

The Washington Game Commission is charged with preserving, perpetuating, protecting, and enhancing the game fish and wildlife resources of Washington State. Management decisions, therefore, must be made based on what is beneficial for the resource. Realizing this, we have developed a broad management goal for elk in the Olympics which is to maintain the highest possible numbers of elk consistent with high herd health as indicated by a high reproductive rate. Preliminary management

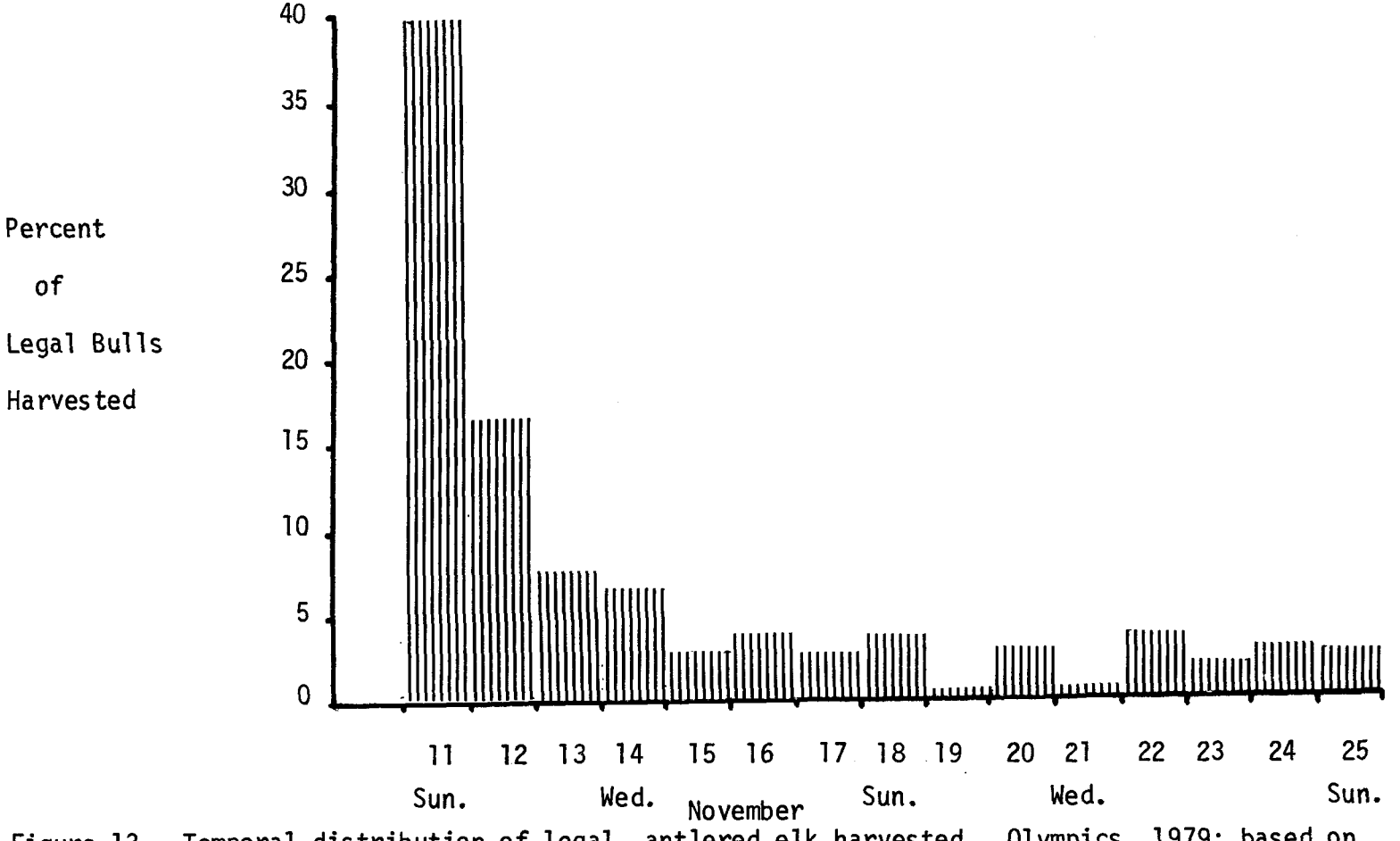


Figure 13. Temporal distribution of legal, antlered elk harvested, Olympics, 1979; based on 312 locker forms.

objectives have been developed to allow moving toward the overall goal. These management objectives are based on information in this report and from other sources. Each management objective will be discussed in relation to important points reported in this study and other factors, such as habitat condition, which affect them.

Preliminary management objectives are:

1) Enhance productivity to a rate of 50 calves : 100 cows or higher as measured in pre-season composition counts September 10 - October 15.
2) Develop optimum female age structure for productivity through antlerless harvest,
   a) Mean age older than calves = 5.0 away from Olympic National Park,
   b) Mean age older than calves = 5.5 adjacent to Olympic National Park,
3) Maintain branched-antlered bulls at 5.0 percent or higher of pre-season herd composition,
4) Maintain distribution of branched-antlered bulls so that 80 percent of groups seen during rut (pre-season composition counts September 10 to October 15) have at least one branched-antlered bull.

Each of these objectives interact and compliment one another. Maintaining the largest possible proportion of cow elk within the 3 - 13 year age group will definitely aid in enhancing productivity, measured in pre-season counts, to 50 calves : 100 cows. Certainly, maintaining a slightly larger branched-antlered bull population, with even distribution, will aid in keeping productivity high, assuming equal population density.

Management Objective 1: As elk harvest management improves, this objective may need updating. Based on four years observations, there was considerable variation in productivity between years. Some of this was undoubtedly due to uncontrollable factors such as weather. However, some was also due to factors over which some influence could be exercised such as habitat condition, population density, age structure differences, and sex ratio changes. Size of clear-cuts, cover forage ratio, and use of herbicides to control competition of early successional plants with conifers are three key habitat factors which could make or break our ability to maintain productive elk herds, regardless of how the population is managed. These factors should be addressed in great detail. Management energies should be directed at maintaining proper values for these habitat factors. In the long term, productivity will be maintained only through good habitat management.

Elk population density is easily regulated. During this study, elk population density in the study area increased slightly, but certainly not to a point where productivity declined because of increased elk density.

A productivity rate of 50 calves per 100 cows during September and early October represents significantly higher productivity than found in an unhunted population in an adjacent area (inside vs. outside ONP). Even present elk management compares favorably with the unhunted situation, when productivity is used as the yardstick. It is possible that higher productivity rates are possible with better habitat and population management. However, enhancement of productivity from the four year average of 45.6 calves per 100 cows, reported in this study, to 50 calves per 100 cows will be a significant achievement.

Management Objective 2: As a starting point, objectives for two classes of management units have been set; those adjacent to Olympic National Park, and those not adjacent to Olympic National Park. The difference between these two classes is based on the assumption that significant numbers of elk occupy ranges overlapping the Park boundary and that these groups are less vulnerable to hunting and poaching because of regulations, prohibiting killing of animals, inaccessibility, and increased escape cover. To avoid reducing female age structure too low in groups not residing in boundary areas, the objective for mean age has been adjusted upward by one-half year from what is considered optimum now, based on preliminary calculations. The magnitude of this adjustment may change as experience with it develops.

The real objective here is to maximize the number of adult cow elk which fall into the 3-13 year age group. It may be necessary to adjust our objective for mean age in the future, or to choose a different statistic, such as median age, with which to monitor female age structure.

Mean age of cow elk has declined from 1976 to 1979 in the Olympics study area. However, mean age may be stabilizing now between 5.4 and 5.7 years. In order to develop the optimum situation overall (mean age 5.2 to 5.3) within the study area, it may be necessary to increase the harvest rate on cows slightly. During 1977, 1978, and 1979, cow elk were harvested at the rate of 40 cows per 100 bulls, approximately. This rate may have to be increased to 45-50 per 100 bulls, to maintain age structure at the desired condition.

Monitoring of female age structure has provided another significant benefit to our management program. It has provided a means to estimate the effects of <u>all</u> mortality factors operating on elk. Not only can the overall effects of female harvest management be assessed, but effects of losses due to illegal hunting, predators, parasites, diseases, accidents, and malnutrition are also assessed. Age structure information has been invaluable in explaining the reasoning behind harvest of female elk, as well as in convincing laymen that the herds are being improved instead of harmed by

controlled female harvest of elk. When combined with other pertinent information, such as population size, age structure information has been invaluable for making biologically based hunting season recommendations and for selling harvest management programs to the public.

Management Objectives 3 and 4: These will be considered together because of their strong correlation with one another. Objectives 3 and 4 were set because during years when these conditions were prevalent in the study area, productivity was very good. During years when these conditions were not met, productivity was not very good. When these conditions were not met, productivity of adult cows was significantly lower (Figs. 8, 9, 10). This strong correlation between lack of branched-antlered bulls and poorer productivity may not be evidence of a cause and effect relationship, but then again it may. Hines and Lemos (1979:41) concluded that calving success was highest in Oregon Roosevelt Elk when 2 and 3 year old bulls bred cows (compared to 1 year old spike bulls). Furthermore, "The collective influence of weather, forage availability, and recent productive history did not mask the consistent relationship between calving success and bull age." Pregnancy rate as well as calf survival were affected by age of the male breeder. This evidence, coupled with the strong correlation between presence of older males in the breeding population and significantly higher pregancy rates found in this study, deserves attention and further analysis. Until questions of such management importance are answered, it is better to err on the side of high productivity.

It is important to point out that maintaining a few more older bulls in an elk population may pay dividends like increasing calf production by 20 percent. This could, in turn, allow for more liberal harvests. Other benefits are that more older bulls (highly desired by hunters) would be available to harvest, upgrading one characteristic many hunters consider important to the quality of an elk hunt. Not to be overlooked is the added benefit to many people of having more large bulls in the population to view. This aspect is becoming increasingly important.

There are many alternatives for increasing bull escapement. A shorter general bull elk season for Roosevelt Elk was adopted by the Game Commission in 1980, because of concern with low bull escapement. Figure 12 emphasizes, however, that a shorter season will not have a large effect on bull escapement. However, with proper distribution, only a slight increase in bull escapement is necessary to insure good productivity. A season of 9 or 10 days, given the present pattern and habitat conditions would probably allow an adequate percentage of branched-antlered bulls to escape but may not insure their proper distribution over the landscape. With better habitat management, a longer season could be allowed.

A "branched-antlered" bull regulation (taking spike bulls illegal) has been ruled out for widespread application for two reasons. First, legal harvest would be significantly reduced because of illegal killing and wastage of spike bulls (Boyd 1970). Secondly, legal harvest would be reduced by a "naturally" occurring high mortality rate in spike bull elk. These ramifications are unacceptable.

Limited entry hunting does not allow participation by those who most enjoy the activity, relegating hunting opportunity to a "lottery". It restricts freedom of activity in a way foreign to our system. Although bull harvest could be regulated this way, it would still be difficult to regulate distribution of the bull harvest within management units under prevailing access and habitat conditions.

Other alternatives have been considered, but the best for the Olympic study area seems to be a slight restriction of bull harvest during the general season coupled with an active program to promote forest mangement practices conducive to providing good elk habitat. This program should consider limiting size of openings created, limiting treatment of shrub and forb vegetation in certain areas, and limiting access. Access is a key factor in harvest of elk. Not enough access makes harvest very difficult. However, too much access makes some bands of elk too vulnerable to overharvest. Restricted access is needed to protect and enhance elk herds on some areas of the Olympic Peninsula. Forage/cover ratios within the home ranges of elk bands should be given consideration also. This habitat alternative is the only one that will provide a long term solution to problems of bull escapement without severely restricting recreational opportunity. It also provides the best means of maintaining or enhancing the valuable elk resource of Washington's Olympic Peninsula.

SUMMARY AND CONCLUSIONS

Hunted elk populations outside Olympic National Park were more productive than unhunted elk within Olympic National Park even with significantly more large bulls in the Park population than outside, respectively.

Female age structure indicated the Olympic herd to be a very "old" female population, rivaling some "completely protected" herds.

A definite and significant decrease in female productivity was noted after 13 years of age.

A high correlation between fewer branched-antlered bulls in the breeding population and lower pregnancy rates in adult cows was observed with sex ratios prevailing outside Olympic National Park.

Management objectives designed to increase productivity by lowering female age structure and providing increased bull escapement were established and discussed.

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LAND USE PLANNING AND HABITAT MANAGEMENT ON CRITICAL WILDLIFE RANGES

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The conference coordinator asked me to give a short talk on land use and habitat acquisition and management for wildlife. The purpose is to provide a general framework to promote discussion rather than describe the details of our limited program. I propose to achieve that objective by outlining briefly the factors and conditions which precipitated the program, the basic elements of the program, the relationship with the coordinated resource management planning process, and the future of the program.

By the early 1970's it became apparent that a new and different approach to wildlife management was required. The land use commitments and conflicts had reached the point where if wildlife was to survive in traditional numbers a planned improvement in habitat conditions was required. The multiple-use concept; everything at once, all at the same time, and the lack of any provincial vehicle for land use planning and allocation was and is responsible for the dilemma. I am opposed to multiple use of the resource lands where the interpretation is that all users have equal status and priority. When you practice multiple use, the highest use, which is based on capability must be the priority. Other uses are subsequent and/or management tools to achieve the primary objectives.

The land use and resource conflicts in the East Kootenay were numerous. They included: (1) increased and unmanaged livestock grazing on Crown range land; (2) increased economic activity which included rural subdivisions and recreational development, major hydro-electric developments with reservoirs and transmission lines, accelerated forest extraction and associated access, coal developments with massive exploration programs and just a general increase in demand for all land based resources.

While we were busily mismanaging the land base mother nature was regenerating the forest on the winter ranges, most of which had been manipulated by wild fires in the late 1920's and early 30's.

By 1970 commitments had been increased on a diminishing land base to the point where there was no flexibility to start habitat management projects. Thus it was necessary to remove some of the over commitments. The only socially and politically acceptable means of achieving this was to acquire land and its associated leases and permits.

The fundamental elements of the program are (1) voluntary sale at fair market value; (2) continued use of improved areas of acquired property to create additional flexibility and hence develop planned grazing systems. Reducing the commitments allows a variety of improvements to be conducted on the Crown land. The balance of the acquired properties are managed accordingly within the context of the program. The governing factor however is to use the property as a key component of an overall range unit plan.

In late 1973 we bought three large properties. Substantial opposition ensued because of a lack of understanding by the agricultural community and criticism by the Department of Agriculture. The swell of negative feelings preempted immediate achievement of the objectives; however, the reduced commitments were beneficial to wildlife and the agricultural community. It was not until 1975 that most of the emotionalism died down and by borrowing Bill Anderson and his Coordinated Resource Management Planning process from Oregon we were able to develop the unit plans we wanted.

The CRMP process coupled with the land acquisition resulted in a reduced and more equitable redistribution of dometic livestock grazing, and the process opened up new lines of communication between resource managers and user groups. All properties acquired for wildlife have been committed to the respective range unit CRMPlans. The difference however, is that this flexibility has allowed a priorization of uses.

As a stop gap measure, we instituted a short term elk feeding program. Between January 8, 1974 and March 20, 1978, we fed 1350 tons of hay on eight sites for a total cost of $154,000.00. In the last year of feeding our costs were $26.00/elk or $6.85 per elk per month (6000 elk).

By 1978, three years after starting the CRMP process and five years after our initial acquisitions we felt the feeding program was no longer required. Conditions are not utopian on 100 percent of the area; however, with time, effort and continuation of the management programs we anticipate improved habitat conditions. In 1970 the post season population estimate was 4950 elk; in 1980 it is 12,500. Naturally not all of this increase is attributable to the land acquisition and CRMPlans. Burning, grazing rotations, logging, improved species management and reduced commitments have also contributed.

Since 1973 we have continued to acquire land for wildlife; most of it from outside funding and at a reduced pace. The scope of the program has broadened however and includes acquisition for fisheries management and waterfowl. The potential of the concept is enormous - we can acquire tree farms, timber quotas, access, water licences and leases.

The future looks bright despite strong pockets of opposition from some segments; but the need to protect and enhance the land base and a process of allocation of uses by capabilities is slowly being realized and accepted. The project is gaining political and social acceptance and we appear to be on the brink of a substantial program. The demand for land for all purposes is such that we must protect the most important areas. Purchase where necessary, enhancement and reserving the land base of critical winter ranges is the only way to maintain our wildlife heritage.

PRELIMINARY OBSERVATIONS ON SEASONAL MOVEMENTS AND HABITAT USE BY VANCOUVER ISLAND ROOSEVELT ELK

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INTRODUCTION

Vancouver Island represents the northernmost natural distribution of Roosevelt elk (Cervus elaphus roosevelti) in North America and the only indigenous population of this subspecies in Canada. The Island also supports valuable populations of black-tailed deer (Odocoileus hemionus columbianus), which contribute 30-45% of the total provincial deer harvest (Hebert 1979). The primary influence on ungulate habitat, indeed most wildlife habitat on the Island, is forest harvesting. The forest lands of Vancouver Island, some of the most productive in Canada, contribute about 20% of the provincial timber harvest. Given the variable product mix of economic and social values possible from these forest lands, it is inevitable that direct conflicts over use allocation occurs.

Prior to the seventies there was little opportunity for public input into logging practices on Crown lands, the majority of which are under some form of forest tenure. Wildlife management consisted primarily of manipulating animal numbers (harvest policy) in response to habitat conditions imposed by clearcut logging.

As a result of public concern and pressure for some form of integrated management, a referral process was initiated during 1973-74, providing the Fish and Wildlife Branch an opportunity for review and input into forest development plans. It soon became apparent that the wildlife manager's knowledge of habitat requirements for many wildlife species was inadequate for recommendations pertaining to habitat preservation and management, especially in view of the economic values associated with the forest resource. The need to acquire information on key factors influencing ungulate populations became the focus of many research projects, especially the role of mature timber in deer-habitat relationships (Bunnell 1979). The developments in the forestry-wildlife planning process also lead to initiation of studies on elk ecology, the focus being more of a general approach than the deer research due to the lack of previous studies of elk on Vancouver Island.

The purpose of this paper is to report on some aspects of field studies on Roosevelt elk, initiated by the Branch in 1975-1976. Objectives of the project were:

1) to monitor seasonal movements and habitat utilization;

2) to obtain quantified information on the determinants of seasonal movement and habitat use, including physiographic features, vegetative structure, composition, quality and dietary analysis;
3) to obtain indices of animal condition; and
4) to relate animal and range condition to animal productivity.

I thank Ms. B. Schenker for typing this manuscript and J. Youds for drafting the figures.

STUDY AREA

Information on movements and habitat use is being collected in the Adam, White and Salmon River watersheds, situated on the east coast of Vancouver Island, west of Kelsey Bay. The majority of the study area is within the Western Hemlock biogeoclimatic zone (wet and dry subzones) with a small proportion of low elevation areas in the wet subzone of the coastal Douglas fir biogeoclimatic zone. The area is under active logging development by MacMillan Bloedel Ltd. (TFLs 7 & 39).

The watersheds differ in logging history, especially on the winter ranges. The low elevation regions of the Adam were harvested during the 1960's under progressive clearcutting policies, resulting in large openings and retention of very little mature forest cover. The lower reaches of the White have also experienced progressive clearcutting, but introduction of patch logging in the early 1970's has resulted in a greater balance of mature to second growth cover types as compared to the Adam. The Lower Salmon was logged in the 1940's and 1950's and is presently dominated by second growth deciduous and coniferous stands.

Data from two instrumented cows in the northern Strathcona Park vicinity (Elk and Ucona Rivers) will also be used to supplement movement data from the Adam and White (Janz and Lloyd 1977).

METHODS

Movement and Habitat Use

Radiotelementry is the technique being utilized to monitor individual animal movements. Habitat utilization is being documented using ratio locations and direct observation of animals.

Environmental Attributes

Biophysical features will be documented by use of air photos, forest cover maps, and biophysical maps. Slope, aspect, elevation, forest cover type, landform, and cover structural characteristics (age, height, density) will be available from these maps. Vegetation plots are being established in general habitat types (timber, meadow, slides, cutover, second growth) to document species composition, percent cover and distribution by strata. Estimates of shrub density by distance methods have also been attempted. Shrub productivity/utilization plots (diameter-weight regressions) have been established on the Adam River winter range.

Food selection is being estimated by the fecal fragment technique. Food selection will be compared to availability as determined above.

Common plant species available on the ranges have been analyzed for nutrient composition by the detergent method. Calcium, phosphorus, and crude protein values have been determined, and dry-matter digestibility was estimated for major species (using Holstein cow innoculum).

Five established weather stations on winter ranges will allow interpretation of the effects of temperature and snow on movements and use patterns. Snow depths were also estimated in areas where animals were observed throughout the winter.

Animal Condition

Fecal nitrogen concentration has been shown to fluctuate in direct proportion to dietary protein intake and is being used to measure animal condition. Supplementary condition indices (B.U.N., kidney fat, femur marrow fat) are being collected on an opportunistic basis.

Population Productivity

Seasonal classified counts are being used to document productivity (calves/100 cows), recruitment (yearlings/100 cows) and estimate total population (best count). Change in ratios of a specific age-class over time may give indications of survivorship. Aerial and ground surveys will be compared to determine precision and variability of the classification data.

RESULTS AND DISCUSSION

The results of this study are presently in the process of analyses (Janz, in prep.).

The present interpretation is thus preliminary, and only specific components are presented to illustrate some observations that appear consistent and important to management.

Movements and Habitat Use

Locations of ten animals fitted with radio collars cover the study period 1976-1978 have not been analyzed to date for home range parameters; thus, the discussion on seasonal movements is general and does not address variability associated with sex and age class and individualistic behaviour.

Winter

Winter ranges within the study area are characterized by various age classes of seral growth created by logging with some patches of low elevation mature timber, the availability being governed by stage of logging development and winter snow depths. Once on the winter home range, averaging approximately 5.2 sq. km. (two square miles) in size, movements are of a limited nature, primarily in response to weather conditions and forage availability.

The proportional use of cover types, based on observed groups for the period February to May 1976 is illustrated in Figure 1. Groups containing collared animals are presented separate from unmarked groups to validate the assumption that the former are representative of the population. The classification of observed groups to cover type is more an indication of observability associated with each type than with actual use. This is exemplified by Figure 2 where proportional use based on locations of unobserved collared animals illustrates the importance of mature timber. The combination of observed and remote locations of instrumented animals, thus, is best representative of proportional use over the winter period (Figure 3). Clearcuts in the 4-10 year age class receive the majority of use within the second growth types. Direct observations and signal characteristics of collared animals (active versus steady signal, Table 1) indicate that animals utilize this type primarily for foraging. While forage production/-availability may be similar in younger age classes, elk do not appear to fully utilize clearcuts until coniferous regeneration offers some degree of security cover (1.0-1.5 m. in height). This observation has been noted by other investigators (Lyon 1976). Locations within the mature forest suggest that this type not only offers bedding sites, but also provides foraging areas (Table 1). More rigorous data analysis should give indications of the importance of mature forest in relation to weather conditions and relative availability of the various cover types.

Figure 1. Proportional use of cover types based on observed animal groups for the period February-May, 1976.

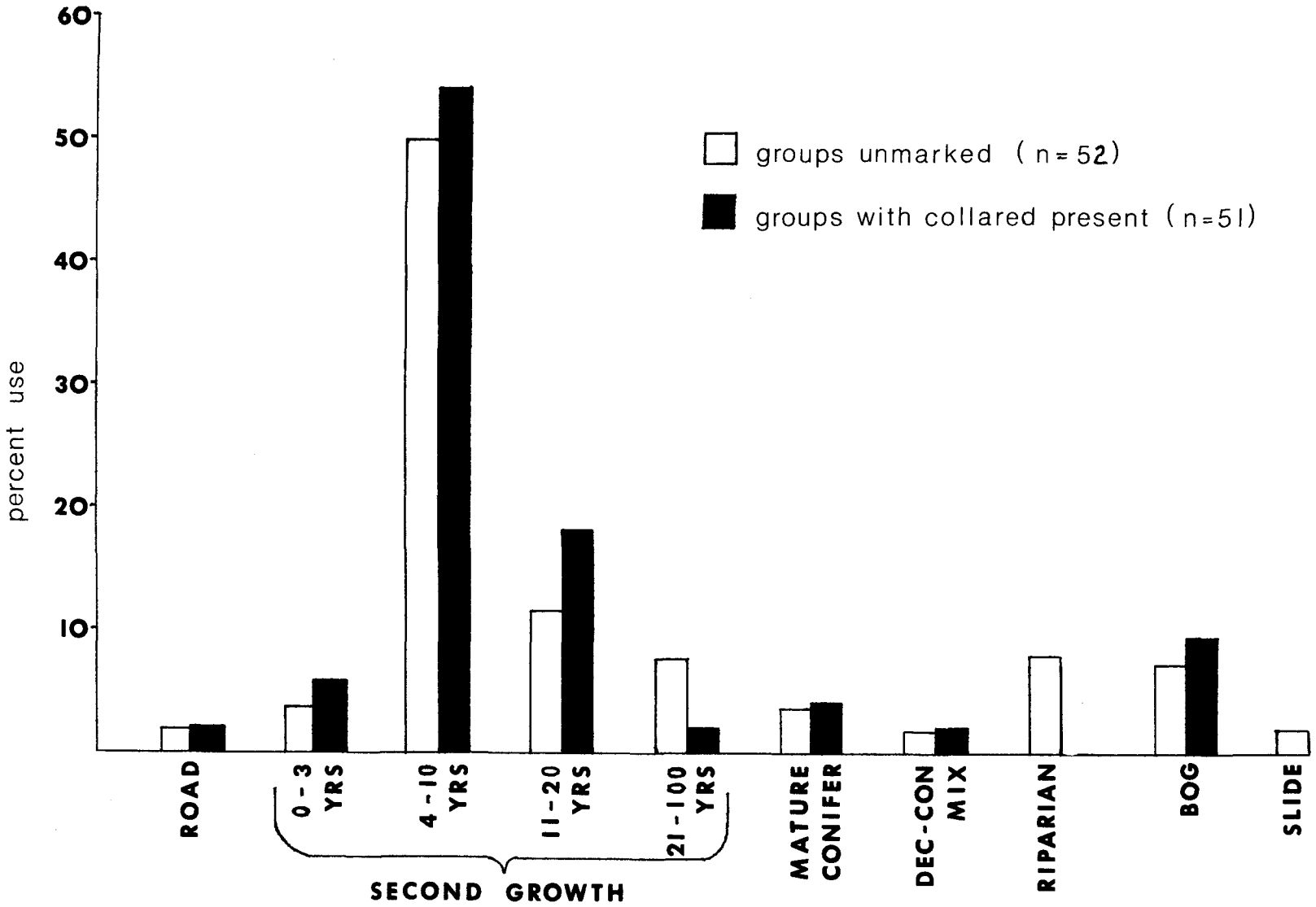

60
50
40
30
20
10
percent use
groups unmarked (n = 52)
groups with collared present (n=51)
ROAD
0 - 3 YRS
4 - 10 YRS
11 - 20 YRS
21 - 100 YRS
SECOND GROWTH
MATURE CONIFER
DEC-CON MIX
RIPARIAN
BOG
SLIDE

Figure 2. Proportional use of cover types based on remote locations of collared animals (February-May, 1976).

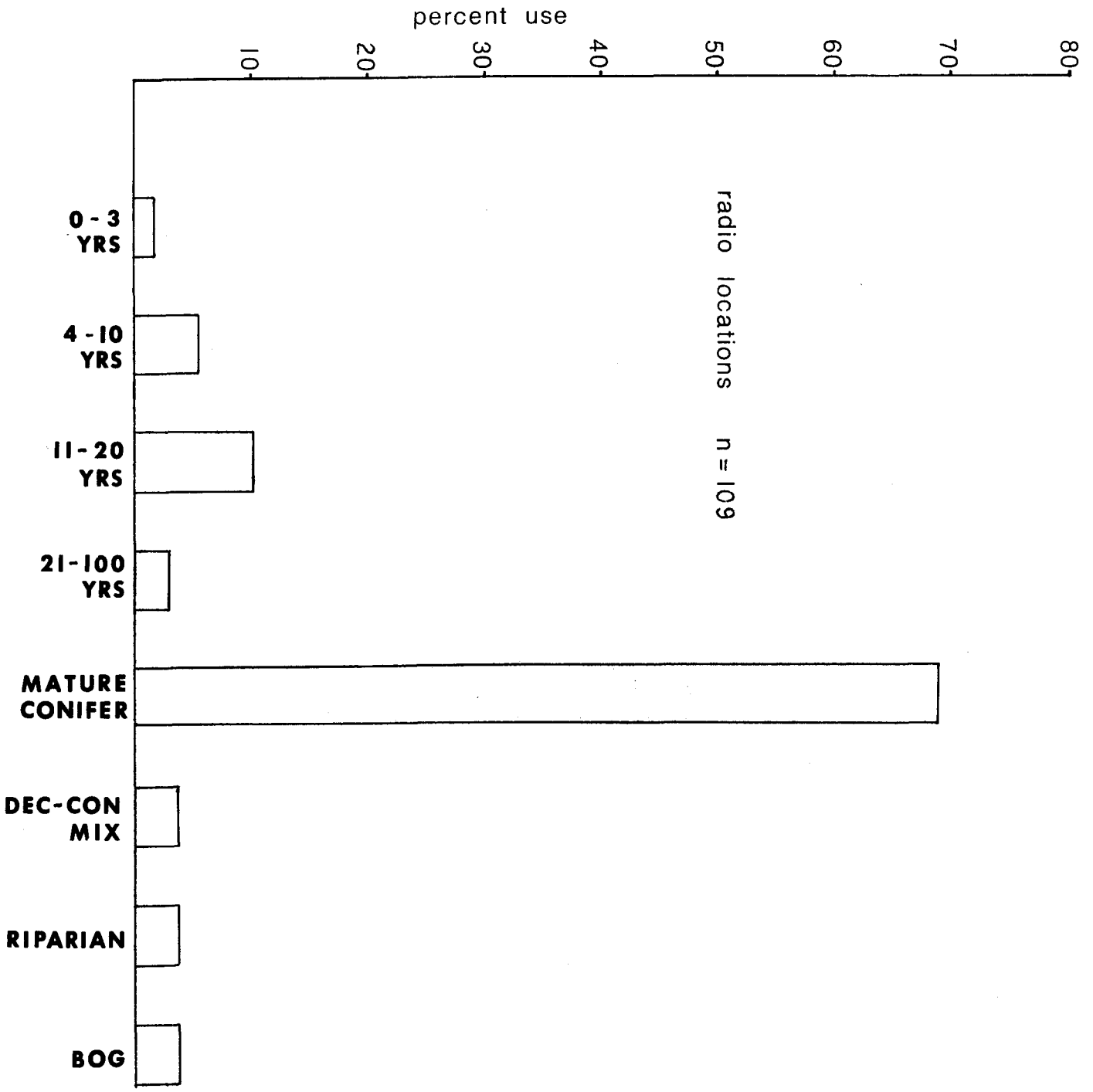

percent use
10
20
30
40
50
60
70
80
radio locations n = 109
0 - 3 YRS
4 - 10 YRS
11 - 20 YRS
21 - 100 YRS
MATURE CONIFER
DEC-CON MIX
RIPARIAN
BOG

Figure 3. Proportional use of cover types based on observed and remote locations of collared animals.

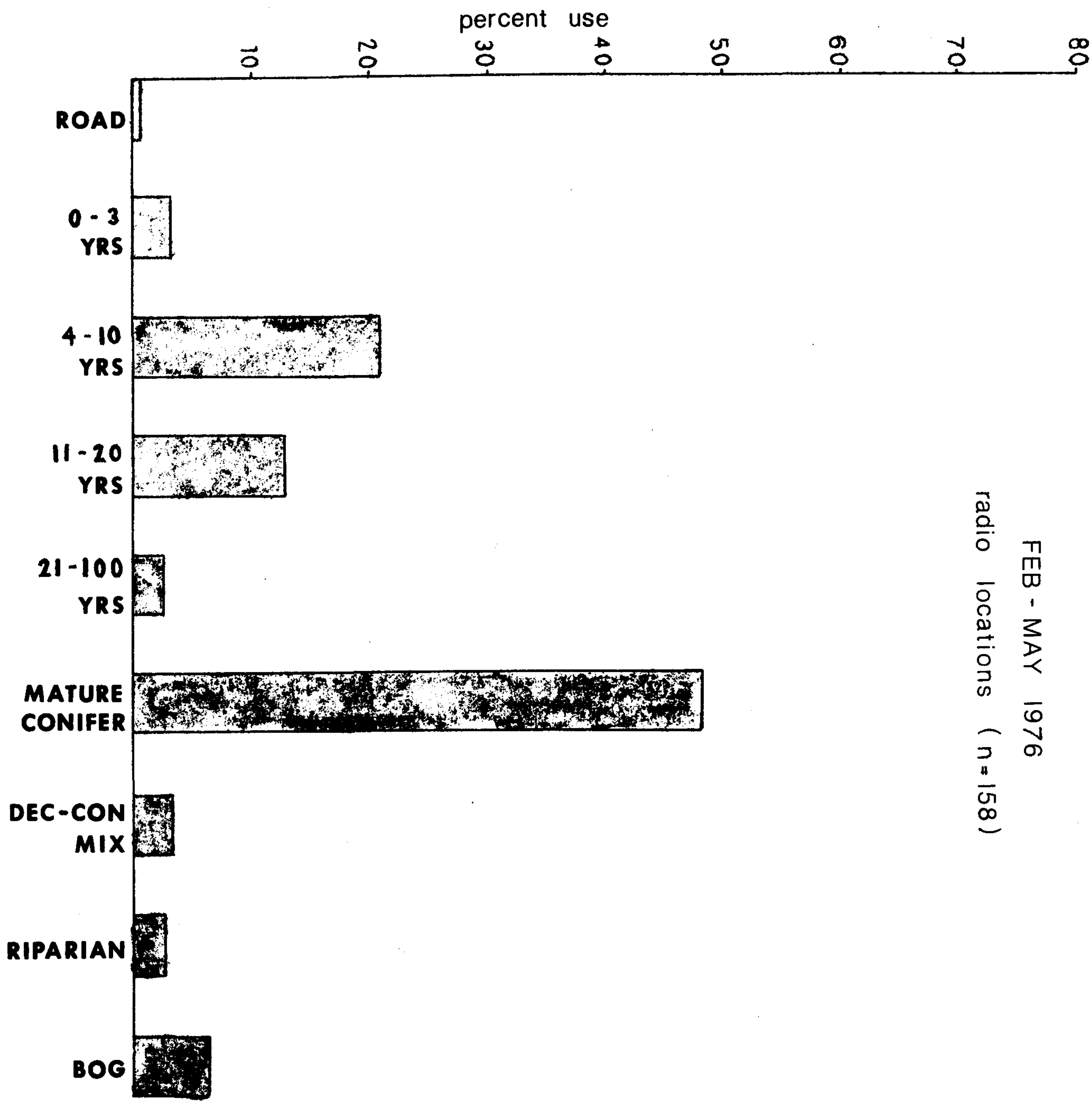

percent use
10
20
30
40
50
60
70
80
ROAD
0 - 3 YRS
4 - 10 YRS
11 - 20 YRS
21 - 100 YRS
MATURE CONIFER
DEC-CON MIX
RIPARIAN
BOG
FEB - MAY 1976
radio locations (n = 158)

Table 1. Radio Activity - February-May, 1976

(N=140)

Cover Type	Per Cent	
	Active	Steady
Road	0.7	- -
0-3 Years	1.4	1.4
4-10 Years	14.3	4.3
11-20 Years	5.7	8.6
21-100 Years	2.1	0.7
Mature Conifer	19.3	29.3
Deciduous-Conifer	3.6	- -
Riparian	2.1	0.7
Bog	3.6	2.1
TOTAL	52.9	47.1

The distance to adjacent cover types was estimated whenever possible to gain information on importance of habitat interspersion. The majority of groups over the winter period were observed within 100 m. of an edge (Figure 4). When animals were observed to be greater than 100 m from an edge, 75% of the adjacent types were mature forest. It was also observed that many groups foraging in clearcuts were in close proximity to clumps of advanced natural regeneration and residuals. Animals were also found to be bedded in these refuges on occasion.

These preliminary observations suggest that available cover is an important factor influencing habitat utilization by elk during winter. Beall (1976) indicated that elk were more associated with cover than with forage types on winter ranges in Montana and suggested that the emphasis placed on food production by logging has been misdirected.

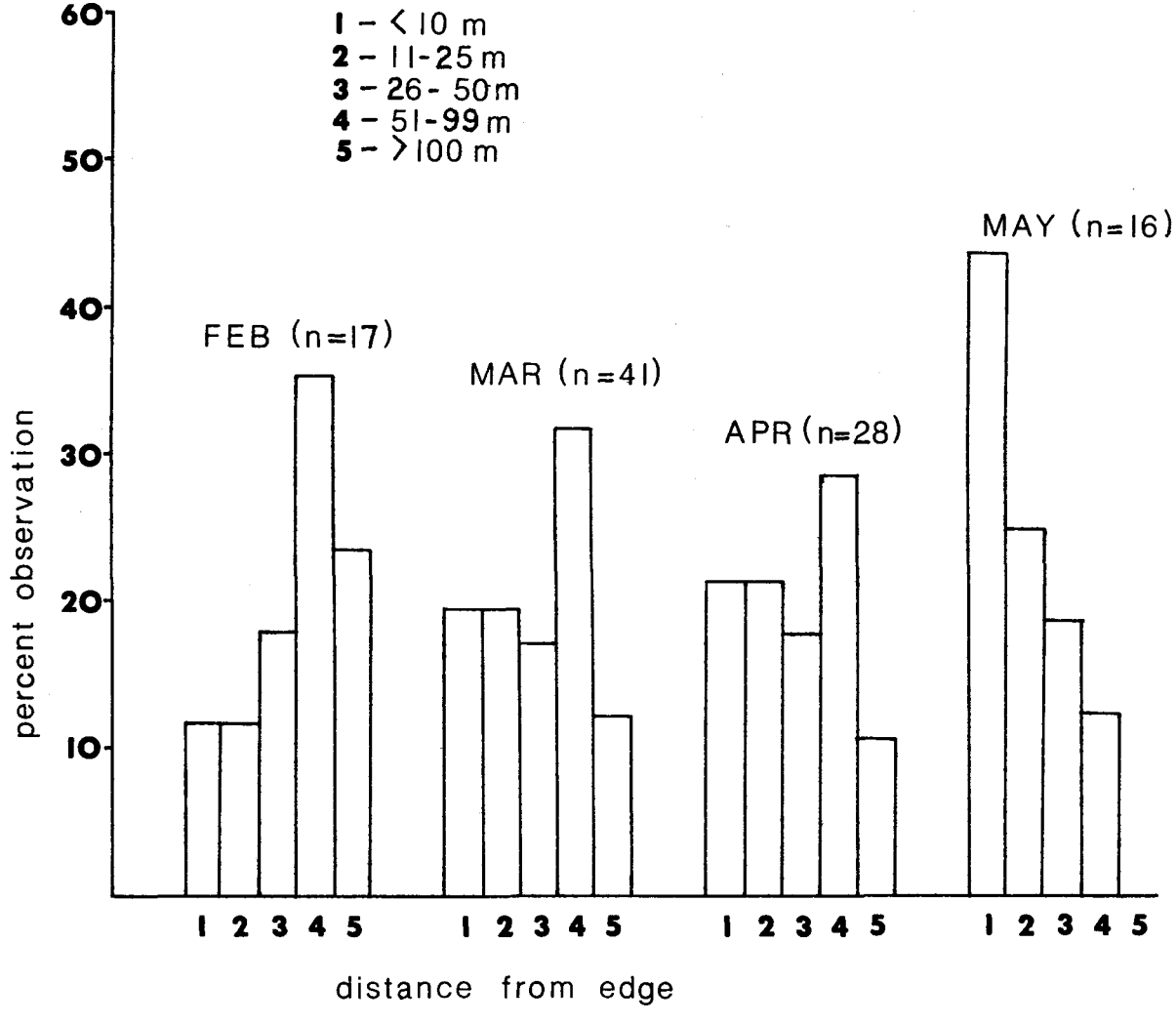
Spring Migration

During late winter and early spring utilization of forage types shifts from clearcuts to the relatively small wet meadow and bog openings. The spatial distribution and availability of these areas influences timing and distance of spring migrations. These moist seepage sites are utilized at very early visual stages of green-up. The majority of animals make short duration, nocturnal, destination-orientated movements. Some animals were observed to make exploratory movements up to higher elevation meadows, returning to the winter range if green-up had not yet occurred. Most of the calving appeared to occur on these spring and early summer ranges, depending on phenology. Some animals, however, remain on the winter range to calve, then migrate to the summer range in late June. Habitat characteristics are similar for the two types of calving areas - relatively flat, open seepage sites adjacent to dense cover.

Summer

Upon arrival on the spring-early summer ranges, often near watershed headwaters, movements are in response to new growth and availability of high quality forage areas. Habitat use gradually shifts from the wet openings to the snow-slide types. These slide tracks, characterized by dense growth of deciduous shrubs interspersed with openings of forbs and grasses, provide high quality and quantity foraging areas throughout the summer. Adjacent mature forest stands are heavily utilized as escape and thermal cover. Depending on the availability of these sites with respect to aspect, elevation and summer weather, utilization and movement between these areas can provide a source of vernal vegetation into September-October.

Figure 4. Estimated distances of observed animal groups from adjacent cover types (February-May, 1976).


1 - < 10 m
2 - 11-25 m
3 - 26-50 m
4 - 51-99 m
5 - > 100 m
FEB (n=17)
MAR (n=41)
APR (n=28)
MAY (n=16)
percent observation
60
50
40
30
20
10
1 2 3 4 5
1 2 3 4 5
1 2 3 4 5
1 2 3 4 5
distance from edge

Fall Migration

The onset of cooler temperatures and subsequent weathering and desication of forage species at higher elevations results in a shift back to the wet meadow and bog habitat types, similar to spring utilization, and increase use of timbered areas for foraging, especially north aspect seepage sites supporting green vegetation. Movements from fall to winter ranges, usually of a gradual elevational decline, appears related to the effects of temperature and snowfall on forage availability. There was no evidence of fall migrations being initiated or influenced by the effects of snow depth on mobility. Animals were on the winter range before snow depths exceeded 10-20 cm.

FOOD HABITS

Estimates of diet composition from three winter ranges and two spring-early summer collections are presented to illustrate preliminary relationships of seasonal habitat use and food habits. Results are expressed by percent importance value (% I.V.) for each forage type (I.V. = % frequency x % cover; % I.V. is proportion I.V. of forage type "i" to total I.V. for all forage types).

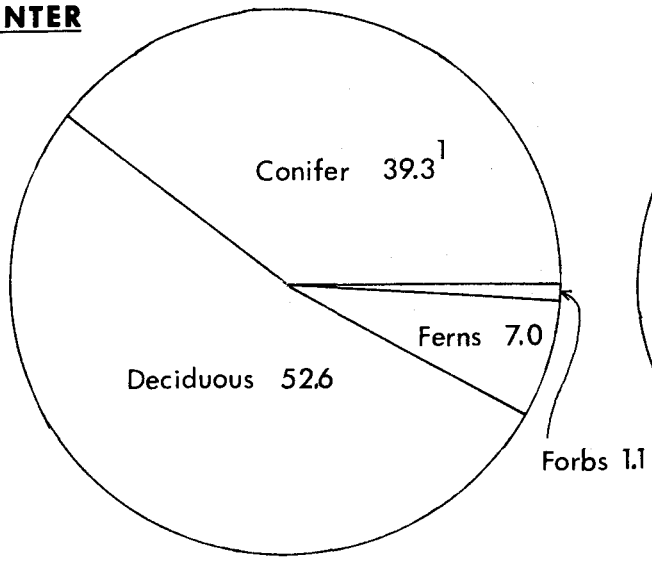
Winter

Winter diets, illustrated in Figure 5, are dominated by coniferous browse (primarily western hemlock (Tsuga heterophylla)), deciduous browse (dominated by cottonwood (Populus trichocarpa), ninebark (Physocarpus capitatus), salal (Gaultheria shallon), oregon grape (Mahonia nervosa), willows (Salix spp.) and elderberry (Sambucus racemosa)) and ferns (primarily deer fern (Blechnum spicant)). Protein levels of these dominant forage items averages 5-7%, with the exception of elderberry (10%) and deer fern (8%). Elderberry appears to be a preferred species as indicated by heavy utilization early in the winter months. Availability of deer fern, a low-growing evergreen fern, is subject to snow cover. Elk have been observed feeding on deer fern and other forbs (bunchberry (Cornus canadensis) and twinflower (Linnaea borealis)) in cutovers by pawing craters up to snow depths of approximately 30-35 cm. Analysis of a small sample of rumen samples collected in early December are also dominated by hemlock, deer fern and evergreen forbs.

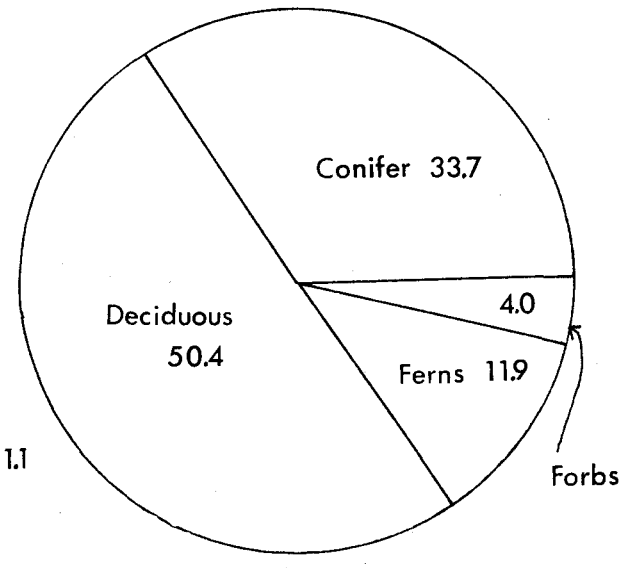
The shift to wet meadows/bogs and snow slides during spring and early summer are reflected in the diet determinations from Tlowils and Moakwa, respectively (Figure 5).

Figure 5. Dietary composition, expressed as per cent importance value of forage types, for three winter and two spring collections.

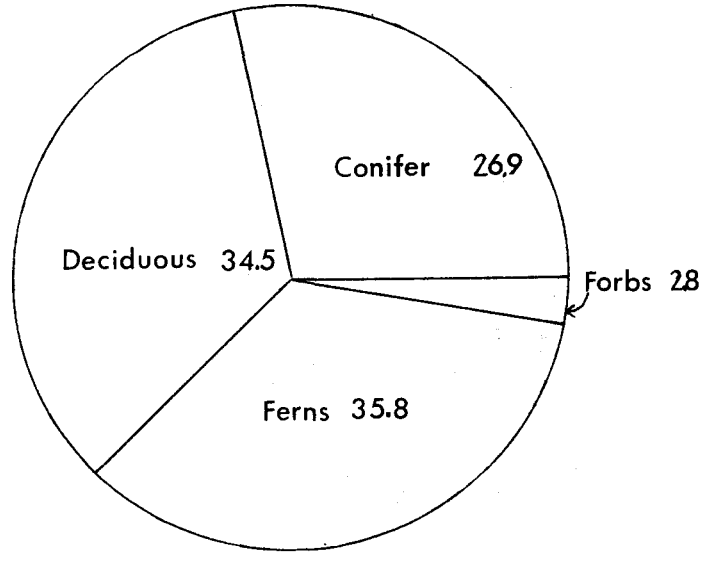
WINTER



SALMON

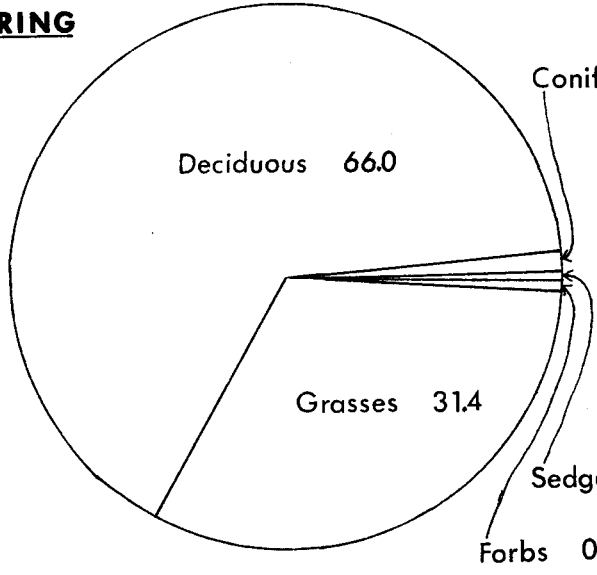


WHITE

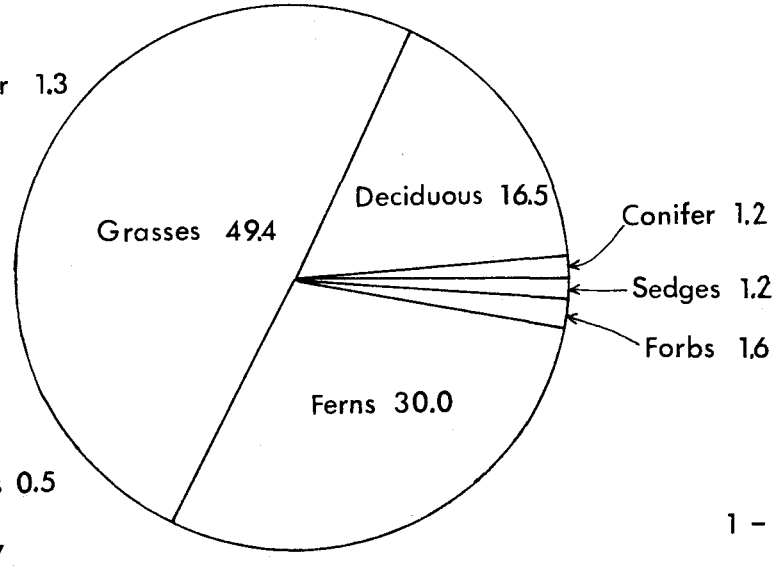


ADAM

SPRING



MOAKWA



TLOWILS

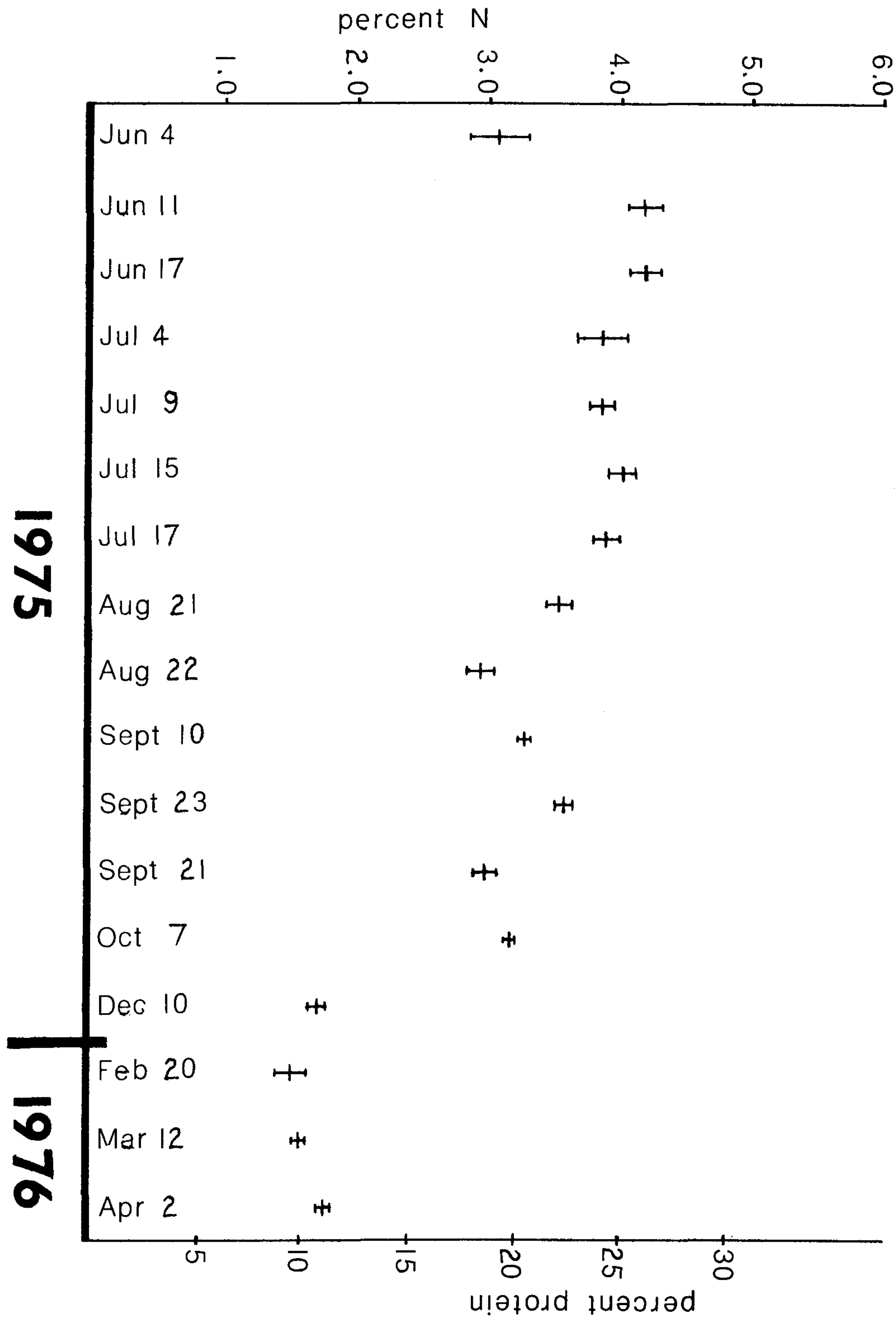
1 - % Importance Value

The importance of palatable new-growth vegetation, especially grasses and deciduous browse, is evident. Habitat utilization of these moist areas coincide with high quality new-growth (i.e., protein content of 20-25%). The high proportion of ferns in the spring diet consists of the new shoots (fiddleheads) of sword fern (Polystichum munitum), available in adjacent timber stands. The importance of wet seepage sites to elk during spring green-up and over summer has been reported by many investigators (Marcum 1976, Hayden-Wing 1979, Pederson et al. 1979). These areas are not only important in terms of forage production but may exhibit higher nutrient concentrations in comparison to species characteristic of xeric and mesic habitats (Klinka 1976).

ANIMAL CONDITION

The most common indices used to estimate animal condition require direct contact with the animal or carcass (i.e., fat indices, blood analysis, etc.). Indirect methods, other than visual classification based on body angles and contours, usually involve interpretation of range condition and diet intake. The analysis of fecal nitrogen allows estimation of diet quality in ungulates after the process of dietary intake and thus eliminates investigator inferences on diet selection. Strong positive correlations between fecal nitrogen and forage quality (crude protein, energy, digestibility) have been demonstrated for many domestic animals, although few studies of wildlife nutrition have explored these relationships (i.e., Hebert 1973). Gates (1975) and McFetridge (1977) have used fecal nitrogen to indicate seasonal shifts in diet quality on bighorn sheep (Ovis canadensis) and mountain goat (Oreamnos americanus) ranges, respectively. Fecal nitrogen values were used in the present study for similar purposes. An example of seasonal trends for the White River herds is illustrated in Figure 6. Values are highest in spring, decline gradually through summer and fall, and reach minimum values over winter, corresponding to general seasonal trends in crude protein content and digestibility of temperate forages (Dietz 1972). Fecal nitrogen values can provide comparisons of relative diet and animal condition between seasons and habitat types (Janz and Lloyd 1977), and, with serial sampling to determine duration of low levels, may be associated with productivity. Gates (1979), for example, has determined a strong correlation between seasonal fluctuations in fecal nitrogen and weight gain in Rocky Mountain elk (Cervus elaphus nelsoni), with weight status occurring at fecal nitrogen levels of approximately 10%.

Figure 6. Seasonal fecal nitrogen values (means and standard errors) collected from the White River elk herds.


percent N
1.0
2.0
3.0
4.0
5.0
6.0
Jun 4
Jun 11
Jun 17
Jul 4
Jul 9
Jul 15
Jul 17
Aug 21
Aug 22
Sept 10
Sept 23
Sept 21
Oct 7
Dec 10
Feb 20
Mar 12
Apr 2
1975
1976
5
10
15
20
25
30
percent protein

PRODUCTIVITY

Seasonal cow:calf ratios and winter carryover (percent calves of total classified) for the general study area over the period (1975-1980) are presented in Table 2. Winter snow depths and duration (Figure 7) appear to greatly influence productivity in terms of juvenile carryover. Ratios of approximately 40 calves/100 cows, obtained during the 1976-1980 succession of mild winters, compare favourably with figures for Roosevelt elk in areas where winter conditions are mild (Trainer 1971). Late summer/fall ratios of 45-50 calves/100 cows are higher than similar ratios from Oregon (Harper 1971) and Alaska (McKnight 1976: 153-160) and comparable to some Washington herds (Kuttel 1975).

Natality

Compulsory returns of reproductive tracts from limited antlerless seasons were initiated in 1977 to gain information on pregnancy rates. The data collected to date indicates that pregnancy rates for mature cows (2 $\frac{1}{2}$+ years) is high (89.5%, N=38). No evidence of alternate year breeding due to stress of lactation and/or poor condition was found. The data is comparable to the 83.8% pregnancy rate determined by Kuttel (1975) in western Washington.

Mortality

Factors affecting mortality are not well documented. Predation on elk by wolves (Canis lupus crassodon), cougar (Felix concolor vancouverensis) and black bear (Ursus americanus vancouveri) has been observed in the study area, but quantified information is lacking. A recent study of two wolf packs in the Adam River (Scott 1979) indicates that adult and calf elk are important dietary items, contributing 14.1% and 13.9% on a relative weight basis, respectively. A few instances of wolf predation on calves during the summer and fall, including one collared calf, have been observed, and may be an important factor in the estimated 20-40% mortality rate of calves from summer to late winter. Other factors, such as accidents and malnutrition, may also have impact on newborn calves (Harper et al, 1967).

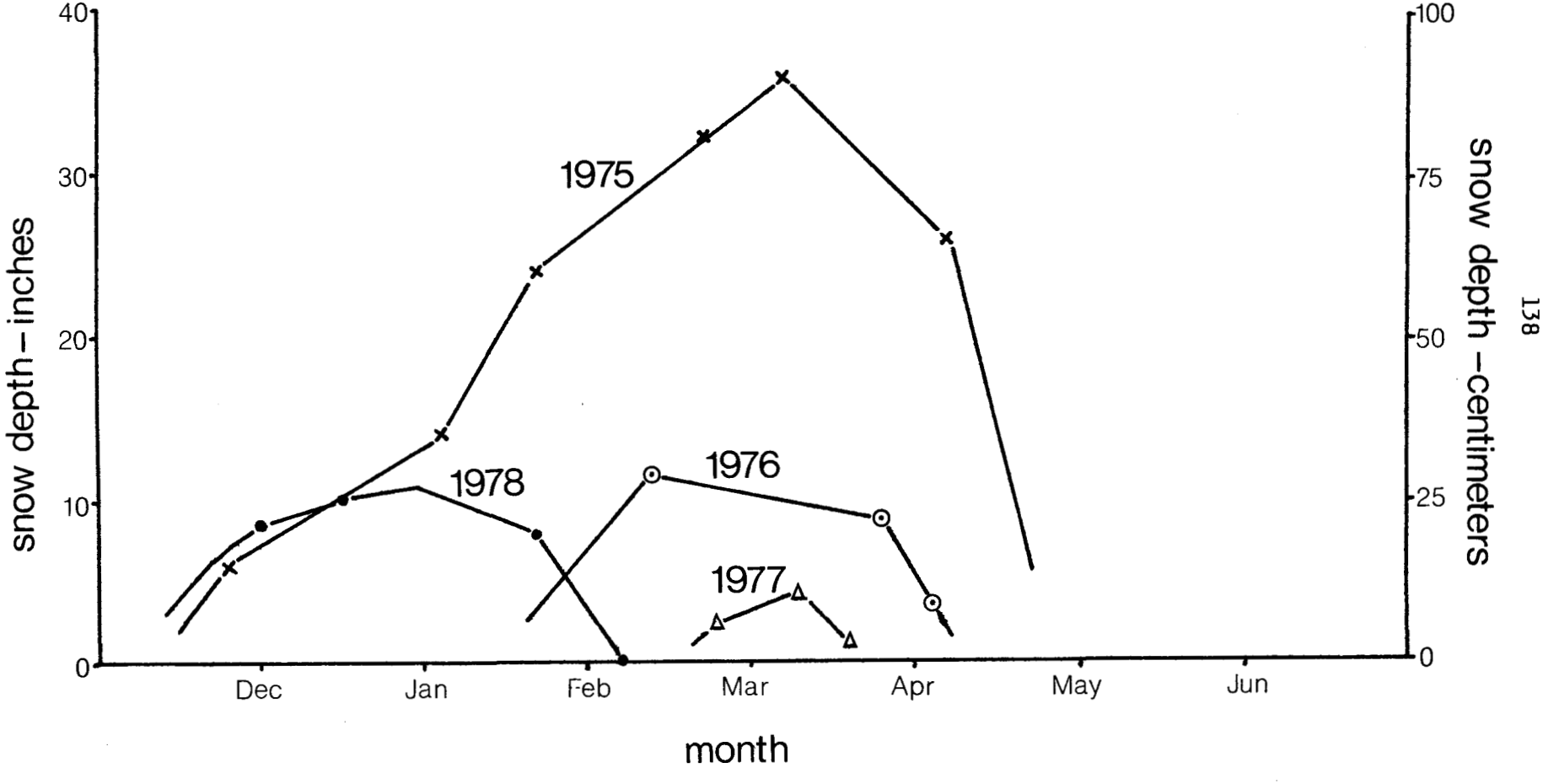
The hard winter of 1975 appeared to have great effect on calf survival (Table 2). The few carcasses examined in the field were in poor condition as evidenced by bone marrow appearance. At present, it appears that the effects of winter conditions on juvenile survivorship is the primary factor influencing population growth, a situation

Table 2. Seasonal composition 1975-1980

Year	Late Winter			Summer-Fall	
	N	Calves/ 100 Females	Per Cent Carryover	N	Calves/ 100 Females
1975	270	15	10.0	70	50
1976	751	29	18.0	180	49
1977	303	42	18.5	101	51
1978	136	39	23.5	152	52
1979	172	41	24.0	131	43
1980	162	37	22.0	- -	- -

.../24

Figure 7. Accumulated snow pack for the Adam River (300 m. elevation), 1975-1978.


40
30
20
10
0
snow depth – inches
100
75
50
25
0
snow depth – centimeters
1975
1976
1977
1978
Dec
Jan
Feb
Mar
Apr
May
Jun
month

reported in other areas (Schwartz and Mitchell 1945, Alexander 1973). A combination of limited winter range and high wolf populations in many watersheds on northern Vancouver Island has led to recent concern over the welfare of deer and elk herds in these areas during the next severe winter (Hebert et al, in press).

MANAGEMENT IMPLICATIONS

These preliminary results, supported by similar observations of elk ecology reported in other studies, allow provision of some management recommendations, especially as related to elk-forestry interactions.

Use of forage and cover types, demonstrated during the winter period, portray a basic principle of wildlife management, the importance of habitat diversity and interspersion. This concept implies planning of complex spatial and temporal patterns of cut if the integration of wildlife requirements with forest harvesting is a stated management objective on public lands (B.C. Forest Service 1976). While logging does provide important winter forage areas, the availability of security and escape cover in the form of coniferous regeneration and refuges of advanced natural regeneration and mature timber is an important factor influencing the use of forage sites. While the importance of mature timber for thermal shelter was not well documented in this study due to relatively mild winter conditions, the collared animals displayed high proportional use of this type. Roosevelt elk populations in other areas also show high use of mature timber stands (Harper 1971, Alexander 1973). During periods of deep snow, mature forests allow greater mobility due to decreased snow depths and provide forage in the form of litterfall and understory browse. The ability of second growth stands to provide similar forage characteristics, especially under 60-90 year rotations, appears low. Recent work on Vancouver Island indicates that old growth stands can provide 25 times the amount of arboreal lichens and two to three times the amount of understory vegetation compared to second growth forests 20-110 years of age (Hebert 1979).

The limited distribution of important wet habitat types on Vancouver Island (meadows, bog, slides, riparian flats) implies stringent protective measures. General recommendations include maintenance of fringe strips to act as visual screens from logging activity and road use, especially main haul roads (Perry and Overly 1976, Ward 1975, Pederson et al. 1979), provide adjacent cover, and help maintain the integrity of these sites (hydrological considerations). Inclusion of these types into long-term firebreaks should be incorporated in the planning process.

Retention of mature timber movement corridors from fall to winter ranges does not appear warranted, as relatively low snow depths initiate movement to lower elevations, a behaviour reported by others (Ward et al. 1975). Provision of cover type interspersion, however, is required along traditional movement routes and transitional ranges to provide cover characteristics similar to the discussion on winter range requirements.

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WASHINGTON STATE'S 1979 ELK HUNTER RE-DISTRIBUTION BY AREA AND TIME STRATA

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Washington Game Department
Olympia, Washington

ABSTRACT

The continual increase of elk hunting pressure from 1935 to 1978 has proceeded at a more rapid rate than the noticeable increase in the elk population. Pressure problems, primarily in the Colockum and Yakima areas, necessitated changing the opening day from Saturday to Monday for 1971 to 1978. While helpful at reducing pressure on the opening day, the Game Commission established a four area, five tag system for 1979, to move hunters away from these two congested popular areas.

Preliminary data indicates that pressure changed from 59 percent eastside - 41 percent westside to the reverse in 1979 with 59 percent being westside. Also, Yakima area pressure, which had been reduced from 30 percent to 17 percent of the total, was further split by two tags: 47 percent early and 53 percent late. Colockum was reduced from 13 percent to 9 percent of the total. The new tag system and/or a gasoline shortage resulted in a drop in sales of 6,000 elk tags. Hunter success in Colockum-Yakima improved from 6 percent to 13 percent but dropped from 17 percent to 10 percent on the westside. Statewide success was similar for 1978 and 1979.

The Game Commission has approved the same system and comparable opening dates for 1980, a continuation of the three-year trial. Of the 20,000 hunters who moved from Colockum-Yakima in 1978 to the westside in 1979, we expect up to half to return to Colockum-Yakima in 1980. The early-late Yakima system may be applicable on a statewide basis when and if pressure increases in the future.

While highly successful, in retrospect, the new plan was the subject of some bitter letters shortly after newspapers published the plan last summer. Some people are still not happy with it, but it seems to be accepted as an improvement by the majority of elk hunters. Publicity and the written regulations, while initially causing confusion, seem to have worked in explaining the radically new concept to hunters.

While our elk population has increased substantially over the past 45 years, interest of sportsmen in hunting elk has increased at a faster rate (Table 1).

Table 1. Increase of elk hunting pressure at 5-year intervals over the 40 years between 1935 and 1975.

Year	Elk Tags Sold	Elk Harvest	Percent Success
1935	878	250	28%
1940	5,310	1,800	34%
1945	20,376	3,212	16%
1950	52,559	10,740	20%
1955	37,701	7,000	19%
1960	51,640	7,760	19%
1965	72,895	11,150	15%
1970	98,699	11,150	11%
1975	103,615	12,730	10%

Hunting pressure problems had become particulary bad in the Colockum and Yakima areas by 1970 when several disagreeable "shoot-outs" occurred. As a result, the traditional Saturday statewide opening day was changed to a Monday in 1971. All elk seasons through 1978 started on a Monday, and while partially successful in reducing Colockum and Yakima hunting pressure on the opening, by 1978 the Game Commission was considering a multiple tag system to re-distribute hunting pressure away from these popular areas.

During this period, two surveys were conducted in 1975 and 1978 to determine hunter opinion on management changes to correct these problems (Parsons 1975; Parsons and Brown 1978). These surveys also obtained data on elk hunter distribution during the 1974 and 1977 seasons. These data are used here to make comparisons with 1979 re-distribution data (Table 2).

Table 2. 1979 incomplete Washington elk tag sales under five elk tag system by percent of total tag sales compared with 1974 and 1977 surveys which showed hunter distribution under one tag system

1979 Tag Area (Prefix)	Percent of Total Elk Tag Sales 1974	1977	1979*
Blue Mountains (M)	16.3%	15.5%	14.9%
Colockum-Yakima	42.5%	43.2%	26.1%
Colockum (K)	-	13.3%	9.2%
Yakima	-	29.9%	16.9%
Early (X)	-	-	7.9%
Late (Y)	-	-	9.0%
Eastside	58.8%	58.7%	41.0%
Westside (W)	41.2%	41.3%	59.0%
State Total Elk Sales	103,593	110,049	112,793

* Preliminary Estimates 2/11/80

The Game Commission adopted a four area, five elk tag system for 1979 Table 3, Figure 1). Figures 2 through 6 are reduced illustrations of the five different elk tags available to hunters on a voluntary basis in 1979. Each hunter could purchase only one tag and if the either-sex permit applications was removed, he could not exchange it for another tag.

Table 3. 1979 Bull elk hunting seasons for five separate elk tags.

Elk Tag	Prefix	Color	Either-sex Permit Appl.	Opening Day*	Days	Dates
Blue Mountains	M	Blue	Yes	Wed.	12	Nov. 7-18
Colockum	K	Gray	Yes	Mon.	10	Oct. 29-Nov. 7
Early Yakima	X	Salmon	No	Sun.	15	Nov. 4-18
Late Yakima	Y	Yellow	Yes	Sat.	9	Nov. 10-18
Westside	W	Green	Yes	Sun.	15	Nov. 11-25

* 1980 openings set for comparable 1980 days and dates, i.e.: Blue Mtns. on Wed. Nov. 5; Colockum on Mon. Oct. 27; Early Yakima on Sun. Nov. 2; Late Yakima on Sat. Nov. 8; and Westside on Sun. Nov. 9.

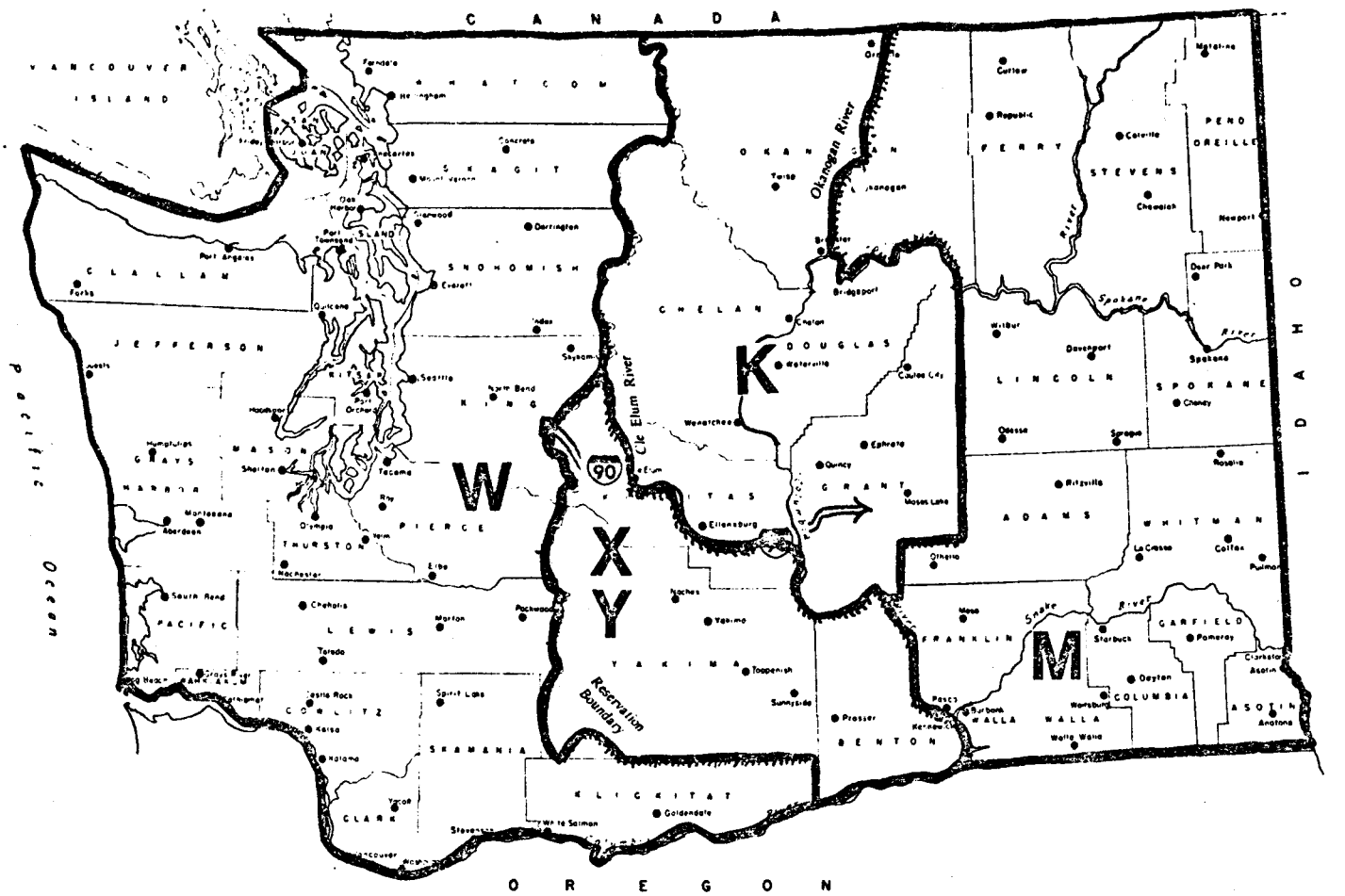
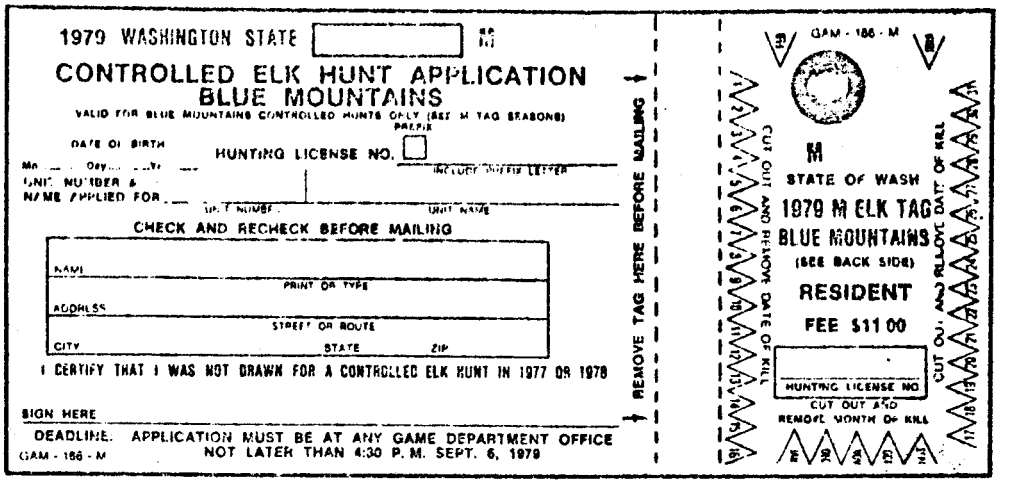


Figure 1. 1979 Elk Tag Areas


1979 WASHINGTON STATE M

CONTROLLED ELK HUNT APPLICATION
BLUE MOUNTAINS

VALID FOR BLUE MOUNTAINS CONTROLLED HUNTS ONLY (SEE M TAG SEASONS)

DATE OF BIRTH Mo. Day Yr.

HUNTING LICENSE NO. (INCLUDE PREFIX LETTER)

UNIT NUMBER & NAME APPLIED FOR (UNIT NUMBER) (UNIT NAME)

CHECK AND RECHECK BEFORE MAILING

NAME (PRINT OR TYPE)

ADDRESS (STREET OR ROUTE)

CITY STATE ZIP

I CERTIFY THAT I WAS NOT DRAWN FOR A CONTROLLED ELK HUNT IN 1977 OR 1978

SIGN HERE

DEADLINE: APPLICATION MUST BE AT ANY GAME DEPARTMENT OFFICE NOT LATER THAN 4:30 P.M. SEPT. 6, 1979

GAM - 186 - M

REMOVE TAG HERE BEFORE MAILING

GAM - 186 - M

M

STATE OF WASH

1979 M ELK TAG

BLUE MOUNTAINS

(SEE BACK SIDE)

RESIDENT

FEE $11.00

HUNTING LICENSE NO.

CUT OUT AND REMOVE MONTH OF KILL

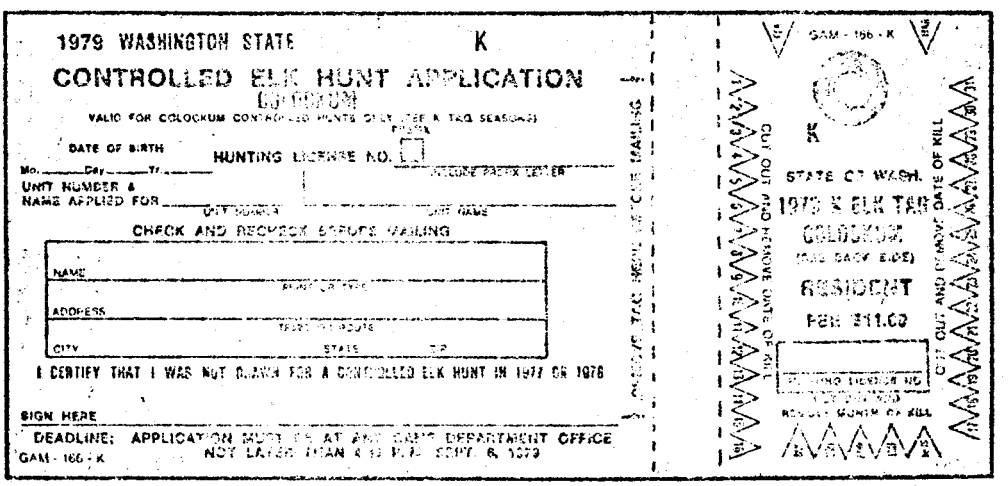
CUT OUT AND REMOVE DATE OF KILL

Figure 2.

Blue M Tag

BLUE MOUNTAINS NOV. 7-18

COLOCKUM OCT. 29-NOV. 7


1979 WASHINGTON STATE K

CONTROLLED ELK HUNT APPLICATION
COLOCKUM

VALID FOR COLOCKUM CONTROLLED HUNTS ONLY (SEE K TAG SEASONS)

DATE OF BIRTH Mo. Day Yr.

HUNTING LICENSE NO. (INCLUDE PREFIX LETTER)

UNIT NUMBER & NAME APPLIED FOR (UNIT NUMBER) (UNIT NAME)

CHECK AND RECHECK BEFORE MAILING

NAME (PRINT OR TYPE)

ADDRESS (STREET OR ROUTE)

CITY STATE ZIP

I CERTIFY THAT I WAS NOT DRAWN FOR A CONTROLLED ELK HUNT IN 1977 OR 1978

SIGN HERE

DEADLINE: APPLICATION MUST BE AT ANY GAME DEPARTMENT OFFICE NOT LATER THAN 4:30 P.M. SEPT. 6, 1979

GAM - 186 - K

REMOVE TAG HERE BEFORE MAILING

GAM - 186 - K

K

STATE OF WASH.

1979 K ELK TAG

COLOCKUM

(SEE BACK SIDE)

RESIDENT

FEE $11.00

HUNTING LICENSE NO.

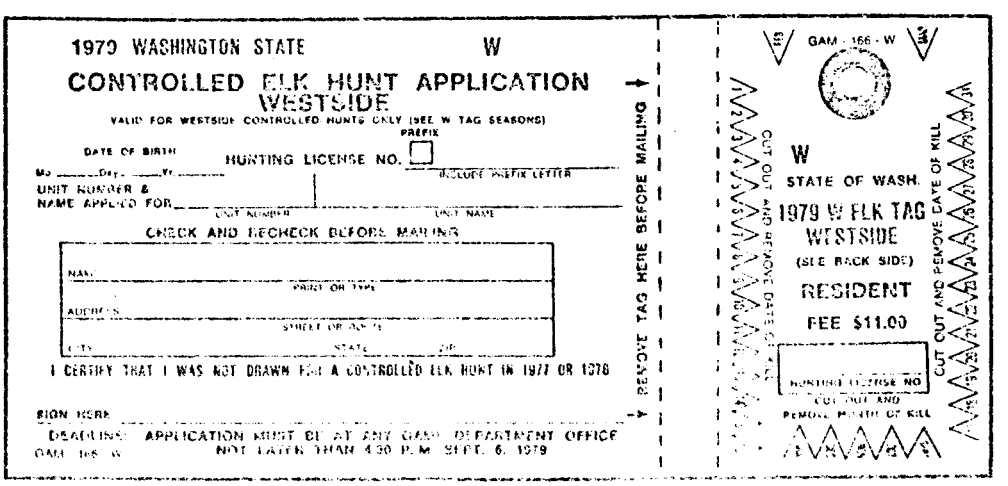
CUT OUT AND REMOVE MONTH OF KILL

CUT OUT AND REMOVE DATE OF KILL

Figure 3.

Gray K Tag

WESTSIDE NOV. 11-25


1979 WASHINGTON STATE W

CONTROLLED ELK HUNT APPLICATION
WESTSIDE

VALID FOR WESTSIDE CONTROLLED HUNTS ONLY (SEE W TAG SEASONS)

DATE OF BIRTH Mo. Day Yr.

HUNTING LICENSE NO. (INCLUDE PREFIX LETTER)

UNIT NUMBER & NAME APPLIED FOR (UNIT NUMBER) (UNIT NAME)

CHECK AND RECHECK BEFORE MAILING

NAME (PRINT OR TYPE)

ADDRESS (STREET OR ROUTE)

CITY STATE ZIP

I CERTIFY THAT I WAS NOT DRAWN FOR A CONTROLLED ELK HUNT IN 1977 OR 1978

SIGN HERE

DEADLINE: APPLICATION MUST BE AT ANY GAME DEPARTMENT OFFICE NOT LATER THAN 4:30 P.M. SEPT. 6, 1979

GAM - 186 - W

REMOVE TAG HERE BEFORE MAILING

GAM - 186 - W

W

STATE OF WASH.

1979 W ELK TAG

WESTSIDE

(SEE BACK SIDE)

RESIDENT

FEE $11.00

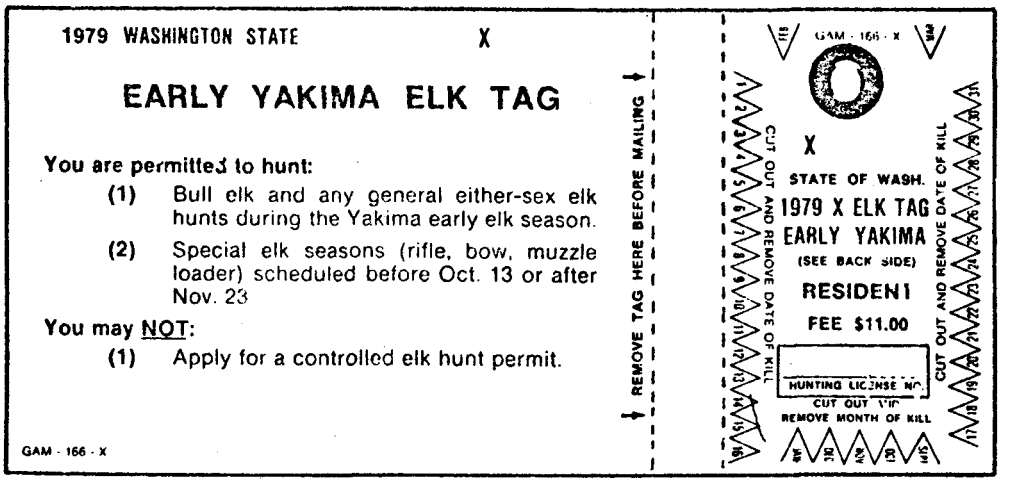
HUNTING LICENSE NO.

CUT OUT AND REMOVE MONTH OF KILL

CUT OUT AND REMOVE DATE OF KILL

Figure 4.

Green W Tag


1979 WASHINGTON STATE X

EARLY YAKIMA ELK TAG

You are permitted to hunt:

(1) Bull elk and any general either-sex elk hunts during the Yakima early elk season.

(2) Special elk seasons (rifle, bow, muzzle loader) scheduled before Oct. 13 or after Nov. 23

You may NOT:

(1) Apply for a controlled elk hunt permit.

GAM - 166 - X

REMOVE TAG HERE BEFORE MAILING

GAM - 166 - X

X

STATE OF WASH.

1979 X ELK TAG

EARLY YAKIMA

(SEE BACK SIDE)

RESIDENT

FEE $11.00

HUNTING LICENSE NO.

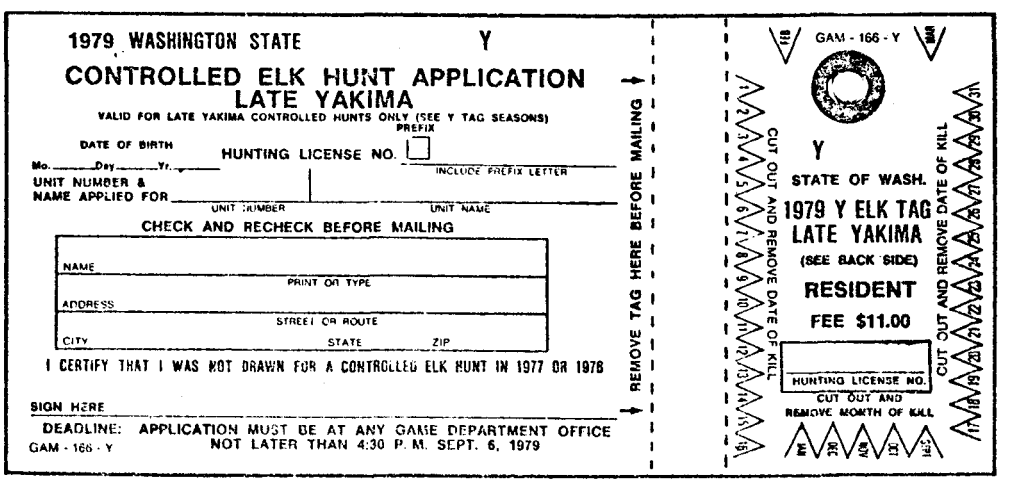
CUT OUT AND REMOVE DATE OF KILL

CUT OUT AND REMOVE MONTH OF KILL

Figure 5.

Salmon X Tag

EARLY YAKIMA
NOV. 4-18
(BULLS ONLY)


1979 WASHINGTON STATE Y

CONTROLLED ELK HUNT APPLICATION

LATE YAKIMA

VALID FOR LATE YAKIMA CONTROLLED HUNTS ONLY (SEE Y TAG SEASONS)

PREFIX

DATE OF BIRTH Mo. Day Yr.

HUNTING LICENSE NO. INCLUDE PREFIX LETTER

UNIT NUMBER & NAME APPLIED FOR UNIT NUMBER UNIT NAME

CHECK AND RECHECK BEFORE MAILING

NAME PRINT OR TYPE

ADDRESS STREET OR ROUTE

CITY STATE ZIP

I CERTIFY THAT I WAS NOT DRAWN FOR A CONTROLLED ELK HUNT IN 1977 OR 1978

SIGN HERE

DEADLINE: APPLICATION MUST BE AT ANY GAME DEPARTMENT OFFICE NOT LATER THAN 4:30 P.M. SEPT. 6, 1979

GAM - 166 - Y

REMOVE TAG HERE BEFORE MAILING

GAM - 166 - Y

Y

STATE OF WASH.

1979 Y ELK TAG

LATE YAKIMA

(SEE BACK SIDE)

RESIDENT

FEE $11.00

HUNTING LICENSE NO.

CUT OUT AND REMOVE DATE OF KILL

CUT OUT AND REMOVE MONTH OF KILL

Figure 6.

Yellow Y Tag

LATE YAKIMA NOV. 10-18

Seasons were established to make the westside more attractive than the Colockum or Yakima tags. Yakima was further stratified with an early tag (bulls only), and late tag (permit application attached). The latter tag purchasers were the only ones who could apply for an either-sex permit. The former could hunt first and six days longer than the latter (Table 3). The Blue Mountains was also given a less attractive season than the westside.

Redistribution was dramatic. Table 2 shows that the 59-41 percent split favoring the eastside in 1974 and 1977 was reversed in 1979. While Blue Mountains distribution was similar, the percentage was slightly less in 1979 than formerly. Colockum and Yakima area use was reduced from 43 percent to 26 percent of elk tag sales. Colockum use was lowered from 13 percent to 9 percent, Yakima from 30 percent to 17 percent. The Yakima area had a 47-53 percent split between the early and the late tags, which represented 8 percent and 9 percent of the total, respectively.

The 1977, 1978 and 1979 tag, harvest, and success data are presented to further illustrate the redistribution (Table 4). The major revision in pressure was the movement of about 20,000 hunters from Colockum-Yakima to the westside. Eastside success was improved from 7% to 12%, while westside success declined from 17% to 10%. While many westside hunters were upset about increased pressure and competition, the larger westside areas were better able to handle this than the restricted Colockum and Yakima areas. A combination of the new tag system, the poor 1978 elk season in Yakima and the gasoline shortage resulted in 6,000 less elk tags being sold in 1979 than 1978.

The Game Commission has set similar opening dates for 1980 (Table 3). Because of the improved situation in the Colockum and Yakima areas, we expect some of the 20,000 hunters who moved their hunting to the westside, to return to Colockum-Yakima in 1980. If this switch is no more than half and divides equally among the three tags, it would improve quality on the westside and would not be critical to Colockum-Yakima. Tentative plans call for a three-year trial of the five tag system, but these preliminary data have been very encouraging. Future seasons, after the three-year trial, will be some modification of the multiple tag system. While some hunters have demanded that we return to the one statewide tag, it appears that we never will.

It would be helpful to know the area of residence of the 20,000 elk hunters who moved from Colockum-Yakima to the westside in 1979. However, we suspect they are largely urban residents from the Everett-Seattle-Tacoma area. We also suspect that they are not the most successful elk hunters and carry their relative incompetence with them from area to area. It is possible that their presence in a hunting area makes hunting worse for those that habitually hunt these areas successfully. I suspect that

Table 4. 1977-1979 elk hunters and success by 1979 tag areas.

Tag Area	1977			1978			1979*		
	Tags	Harvest	Success	Tags	Harvest	Success	Tags	Harvest	Success
Blue Mountains	17,058	1,990	11.7%	18,388	2,070	11.3%	16,826	1,850	11.0%
Colockim-Yakima	47,542	4,920	10.3%	51,251	2,900	5.7%	29,477	3,870	13.1%
Colockum	14,637	1,490	10.2%	15,779	1,290	8.2%	10,392	*	*
Yakima	32,905	3,430	10.4%	35,472	1,610	4.5%	19,085	*	*
Eastside	64,600	6,910	10.7%	69,639	4,970	7.1%	46,303	5,720	12.4%
Westside	45,449	5,910	13.0%	48,997	8,200	16.7%	66,490	6,605	9.9%
State	110,049	12,820	11.6%	118,636	13,170	11.1%	112,793	12,325	10.9%

*Preliminary Data (2/11/80): 1979 harvest data for Colockum-Yakima is a composite of Region 2 and 3 harvests but it will not be possible to get a breakdown until 1979-1980 Big Game Status Report is compiled about May 10, 1980.

these people cause most of our problems. Excerpts from a few pre-season letters from the Seattle area follow:

(1) Letter, in part, to Governor Ray from suburban Seattle (Ravendale): "I feel, and all my hunting friends believe, that this state's game management has been getting worse year after year, and this year is more than a thinking hunter can comprehend. It is not only too, too, too impossible to figure out what is open and where, but the good hunting areas are NEVER open.

"As you know, elk are migrating animals; and they generally move in the same areas, at the same time of year, every year. Our Game Department opens an area before the game gets there and then closes it. Then they reopen the area where they were, but are no longer. It all becomes more of a contest between the hunter and the Game Department than the hunter and the game.

"It is obvious to most hunters that the Game Department does not want hunters to kill their elk, but they still want the hunter's money. Rather than making it virtually impossible to get an elk but still get the hunter's money, try this idea:

1. Deer Season, November 1-15, statewide.
2. Elk Season, November 15-30, statewide.
3. Deer tag cost of $100.00
4. Elk tag cost of $250.00

"This would reduce your hunting pressure, reduce the game kill and not reduce the income."

(2) Petition from a plant in suburban Seattle (Kent) sent in by a Sumner man. The petition has 36 signatures and has xerox copy of a newspaper article describing the regulations for the 1979 elk season and says:

"We the undersigned hereby are giving you notice of our displeasure with your area elk tags. We request you void out this nightmare before elk season is as bad as salmon and steelhead fish." The author adds a note: "These names were collected from National Can Corp., Kent, a plant of about 175 people. This means that the percentage of people against this is quite high, considering hunters to non-hunters.

These letters were received about August 1, 1979, and it is interesting that we have received as much favorable as unfavorable comments in post-season letters. Our field personnel say that most elk hunters favored the changes and season patterns were accepted with very little criticism.

For future increases in hunter numbers, we have the stratification option used in the Yakima area. The 47-53 percent early-late split on two separate openings might even be used on a statewide basis. However, we should look at data for three seasons before any major revision.

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SOME COSTS AND BENEFITS OF ELK IN WYOMING

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Elk management in Wyoming is unique because a large portion of the elk in the state are artificially fed each winter. Some other state and provincial game management agencies feed elk but on a more limited or intermittent basis. The cost of feeding elk is great and this paper presents some figures on economics of elk management in Wyoming.

A brief explanation of the elk feeding operation in Wyoming is necessary so that the cost figures presented will have more meaning. Approximately 22,000 elk are fed each winter, which is about one third of the total elk population in the state. The National Elk Refuge near Jackson, Wyoming, feeds about 7,500 each winter. The Wyoming Game and Fish Department primary involvement in this feeding program is purchasing half the hay fed. The U.S. Fish and Wildlife Service maintains the grounds, feeds the elk and purchases the other half of the hay. There are 22 state operated feedgrounds. All of these are in northwest Wyoming in Game District 1, which occupies about 12 percent of the total land area of the state.

There are two primary reasons elk are fed in northwest Wyoming, i.e., damage prevention and loss of traditional winter ranges. Topography in District 1 consists of high mountains and flat valleys. Nearly all of the low country is in private ownership. The mountains receive considerable depths of snow during the winter months and consequently the elk are forced onto private property. Wyoming has a damage law that states, essentially, that the Wyoming Game and Fish Department will pay for damages caused to private property by animals under their jurisdiction. Tremendous problems are caused to both landowners and the Game and Fish Department when 10,000 to 12,000 elk move toward private property in the fall and winter. Feedgrounds have been established around the edges of the private land and the elk gather on these instead of going to haystacks, etc.

The second reason for feeding elk has to do with the loss of traditional elk winter range. Much of the land that was once used by wintering elk is no longer available. This, plus the damage problem, has resulted in a situation that requires a feeding program if elk are to exist in traditional numbers in northwest Wyoming.

The elk are fed baled hay each day. The feeding season varies from 90 days on some feedgrounds where damage prevention is not a major factor to 180 days on feedgrounds in deep snow country where damage prevention is important. Table 1 shows

general data about feedgrounds. A total of 12,292 elk were fed during the winter of 1978-79, varying from 265 on the smallest feedground to 1,200 on the largest. Intake rates varied from 7.2 to 11.3 lb/elk/day. A total of 137 elk died on the feedgrounds which is about 1 percent of the total elk fed.

Table 1. Data on feedground elk numbers, hay fed, and death rates for fiscal year 1979

	Elk Numbers	Tons Fed	lb/Elk/Day	Dead Elk
Average	585	351	9.1	6.5
Range	265-1,200	133-672	7.2-11.3	0-23
Total	12,292	7,378		137 (1%)

Fifty-four percent of the elk hunters in Wyoming during 1979 hunted feedground elk to some degree, (they could have hunted other places as well), Table 2. About 10.6 percent of all Wyoming's population hunt elk. Nearly 44 percent of all bulls and 43 percent of the total kill came from feedground herds. Hunters spent 31 percent of their time hunting in District I. Figures from Table 2 indicate that feedground elk provide much of the elk hunting recreation in Wyoming.

Table 2. Comparison of feedground elk with remainder of elk in Wyoming. Hunt information in 1979.

	Number Hunters	Bulls Killed	Total Harvest	Hunter Days
District I	29,713 (54%)	1,765 (44%)	5,809 (43%)	111,812 (31%)
State Total	55,027	4,005	13,507	358,685

As the previous paragraph indicates the importance of feedground elk to hunting in Wyoming, Table 3 illustrates the cost of feedground elk to the Game and Fish Department. Nearly 53% of all elk costs in the state went to feedground elk. During 1978-79 it cost about $22.85 per animal to manage non-feedground elk and $41.87 for feedground animals with the state average being $30.02. Although the Game and Fish Department is not in the business of selling meat, it is interesting to look at management costs per elk harvested. Cost per feedground elk harvested was $176.58 compared to $120.21 for non-feedground elk. The total cost of elk management in Wyoming for fiscal year 1979 was $1,951,104 while the sale of elk licenses generated about $1,700,000.

Table 3. Costs of elk management in Wyoming, Fiscal Year 1979.

	Total Cost	Cost Per Elk	Cost per Elk Harvested
District I	$1,025,747	$41.87	$176.58
Other	$ 925,357	$22.85	$120.21
State Total	$1,951,104	$30.02	$144.45

Table 4 shows the costs of managing feedground elk at the local level, i.e., District I feeding budget. About 10% of the total cost goes to employing elk feeders, 21% administrative (salaries, cost, etc., of permanent employees; supply items associated with the operation of the feedgrounds) and 69% is spent in the purchase and hauling of the hay. It cost an average of $48.50 in 1978-79 to feed an elk.

Table 4. Specific feedground cost information Fiscal Year 1979.

	Elk Feeders	Administrative	Hay	Cost/Elk/Fed
Total Cost	$57,179	$122,220	$415,541	$594,940
Percentage	10	21	69	-
Average	-	-	-	48.40
Range	-	-	-	34.26-81.00

The economic benefits of elk hunting in 1975 to the general economy of Wyoming is shown in Tables 5 and 6. At that time each resident hunter spent $147.03 and each non-resident hunter spent $693.13 to hunt elk in Wyoming. The total money generated to the economy of Wyoming was $10,466,465 in 1975. By 1979 this had increased to nearly $15,000,000.

Table 5 Economic Benefits of elk hunting to Wyoming, 1975.

		Resident	Non-Resident
TOTAL		$147.03	$693.13
	Meals(%)	7	6
	Guide (%)	2	45
	Fuel (%)	22	11
	Clothing (%)	8	2
	Guns, Ammo (%)	4	1
	License (%)	10	18
	Liquor-Groceries (%)	16	6

Table 6. Economic income to Wyoming from elk hunting, 1975.

Resident Elk	Non-Resident Elk	All Big Game
$6,415,197	$4,051,268	$38.3 Million

In summary, while it cost the Game and Fish Department $41.87 to manage each elk in District I, each elk generated about $244.90 to economy. This pertains only to

benefits from elk hunting. In addition to this, feedground elk attract thousands of people to the Jackson area each winter to observe and photograph them. For example, at least 17,000 people rode on the elk sled on the National Elk Refuge during fiscal year 1979. This is a small part of the number of people that actually come to the area to view feedground elk. The amount of revenue generated from this activity is large and has considerable effects on the local economy. Therefore the feedground elk of District I cost the Game and Fish Department more than non-feedground elk and at the same time are very important to the local economy in northwest Wyoming.

MANAGEMENT OF THE NATIONAL ELK REFUGE JACKSON, WYOMING

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ABSTRACT

The conversion of historic elk winter range to domestic livestock use in the late 1890's and early 1900's, coupled with the severe winter of 1909, brought the elk situation in Jackson Hole, Wyoming to national attention. Ranchers' hay supplies were threatened and residents of the valley appealed for help. The Wyoming legislature appropriated $5,000 to purchase feed. In 1911, the U.S. Congress appropriated $20,000 for the purchase of hay and directed that studies be conducted to determine what should be done to alleviate the situation. As a result of the investigations, Congress authorized the purchase of land for the production of feed for the elk. The present size of the Refuge (1980) is 24,000 acres.

In 1970, investigations of supplemental feed other than baled hay was begun. It was realized that the need for supplemental feeding would continue, but that baled hay could not be obtained from Grand Teton National Park after 1972. Other types of feed were investigated and pelletized alfalfa was chosen for further study. Field tests conducted from 1971 through 1975 indicated that alfalfa pellets were an acceptable feed for elk under conditions at the National Elk Refuge. Pellets were gradually "phased in" as the supplemental feed at the Refuge, and in 1975 all of the wintering elk were fed pellets for the first time.

HISTORY

The early history of the Jackson Hole country indicates that the valley was heavily trapped for beaver during the 1830's and then from 1840 until the 1870's there were only occasional visists to the valley by white man. In 1884, the first settlers arrived. By 1889, 65 people lived there. (Cole, 1969).

There has been considerable speculation about whether Jackson Hole was a historic wintering area for elk. Some investigators have indicated that historically the elk moved through Jackson Hole valley to winter range 50 miles to the southeast of Jackson in an area called the "Red Desert". Others disagree. Mr. A.P. Nelson, manager of the

National Elk Refuge from 1923 until 1956, interviewed Emil Wolfe in 1937. Mr. Wolfe had camped in Jackson Hole in the early 1870's. He found elk wintering in the valley, especially in the southern portion where the Refuge is now located. Mr. Wolfe's impression was that the winter distribution of the elk 1937 was much the same as he had observed in the early 1870's.

In 1890, Wyoming became a state and by 1909, ranchers and homesteaders had settled on most of the elk's historic winter range. This competitive use of historical winter range, coupled with severe winters, resulted in heavy losses of elk during the winters of 1890, 1891, 1897, 1909 and 1911. Although winter losses in these early years may have been exaggerated, they indicate that such losses occurred before man greatly altered the picture (Craighead, 1952).

The first suggestion for a permanent elk refuge in Jackson Hole was made about 1906 by D.C. Nowlin, the State Game Warden of Wyoming. The severe winters of 1909, 1910 and 1911 finally brought the situation to national attention. The early ranchers and settlers were upset with the losses of elk and hay, and with conflicts with their livestock operations. In the winter of 1910, they so aroused public sentiment in the State that the Wyoming Legislature appropriated $5,000 to purchase all available hay in the valley to feed the elk. Even with that appropriation, the supply of hay was inadequate and many hundreds of elk died that winter. The equally severe winter of 1911 caused losses conservatively estimated at 2,500 elk and included 75% of the calves.

Through the interest of the citizens of Jackson Hole, appeals for assitance were disseminated throughout the United States. In answer to these appeals, the Wyoming Legislature on February 17, 1911, passed a Memorial requesting the U.S. Congress to cooperate with the State by making an adequate appropriation for "feeding, protecting and otherwise preserving the big game which winters in great numbers within the confines of the State of Wyoming". Congress responded on March 4, 1911 by appropriating $20,000 "to be made available immediately for feeding and protecting the elk in Jackson Hole and vicinity, and for removing some of them to stock other localities."

An Act of Congress on August 10, 1912, which appropriated $45,000 for the purchase of lands and maintenance of a winter elk refuge, actually created the present National Elk Refuge. During the autumn of 1912, available locations for a refuge were examined and a site was selected a little north of the town of Jackson. On March 4, 1913, Congress appropriated an additional $5,000 for purchase of private lands and granted authority for inclusion in the Refuge of 1,000 acres of unoccupied public lands.

Negotiations began at once with private landowners. A series of Presidential Executive Orders in 1914-16 reserved 1,760 acres of purchased lands and 1,000 acres of Public Domain Lands for the Refuge, bringing the total to 2,760 acres. An Executive Order of December 22, 1921, signed by President Warren Harding designated "All lands that are now or may be hereafter included within the boundaries of the National Elk Refuge are hereby reserved and set apart as a refuge and breeding ground for birds." In about 1919, the U.S. Forest Service lands adjacent to the east side of the Refuge were excluded from grazing of dometic cattle and classified as big game winter range.

The Biological Survey and State personnel worked together to reduce depredations, shared in the work and expense of raising and feeding hay, and frequently pooled their limited funds to purchase the last remaining hay in the valley. Despite these efforts, heavy losses continued to occur. In 1917 about 2,500 elk died in the valley and again in 1922, 886 elk were lost on or near the Refuge.

It wasn't long before the situation regarding limitations on managing the elk herd was again brought to national attention. The Izaak Walton League of America launched a nationwide campaign for funds to be used to purchase needed lands for the Refuge. In 1925, they purchased 1,760 acres of private ranch land and in 1927 Congress accepted title to the Izaak Walton League addition. The Refuge was now expanded to 4,520 acres.

On June 15, 1935, the U.S. Congress passed an Act called the "Six Million Dollar Fund" which designated these monies to be used to purchase wildlife lands throughout the United States. As a result of considerable public support given to the expansion of the National Elk Refuge winter range, about 16,400 acres of private lands were acquired. Presidential Executive Orders in 1935 and 1936 added an additional 3,783 acres of Public Domain lands.

Today (1980), the Refuge totals 24,000 acres of land devoted to elk winter range.

SUPPLEMENTAL FEEDING

The practice during the early years of the Refuge of providing hay on Refuge lands to lure elk away from privately-owned hay stacks soon became routine. Continual harassment of the elk trying to feed at private stacks eventually concentrated most of the elk on the Refuge. Almer Nelson, manager of the Refuge from 1923 until 1956, and before that a game warden in the valley, related the following rather humorous incident that happened about 1920 (Nelson, Personal Communication, 1976).

> "I remember Bert Charter had a ranch over there in the Spring Gulch and he called me one night, I think I was a game warden then, and he said, I want you to gather up all the men you can get, be over here about daylight and get these 50 elk out of my haystacks.

"Well, I said, I will do the best I can.

"I got the game warden and some of the merchants with snowshoes. They were glad to go, I think there were eight of us and we went through that gap and dropped right down to his ranch over there, but, by the time we got there, the elk had gone back up on that other hill the other way.

"So Bert said, Hell, there's no use, you can't do anything now. You just as well come in the house. We went in there and visited with him until about noon and finally he felt sorry for us and he got up - his wife was gone - and he built a fire and made us a big dinner. We ate all his food, and so he finally decided he would go out and hitch up his team. Well, he says, I will hitch up the team and take you fellows back to town. I would rather keep those 50 elk all winter than feed you all day.

"So he did. When we got to town he drove up to the hitching rack in front of the old saloon and took us in and bought us a drink. And we never had another complaint from him. He just kept the elk all winter."

As is often true, a pattern once established is very difficult to alter or reverse. The Refuge was small and the wintering elk herd was large. The elk were fed to take pressure off the ranchers' hay supplies. At first the elk were fed loose hay from stacks right on the Refuge land where the hay had been harvested. Hay supplies were limited and were rationed out in an effort to make the hay last all winter. Refuge records indicate that at times the animals received as little as 3 pounds of hay per day. Some high losses of elk occurred. In 1917, 15 percent of the wintering herd of 6,000 elk died. In 1922, 21 percent of the wintering herd of 4,300 died. These heavy losses on the Refuge were probably caused by inadequate supplies of hay and very limited range. From 1922 through 1926 the average length of the supplemental feeding period was 76 days and ranged from 23 to 111 days. Starting in the mid-1920's, additional hay was purchased and hauled to the Refuge to more adequately provide for the animals. At this time in the history of the Refuge, it was logical to view the operation as a "feedground" for wintering elk. The Refuge continued increasing in size.

In 1938, the Refuge was fenced on the western and southern sides. The fence kept the elk off private land and, probably just as important, it permitted a later starting date for supplemental feeding. Before construction of the fence, supplemental feeding was started in the winter to hold elk on Refuge lands.

Also in 1938, a change was made from loose hay to baled hay. In his Annual Report, Refuge Manager Nelson stated:

"This was the first winter that the bulk of the hay fed the elk was from bales in the storage sheds and we found that much less work is required in feeding bales than in feeding loose hay from stacks in the fields. In feeding out the baled hay one man can take care of fully 1,500 elk, while in feeding loose hay from the stacks about the best one man could do was to provide feed for

> 1,000 elk. Therefore, in feeding baled hay there will be a saving of one-third in labor from the amount that we have paid out in past years when feeding the stacked hay from the fields."

From 1927 to 1945 the average elk mortality was 3.3 percent. The average length of the supplemental feeding period was 73 days and it ranged from 30 to 110 days.

In 1952, a 20-year agreement was established between the National Park Service and the U.S. Fish and Wildlife Service, whereby the Refuge was permitted to harvest hay from Grand Teton National Park lands. At the same time the U.S. Fish and Wildlife Service and the Wyoming Game and Fish Department signed an agreement whereby the Refuge would farm the park lands for hay and the Wyoming Game and Fish Department would pay for the harvest and hauling of the hay to storage areas on the Refuge. In 1958 the use of horses to pull the sleds was abandoned in favor of tractors. This permitted the feedgrounds to be located farther from the hay storage areas.

Since 1966, all forage produced on the Refuge has been left standing for elk to use on a free-ranging basis.

From 1946 to 1977, the average length of the supplemental feeding period was 71 days and mortality from all causes averaged 1.07 percent of the wintering herd. The longest feeding was 147 days and the shortest was 16 days.

In 1970, it was found that baled hay from Grand Teton National Park would not be available after 1972. The following questions were posed: Where will future supplies of supplemental feed come from? What improvements can be made in management programs to obtain better utilization of the natural habitat? Are there other forms or types of forage that are equal to or better than baled hay?

After investigating various types of feed, it was decided that pelletized feed, such as alfalfa pellets, held promise as a supplemental elk food. Pellets are basically the same feed as has been used on the Refuge for many years, only in a different form. Alfalfa pellets contain the leaves as well as the stems of the alfalfa plant. Baled hay, through handling many times, often loses a high percentage of the leaves. The elk can select choice hay and leave the least desirable portions in baled hay, but can not do this with pellets. Thus, use of pellets minimizes waste.

In the winter of 1970-71, it was decided to test the feasibility of using alfalfa pellets as a supplementary elk feed on the National Elk Refuge. The study was continued for 5 years through the winter of 1974-75. During the winters of 1970-71, 1971-72, and 1972-73, alfalfa pellets were tested on penned elk. In addition, from January 25 through March 11, 1972, alfalfa pellets were fed to a large group of elk (700 to 900 head) in an unconfined area. These studies indicated that alfalfa pellets are an acceptable supplemental feed for elk, and pellets were "phased" into the supplemental feeding program.

From February 5 through April 15, 1973, an unconfined herd of 2,200 elk (one-third of the elk on the Refuge) was fed 8 pounds of alfalfa pellets per elk per day. From February 8 through April 4, 1974, two-thirds of the elk on the Refuge received alfalfa pellets and from February 18 through April 20, 1975, all of the elk on the Refuge received alfalfa pellets. This represented the completion of the "phasing-in" of the use of alfalfa pellets in place of baled hay.

The results of the 5 years of study permit the following conclusions to be made about alfalfa pellets as supplemental elk feed: (1) Each year the penned elk on 8 lbs. of alfalfa pellets per day gained slightly more (body weight) than elk fed 10 lbs. of baled hay per elk per day, but not significantly so; (2) Elk readily accepted the alfalfa pellet form: (3) Calves in the penned elk studies gained more weight on pellets than the calves on baled hay; (4) A herd of 7,330 (all elk wintering on the Refuge) elk was quickly and easily fed pellets using a 20-ton capacity truck: (5) There was a 4 percent waste of alfalfa pellets (almost exclusively dust) and a 24 percent waste of baled hay: (6) In 1975, when for the first time all the wintering elk were fed alfalfa pellets, it cost $0.2412 per day per elk for the pellets, maintenance and operating cost of equipment, and labor. It was estimated that if baled hay had been used the total cost would have been $0.2734 per elk per day. Thus, the total savings from using alfalfa pellets rather than baled hay during the 62-day supplemental feeding period was an estimated $14,619.60. It is impossible to put a dollar value on the additional advantage permitted by the mechanized distribution of pellets, of moving the herd over a large area during the winter, keeping the animals on clean (and less disease-prone) feeding areas, and breaking the herd into several smaller groups.

POPULATIONS

In 1943, the Wyoming Game and Fish Department and the U.S. Fish and Wildlife Service entered into an agreement to hold the herd at a minimum of 5,000 and a maximum of 7,000 on the National Elk Refuge. In 1974, this agreement was modified to a maximum of 7,500. The Wyoming Game and Fish Department accepted the responsibility for keeping the herd to this number by hunting. Marking studies and census data have provided information on the origins of elk that winter on the Refuge. The best indications are that about 40% come from Yellowstone National Park, 35% from Grand Teton National Park, and about 24% from the Bridger-Teton National Forest; most of these are from the Teton Wilderness. The herd is presently managed to maintain a winter population on the Refuge and adjacent mountain slopes at a maximum of 7,500

animals. The highest Refuge population during any winter was 11,600 in 1956. The lowest number was 3,000 in 1919 and in 1931. The number of elk on the Refuge does not ncessarily reflect total wintering populations in the area. During severe winters most of the elk are forced down to the Refuge and adjacent lands, but during more mild, open winters, the population is more widely scattered.

About 60% of the estimated 16,000 elk in the herd in the winter of 1977-78 were on or immediately adjacent to the Refuge.

REFUGE OBJECTIVES

The Refuge is now managed as elk winter range with the objective of minimizing supplemental feeding and restricting feeding to periods when free-ranging by the elk is limited by weather and the forage availability. If all the lands now under Refuge administration (24,000 acres) plus the adjacent Forest Service lands, had been available in 1912, the program of winter feeding of elk might never have evolved. Now that these lands are available, it is feasible to manage the Refuge as winter range. There are management practices that can be and are being attempted to increase the carrying capacity of the Refuge. Increased emphasis has been placed on irrigation of grasslands and prescribed burning of extensive stands of sagebrush. In addition, salt blacks, water developments, and the placement of hay in selected areas are being used to adjust patterns of range use and achieve better distribution of the elk. Elk are now on the Refuge for about 6 months each year (November - May). They free-range for four of these months and use supplemental feed for about 2 months (mid-February - mid-April).

Providing of supplemental feed is not necessarily because of the lack of native forage. Range studies have indicated that on the southern one-half of the Refuge forage production exceeds 8,500 tons annually. This area is available to the elk during most winters. The northern portion of the Refuge is at a higher elevation where snow depths occasionally limit free-ranging by the elk. Forage production in this area is about 3,500 tons annually. Supplemental feeding results from excessive elk numbers, poor distribution of the elk, weather conditions limiting free-ranging, and political considerations. During the 67-year history of the Refuge (1912-79), the period of supplemental feeding has averaged 75 days and ranged from "no feeding" in 8 years (1915, 1926, 1931, 1934, 1940, 1944, 1948, and 1977) to a maximum of 147 days in 1962. Records indicate that the "no feeding" winters had very little snow. Thus, the elk could forage for feed off the Refuge, at least for a portion of the winter, and were not forced to concentrate in large herds. The Wyoming Game and Fish Department has shared the

cost for supplemental feeding on the Refuge since the early 1950's. From 1952 through 1974, hay was grown and harvested on land within Grand Teton National Park. The Fish and Wildlife Service cultivated and raised the hay, and under a separate agreement, the Wyoming Game and Fish Department contracted for the harvest of the hay and its placement in storage facilities on the Refuge.

HUNTING AND ANNUAL HARVESTS

Hunting of elk on the Refuge became necessary in 1943 because of an excessive Refuge summer population. The early migrating elk have a tendency to concentrate in the lower meadowlands which should be reserved for winter grazing. Eventually, hunting evolved as an annual event to keep a resident herd from building up and to disperse and obtain a harvest of early migrants to the Refuge. Hunting on the Refuge scatters these animals onto adjacent forest lands. Forage is still available at this time, both off the Refuge and in the more remote and higher reaches of the Refuge itself.

A quality hunt has been designated and conducted on the Refuge. About 16,000 acres are open for approximately 5 weeks. A public drawing is held weekly to select 40 hunters for each of 3 hunt periods. Hunting has been restricted to "on foot" or "on horseback" and all hunters are required to have a current hunter safety certificate.

During the 37-year period that hunting has been authorized, hunts have been held in 22 years and 3,398 elk have been harvested. The average harvest has been 155, ranging from 435 in 1946 to zero in 1976. The kill includes hunter take, crippling, and illegals. Hunter interest has varied, but it reached a high in 1974 when 1,655 hunters applied for 162 permits.

With the exception of the very limited number of elk actually killed on the Refuge, the harvest from the Jackson Hole elk herd occurs on U.S. Forest Service lands and in Grand Teton National Park. The migration route of most elk passes through Grand Teton National Park. The Park hunt is necessary to help keep the herd in balance, and is, in reality, a reduction program. At times it has been difficult to obtain the desired harvest of this herd. The seasons are long; most of the hunting areas open on September 10 and remain open until the end of November. Elk do not start migrating south from Yellowstone and the Teton Wilderness until snow depths force them to lower elevations, often not until late November or even well into December. The snow depth that triggers the elk migration can also limit hunter access. A major snowstorm may move the elk from areas open to hunting to the Refuge in a matter of a few days. When these conditions prevail, a light harvest results.

OTHER REFUGE PROGRAMS

Although the primary objective of the National Elk Refuge is to preserve and manage the area for elk winter range, there are other wildlife considerations which make the area attractive and important. In 1938, several pair of endangered Trumpeter Swans from the Red Rock Lakes National Wildife Refuge in Montana were introduced, and have successfully established a small population. In addition, the Great Basin Canada Goose along with numerous other waterfowl are nesters and year-round residents. The Greater Sandhill Crane nests on refuge marshes and a small population gathers each fall before migration. Wildlife viewing from the adjacent highway, which annually carries over 3 million people into the nearby national parks, is a popular pastime. As with all areas of Jackson Hole, the Refuge attracts artists that capture the beauty of landscapes or wildlife on film or canvas. By far the most popular attraction is the viewing of the elk. Elk watching began when people were allowed to ride along on the sleds which carried hay to the herd. It soon became so popular that the Refuge had to put on extra sleighs and drivers just to handle the hordes of visitors. During recent times the Refuge has had a contract with the local Jaycees to provide this service to the public. In 1977-78 about 21,000 visitors took advantage of this opportunity.

For the last decade the Refuge has allowed the Boy Scouts, under a Special Use Permit, to remove antlers from the Refuge. The antlers are bundled and sold at auction in Jackson's town square. This annual event attracts hundreds of people from all over the world and bidding is lively as they purchase antlers for belt buckles, bolos, buttons, and aphrodisiacs. Prices range from about $3 to over $12 per pound and the local Scout Troop grosses anywhere from $3,000 to $51,000 from the sale. Besides supporting their own activities, they spend a considerable amount of the money supporting community service projects locally.

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WHY DO WE WANT ELK, ANYWAY?

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In Montana we are trying to use timber, livestock grazing, minerals, fossil fuels, and space in such a way that elk and their use by humans are kept within traditional desires of the people. (This statement could also apply to the wildlife resource in general). Such desires include maintenance of large free roaming wild elk herds for hunting and viewing in wild natural settings. Maintenance of a relatively long hunting season with as few restrictions and regulations as possible is also being attempted. Of course, these desires are concurrent with other societal desires to maintain economic growth. This means better transportation systems, more efficient agricultural production, fossil fuel exploration and extraction, and generally intensifying the use of the land.

How much is the elk resource worth to the people of Montana? Or, how much are Montanans and even the people of the Nation, now and in the near future, willing to pay, so that large free roaming elk populations will remain a part of the environment? We know, by license revenues and costs incurred while pursuing elk, that people are willing to spend a large amount of money. During the hunting season in 1978, 99,714 people bought an elk license which totaled to a little under $4.4 million. Non-resident hunters contributed about 80% of that license revenue. Elk license sales contributed about 60% of the license fee revenue generated by all hunting during that year. In 1978, 643,604 hunter days were spent on elk hunting and this number multiplied by a recent estimate of $45/elk hunter day from the State of Washington (13), equals almost $29 million. Since about 12,000 elk were taken that same year, does this mean that each elk bagged was worth approximately $2,400? If each elk bagged was worth $2,400, could we then say that each live elk in Montana has a potential worth of $2,400? If that estiamte is valid, the elk resource in Montana may be worth nearly $200 million if sold outright! It is interesting to note that the 643,604 elk hunter days spent in 1978 compares closely to the 704,500 skier visits that were made during the 1978-79 winter on all the major ski slopes in Montana (3). I could go on trying to assess the economic worth of elk, but it would all boil down to the fact that the importance of elk and elk hunting is expressed well through our economic values, but not through our economic system. Trying to cost out elk and elk hunting is like trying to cost our motherhood.

Numbers in parentheses are keyed to References Cited

Are elk important in other ways? What about the ecological importance of elk in Montana or for that matter in all of the Canadian provinces and western states where elk occur?

At one time our North American ancestors were vitally tied to the large wild mammals of the continent for food, clothing, and tools. In fact, this is probably where most of our desire to maintain and use such animals stems from. Professor Paul Martin of the University of Arizona speculates that our North American ancestors of several thousand years ago left an unmistakable record of overkill and extermination of the many large mammals that once roamed this land (4). There are even a few people alive today that witnessed the large scale near-extermination of the American buffalo, and at one time the elk were the most widely distributed deer in North America (7).

What was the ecological significance of these large scale removals by man? From all appearances it did not significantly impact man's survival in North America, mostly because domestication of livestock and farming provided the bulk of the population with plenty of food. It is interesting to note that some historians believe the first and most important conservation effort began about 10,000 years ago with the domestication of animals.

If we change this last question to the present tense and direct it toward elk, i.e. what is the ecological significance of our remaining large wild elk populations?, can we justify their existence be maintained to keep our environment from being severely upset? Are they an important component in maintaining the so-called "balance of nature" or, since they occupy an upper trophic level, are they ecologically expendable? If we assume their removal from the environment of North America would have mild ecological consequences at worst, why spend so much money and effort in the maintenance and management of several hundred thousand elk? These and similar questions find me groping for answers, especially when arguments lead to other possibilities of using the land in maybe a more productive and efficient way for the good of mankind. This point has an even sharper and different ring to it when the anti-hunting movement is considered, since this movement renounces sport hunting and is going so far as to call it "an immoral human activity that should be made illegal". I believe the answers to these and similar questions are deeply embedded in the following quotations.

In his book, The Cosmic Connection, Carl Sagan (12) states, "The Earth is overcrowded. Not yet in a literal sense. Our technology is adequate (or has the potential) to maintain comfortably a population significantly larger than our present 3.6 billion. The earth is overcrowded in a psychological sense. For the restless and ambition-driven fraction of mankind that has layed new paths for our species, there are

no new places to go. There are places inside of ourselves, but this is not the forte of such individuals. There are the ocean basins, but we are not yet committed to exploring them seriously (and on a large scale basis)... At just this time in our history comes the possibility of exploring and colonizing our neighboring worlds in space." But this is fantasy to the average citizen, so a more practical and realistic point of view must prevail. As Jose Ortega Y Gasset (10) said in Meditations on Hunting, "When you are fed up with the troublesome present, with being 'very twentieth century' you take your gun, whistle for your dog, go out to the mountain, and, without further ado, give yourself the pleasure during a few hours or a few days of being 'Paleolithic.' And men of all eras have been able to do the same, without any difference except in the weapon employed. It has always been at man's disposal to escape from the present to that pristine form of being a man, which, because it is the first form, has no historical suppositions. History begins with that form. Before it, there is only that which never changes: that which is permanent, Nature. 'Natural' man is always there, under the changeable historical man. We call him and he comes--a little sleepy, benumbed, without his lost form of instinctive hunter, but, after all, still alive. 'Natural' man is first 'prehistoric' man---the hunter." So in these quoted words, may be a key to help justify the maintenance of our large elk populations. Not because of their pure economic worth or ecological importance, but because individuals in society (not society as an entity in itself) believe the maintenance of this resource very necessary to help provide them with a needed psychological release.

I find myself, with many other natural resource specialists, getting too wrapped up in my work of being so professional in my thought processes that I seldom give much thought to my fellow man who casts the vote on whether or not I should have a job as natural resource specialist. This reminds me of the Greek fable about the philosopher who fell into a hole because he was too busy looking at the stars, but in reverse--the fable of modern resource specialists who do not see the stars of human aspirations because they keep their eyes too firmly fixed on their feet or their data collection or revenues gained. This parochial approach is broadening primarily through planning efforts, with which most of you are familiar in your own states or provinces. This planning effort, by announcing present and future goals and objectives, is a major step in attempting to integrate elk and wildlife management with other resource management endeavors. The team effort must prevail but the team must also know the direction and the distance to the goal line.

A state survey in 1977 showed that over 55% of the men and 20% of the women in Montana claim to be hunters. Whether they hunt or not, about 70% of Montana's residents made special efforts to observe wildlife in its natural setting (6). Hunting and

fishing is still the foundation the Montana Department of Fish, Wildlife and Parks is built upon, and I believe hunting to be more of an objective than a tool in maintaining a maximum sustained number of elk.

Graeme Caughley (1), in a thought stimulating paper he gave at a symposium on elk ecology and management held in Laramie at the University of Wyoming in April, 1978 said, "...very often cause and effect get mixed up so that hunting is presented simply as the means of ensuring that the animals are large and fecund. Hunting is then seen as a noble ecological duty applied with sorrow and reluctance for the greater good of the animal population and its habitat. That is one message that comes through clearly in William Dasmann's (1971) book 'If Deer Are to Survive.' The sentiment is admirable but the logic is suspect. As I see it, the function of hunting is hunting. People hunt for reasons no worse nor better than they enjoy hunting."

The point Caughley makes about hunting as a primary reason for the maitenance of large wild ungulate herds is critically important whenever we discuss and plan integration of elk management with other land uses.

For the past ten years in Montana we have placed much emphasis on elk-logging relationships in the form of a cooperative elk-logging study. To date this research effort has developed seven recommendations for consideration by land managers (2). In conjunction with this study, the Northern Region of the U.S.F.S. in cooperation with the Montana Department of Fish, Wildlife and Parks have developed two documents to further assist land and game managers with understanding elk habitat/timber management relationships. One of these documents is for those Montana forests west of the Continental Divide (8) and the other for forests to the east (9).

The results of these efforts have generally been accepted and fairly successful in application, but has this success been due to a positive biological response of the elk (i.e., better reproductive rates, better physical condition, and better survival rates) or due to a positive response of the hunters to maintain their traditional way of hunting these animals? For the time being, this success seems to be attributable mostly to the positive response of the hunters. In fact, much of this overall effort has resulted in recommendations of guidelines addressing hunting tactics (road and/or area closure -- cover relationships), while the primary concern was for the biology and welfare of the elk.

Logging and roading have been going on for many years in Montana and elk herds have not only remained healthy and reproductive, but populations have increased in numbers in spite of this habitat alteration. Although we have 16 deeded or leased pieces of real estate to serve almost exclusively as elk winter range, about 90% of our elk winter elsewhere, either on private or other public lands.

Could it be that the biological and ecological tolerances of the elk are broader than society's tolerances and traditional ways of how, when, and where hunters should hunt them? If this is so, more emphasis and consideration should be given to the impacts of roads and timber removal on hunting strategies and traditions!

Montana is generally a rural state with a human population density of 5 people per square mile. Most all of the elk live in the western half of the state where most all of the National Forest land also occurs. In this part of the state most of the human population lives in cities or towns, so the elk and other wildlife are essentially the only permanent residents that live on our National Forests and bordering lands. Picton, in a study of biogeographics, determined that the presence of 10 species of large mammals in 24 mountain ranges of central Montana has been largely due to the insulation of the larger mountainous areas that protected them from human impact extinction. He found that the historical tide of human impact more or less overwhelmed the smaller mountainous areas, but the larger areas (at least 710 km^2 in size) had an insular effect, providing more protection to larger mammal species from increased agriculture, construction of transportation systems, and subsistence hunting (11).

The replacement of subsistence hunting by controlled sport hunting was another key to the survival and perpetuation of our large elk herds. This is currently being done by using a quota on the cow/calf harvest with any antlered elk legal to shoot throughout a 36 day general rifle season in October and November (the season length varies slightly year to year). Although we have archery hunting in September and early October and a few late hunts in the winter months, over 90% of the elk harvest is during this general rifle season.

It seems then, that as long as hunting is controlled and elk have large areas of undeveloped forest land to use, they can apparently tolerate and live with a fair amount of roading and logging. But how much more roading and logging can occur before an undesirable impact starts to take place on how the people of the state want to use the elk resource? Our statewide objective is to provide 700,000 days of elk hunting annually at a hunting success rate of 16% and average effort of 48 hunter days per elk harvested by the early 1980's (5). (We are presently not far from this objective). I believe the 700,000 days of elk hunting is the essence of this objective. This means providing the elk hunter with as much and even more hunting opportunity as we have traditionally had in the past. Our National Forests and adjacent lands in Montana presently provide the elk and elk hunter with enough security (timber, topography, low road densities, and lack of development) to allow a 30-40 day general rifle season. There is generally a good opportunity to kill an antlered bull throughout this season. These characteristics of elk

hunting seem to be what the people want and expect and may be the reason why hunting today is highly regarded as a sport.

Again, I must quote Ortega Y Gasset, "...hardly had the weapon been perfected when all urgency for putting an end to the animal, by whatever means, disappeared--that is to say, hunting became a sport. And since then, *as the weapon became more and more effective, man imposed more and more limitations on himself as the animal's rival in order to leave it free to practice its wily defenses, in order to avoid making the prey and the hunter excessively unequal*...transforming it into pure killing and destruction." As Ortega Y Gasset points out, man tends to impose more and more limitations on himself in order to maintain sport hunting.

Limitations on hunting can be either self imposed or by the government. Governmental limitations such as more hunting regulations and restrictions (i.e., short seasons, permit only hunting, road and area closures, and vehicle restrictions) are what the average Montana hunter complains about most. Granted, many of these are needed to compensate for the increasing number of elk hunters, but many are also needed to compensate for results of other land use practices, such as logging, that remove cover and increase road densities. Intensifying land use practices on our public lands is going to cost the hunter and the general public something. <u>If</u> this cost means more regulations and restrictions to keep hunting a sport and not an activity "of pure killing and destruction" and these costs are accepted by the people through public hearings and legislative action, then so be it. However, I believe these costs should be spelled out to the citizens in very specific and detailed terms, including loss of traditions, not in broad categorical phrases.

I recently read a statement made by a government official in the natural resource management business. He said "there are no rewards or punishments, only consequences". I find this attitude both unacceptable and irresponsible. Our system is primarily framed by cost/benefit and supply/demand ratios, but human ideals and aspirations are still its foundation. These ideals and aspirations, therefore, must be given the primary consideration in the decision making processes of resource management agencies.

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Survey of Agency Policies on Big Game/Agriculture Conflicts

Wildlife Agency	Provide Monetary Compensation For Big Game Damage (Legally Responsible)	Provide Materials And/Or Devices to Minimize Damage	Provide Extension Services	Damage Control Hunts	Land Aquisition Program
Alberta	No	Yes	Yes	Yes	Yes (Minor)
Arizona	No	Yes	Yes	Yes	No
British Columbia	No	No	Yes	Yes	Yes (Increase)
Colorado	Yes (No Limit)	Yes	Yes	Yes	Yes
Idaho	No	Yes	No	Yes	Yes
Montana	No	Yes	No	Yes	Yes
New Mexico	No	Yes	No	Yes	Yes
Oregon	No	Yes	Yes	Yes	Yes
Utah	Yes (Max. $2000.)	Yes	Yes	Yes	Yes
Washington	Yes (Max. $1000.)	Yes	Yes	Yes	Yes (Declining)
Wyoming	Yes (No Limit)	Yes	Yes	Yes	Yes (Declining)