Management Plan for Bighorn Sheep in Alberta

Wildlife Management Planning Series Number 6

Alberta
FORESTRY, LANDS AND WILDLIFE
Fish and Wildlife

MANAGEMENT PLAN FOR BIGHORN SHEEP IN ALBERTA

Wildlife Management Planning Series
Number 6

July 1993
Edmonton, Alberta

Environmental Protection
Fish and Wildlife Services

Pub. No. T/248
ISBN: 0-86499-846-5

Copies of this report are available from:

Alberta Environmental Protection
Fish and Wildlife Services
4th Floor, Bramalea Building
9920 - 108 Street
Edmonton, Alberta
T5K 2G6
(403) 427-6750

OR

Information Centre
Alberta Energy/Environmental Protection
Main Floor, Bramalea Building
9920 - 108 Street
Edmonton, Alberta
T5K 2M4
(403) 427-3590

OR

Information Centre
Alberta Energy/Environmental Protection
Main Floor, Bantrel Building
703 - 6th Avenue S.W.
Calgary, Alberta
T2P 0T9
(403) 297-6324

PREFACE

This plan presents Fish and Wildlife Services' goals, objectives, and management strategies for the management of bighorn sheep in Alberta; it will be periodically reviewed and updated, as necessary. Implementation will be subject to the Services' priorities established during the budgeting process.

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	BACKGROUND TO THE PLAN	3
	2.1 Population Status and Management in North America	4
	2.1.1 Evolution of Population Management in North America	6
	2.1.2 Habitat Management	8
	2.2 Evolution of Bighorn Management in Alberta	9
	2.2.1 Hunting Seasons, 1877-1906	10
	2.2.2 Hunting Seasons, 1907-1949	12
	2.2.3 Hunting Pressure and Numbers of Sheep Harvested, 1909-1949	12
	2.2.4 Population Status, 1909-1949	15
	2.2.5 Licensing and Licence Fees, 1909-1949	17
	2.2.6 Hunting Seasons, 1950-1989	18
	2.2.7 Hunting Pressure, 1950-1989	22
	2.3 Biology	26
	2.3.1 Habitat Requirements	26
	2.3.2 Parasites and Diseases	26
	2.3.3 Population Characteristics	28
	2.3.4 Census	34
	2.4 Current Status	35
	2.4.1 Supply	35
	2.4.2 Use	38
	2.5 Summary and Mangagement Issues	43
3.0	MANAGEMENT PLAN	47
	3.1 Policy Framework	47
	3.1.1 Resource Protection	47
	3.1.2 Resource Allocation	47
	3.1.3 Recreational Use	48
	3.1.4 Commercial Use	48
	3.2 Management Goals and Objectives	49
	3.2.1 Resource Protection	49
	3.2.2 Resource Allocation	49
	3.2.3 Recreational Use	50
	3.2.4 Commercial Use	51
	3.2.5 Populations and Habitat	52

Table of Contents (cont'd)

Page

3.3 Management Strategies 52
3.3.1 Population Allocation 52
3.3.2 Population Management 54
3.3.3 Population Inventory 55
3.3.4 Hunter Harvest and Effort 56
3.3.5 Hunting Seasons 56
3.3.6 Licensing 59
3.3.7 Control of Unlicensed Harvest 61
3.3.8 Habitat Management 62
3.3.9 Extension 63
3.3.10 Research 63
3.3.11 Population Monitoring 64

4.0 MANAGEMENT PLAN APPLICATION 65
4.1 Provincial Summary 65
4.2 Regional Perspective 67
4.2.1 Eastern Slopes 67
4.2.2 Southern Region 71

5.0 LITERATURE CITED 72

APPENDIX I. Hunting seasons and licence fees for trophy bighorn sheep in Alberta during 1964-1989..... 75

APPENDIX II. Major wintering areas for bighorns in the regions of Edson, Rocky Mountain House, Calgary and Lethbridge.... 83

LIST OF FIGURES

Figure		Page
1.	Historical (before 1800) and recent (1970s) distribution of bighorn sheep.....	5
2.	Summary of annual harvests of trophy rams in Alberta during 1961-1989.....	24
3.	Sheep Management Areas for Alberta.....	39

LIST OF TABLES

Table		Page
1.	Estimated populations of bighorn sheep in North America.	7
2.	Bighorn hunting seasons for Alberta during 1887-1906....	11
3.	The bighorn sheep kill recorded for Alberta during 1909-1924	14
4.	Estimated bighorn sheep populations in Alberta in 1915..	16
5.	Annual licence sales and estimated kills of trophy bighorn sheep in Alberta by recreational hunters during 1950-1989.....	21
6.	Annual licence sales and recorded non-trophy sheep kills in Alberta during 1966-1989.....	25
7.	Maximum counts of bighorn sheep on winter ranges in Alberta (excluding national parks) during 1968-1990.....	37
8.	Sheep Management Areas, winter ranges and estimated preseason populations of bighorn sheep in Alberta, 1989.....	40
9.	Success of hunters who applied for non-trophy sheep licences at being drawn in 1988, according to zone or Wildlife Management Unit.....	42
10.	Current (1989) and future (year 2000) population and harvest objectives for trophy and non-trophy bighorn sheep in Alberta.....	53
11.	Timing of survey occurrence for provincial winter ranges of bighorn sheep in Alberta.....	57

ACKNOWLEDGMENTS

Efforts by J. T. Jorgenson, A. W. Todd, W. D. Wishart and M. Watson have culminated in the production of this plan. This plan was prepared for Fish and Wildlife Services (R. R. Andrews, Director of Wildlife and B. J. Markham, Head of Planning and Game Management). G. Lynch and S. Schurman provided technical assistance. Comments on earlier drafts were provided by R. Bjorge, E. Bruns, D. Culbert, D. Empson, G. Erickson, B. Markham, T. Nette, B. Rippin, L. Russell and K. Smith. L. DeBlois, S. Trott, A. Turlione and Y. Pearson did the word processing. B. Becker and D. Norton prepared the figures. D. Ealey provided editorial assistance.

MANAGEMENT PLAN FOR BIGHORN SHEEP IN ALBERTA

EXECUTIVE SUMMARY

Historical Populations and Management

Bighorn sheep were widely distributed in most mountain ranges and badlands of western North America before continental exploration and settlement by Europeans. During the latter half of the nineteenth century, the number of bighorns declined drastically, which was attributed primarily to competition from domestic livestock and mortality caused by diseases of livestock origin. Persistent, unregulated hunting contributed to further declines around the turn of the century. Bighorn management programs commenced with controls on hunting (bag limits, male-only seasons and size restrictions), and then extended to establishment of sanctuaries, and control of predators. In Alberta, bighorns declined from an estimated 10 000 (including national parks) during 1800-1860, to about 2000-3000 in 1915. Bighorn sheep responded to management programs and increased in numbers, reaching about 4000 in Alberta (national parks excluded) by 1936. However, in the 1940s many populations at high levels declined, which was attributed to die-offs precipitated by a lungworm-pneumonia complex, aggravated by poor nutrition on ranges that had been overgrazed by both wild and domestic ungulates; about 1500 bighorns existed on provincial lands in 1950.

Trophy seasons for rams were introduced in Alberta during the recovery from the 1940s die-offs (3/4-curl restriction in 1956, 4/5-curl

restriction since 1968). For non-trophy sheep (ewes, and lambs of either sex less than 1 year old), regulated hunting was introduced to Alberta in 1966. Since then, non-trophy harvests have been used in an attempt to stabilize bighorn numbers and prevent further die-offs.

In recent years, the emphasis in bighorn sheep management has shifted to habitat management. Bighorns are highly reliant on grassy winter ranges that are largely or completely free of snow during winter. The carrying capacity of a bighorn range can be reduced through overgrazing by bighorns, other wild ungulates, and/or domestic livestock. In addition, intensive forest fire control has resulted in forest encroachment on bighorn ranges that were formerly maintained by fire. Finally, recreational, industrial and urban developments have resulted in habitat loss and/or disuse of existing habitats because of disturbance.

Current Status

About 5215 bighorns existed in mountainous regions of Alberta (excluding national parks) before the 1989-90 hunting season. It appears that a number of populations are currently below the carrying capacity of their ranges. Major wintering areas for bighorns are known to include 89 ranges, and all are regarded to be critically important to local herds. In 1989, about 2500 hunters were licenced to hunt trophy rams, and harvested about 230 rams. In addition, 291 residents held non-trophy sheep licences and harvested about 90 sheep. About 21 000 recreation-days were enjoyed by bighorn hunters in Alberta that year. Bighorn hunting contributed about $160 000 to licence sales and about $700 000

to the outfitting and guiding industry. Subsistence hunting is unmeasured but is believed to be unimportant provincially. Nonconsumptive use is also unmeasured, although many persons enjoy seeing this member of the fauna in mountainous environs. A viewing and interpretative site is maintained at the Sheep River Wildlife Sanctuary; it attracts large numbers of people from Calgary and surrounding area to view and photograph bighorns.

The current demand for bighorn sheep by recreational hunters exceeds the supply. The recent and current success for hunters of trophy rams is about 7 percent. The demand for non-trophy sheep also exceeds supply; only 19 percent of 1542 applicants for non-trophy sheep licences were successful at being drawn in 1989.

Disturbance and habitat loss remain as central issues in the management of Alberta's bighorn sheep. In addition, contact with domestic livestock (particularly sheep) has been increasingly implicated in the introduction of diseases into bighorn populations, with the result that recent, major die-offs of local bighorn herds have occurred.

Management Policies, Goals, Objectives and Strategies

1. Area-specific population goals to the year 2000 are established for bighorn sheep. The provincial bighorn population in summer will be managed so that it increases from 5215 to 6900.
2. Bighorn sheep habitat will be more precisely identified and protected. Emphasis will be placed on winter ranges (89 major wintering areas are known), although habitats used in other seasons

(lambing areas, rutting ranges, mineral licks, etc.) will also require protection, and reclamation in some cases. Measures to mitigate recreational or industrial developments will be considered and comprehensively implemented.

3. A comprehensive examination of winter ranges will be carried out, culminating in plans to ensure viability of all ranges, through habitat improvement or stabilization. Plans will include upgrading ranges by prescribed burning, slashing, and fertilizing/reseeding. Multispecies grazing will be considered, and grazing by domestic livestock on and near bighorn ranges will be addressed.
4. Trophy rams will be managed on a maximum, sustained yield basis, providing about 289 trophy rams annually by the year 2000 (248 to residents, 41 to non-residents). Non-resident hunting of trophy rams will be directed to more remote, northerly bighorn ranges.
5. Non-trophy sheep will be harvested, where appropriate, to maintain healthy, productive herds; nearly 500 animals will be harvested by residents annually by the year 2000, provided population goals are met (1989 harvest was about 90 non-trophy sheep).
6. Subsistence and nonconsumptive uses, and scientific and educational activities will continue.

1.0 INTRODUCTION

The bighorn is probably the most highly esteemed big game animal in North America. Most people are impressed by the sight of a large ram with his massive horns. Certainly this awe is evident in the writings of Pedro de Castadena, a soldier in Coronado's army who, in 1540 when he sighted bighorns at the confluence of the Gila and San Francisco rivers in Arizona, described them as "Sheep as big as a Horse, with very large horns and little tails. I have seen some of their horns, the size of which was something to marvel at" (Seton 1929:532). The bighorn constitutes a symbol of wilderness and, as such, is seen on the logos of wildlife conservation and sportsmen's groups alike. It has been officially designated Alberta's provincial mammal.

The historical pattern of highs and lows in bighorn numbers in Alberta points to a definite need for strong policy and management guidelines, as current industrial and recreational developments have the potential to impact bighorns like never before. A primary objective of the Fish and Wildlife Policy For Alberta is "to ensure that fish and wildlife populations are protected from severe decline and that viable populations are maintained." Protection from the increasing number of consumptive users also is a reality that requires sound management strategies if opportunities are to endure for all user groups. Underlying such management practices is the need for a sound understanding of the ecology, population dynamics and seasonal distribution of bighorns throughout the province, as well as the effects that various user groups have on bighorns and their habitat.

It is the objective of this document to provide a historical

perspective on bighorn management in Alberta and to describe the current supply and demand for bighorns. A plan is then presented for the management of this species to the year 2000.

2.0 BACKGROUND TO THE PLAN

Asia is generally accepted as the ancestral home of North American sheep, since their characteristics seem to reflect a close relationship to the more primitive Ovis nivicola of northeastern Asia (Cowan 1940; Geist 1971). It is probable that sheep reached North America by way of the Bering Strait land bridge during the Pleistocene. Successive ice ages have since resulted in division of the population into two groups that have evolved into the thin-horned species of the north (Ovis dalli) and the bighorn to the south (Ovis canadensis).

The first detailed description of bighorns (including their excellent eating qualities) was written by Franciscan missionaries on the California peninsula in 1702 (Seton 1929:524). However, it was not until 1804 that the species was described and named Ovis canadensis by Dr. George Shaw of the Royal Society of London. Shaw's description was based on a preserved specimen that had been collected by Duncan McGillivray near Exshaw, Alberta in 1800 (Seton 1929:524). An account from the diary of David Thompson, the Canadian explorer and map maker (November 29, 1800 entry), included the following perceptive description of the collection (Hopwood 1971:224):

> "Our road lay along the Bow River, which to the very mountains has beautiful meadows along its banks. Mr. McGillivray, [and] a man, and the Indian set off ahead to hunt the mountain goat [sheep]. Several herds of them were feeding a little distance before us in our road, and three of them were killed by the Indian and a large old buck by Mr. McGillivray, which

> we skinned round. We found their meat to be exceedingly sweet and tender and moderately fat. The she-goats might weigh from about 120 to 140 pounds [54 - 64 kg] alive. The buck that was killed might weigh about 190 or 200 pounds [86 or 91 kg], thirty of which may be the weight of his enormous horns, which measured along the curve were 3 1/2 feet [1.07 m] long and 15 inches [38.1 cm] in circumference"

The subspecies that constitute the bighorn sheep complex include the following: the "type" species Ovis canadensis canadensis Shaw (Rocky Mtn. bighorn); the California bighorn O. c. californiana Douglas; and the desert bighorns O. c. nelsoni Merriam, O. c. mexicana Merriam, O. c. cremnobates Elliot and O. c. weemsi Goldman (Cowan 1940). Bighorns were widely distributed in most mountain ranges and badlands of western North America before exploration and settlement by Europeans (Figure 1).

2.1 Population Status and Management in North America

Estimates of bighorn numbers from before European settlement are a matter for debate. However, numbers since then have probably never approached the 1-1.5 million estimate of Seton (1929). Bighorns declined drastically during the latter half of the nineteenth century (Buechner 1960). Competition from livestock, and introduction of parasites and diseases to bighorns from livestock (particularly scabies) have been implicated as the principal causes of bighorn declines during early settlement. Estimated bighorn sheep numbers in 1974 were 36 725 - 41 570. Intensive sheep relocation programs and more effective

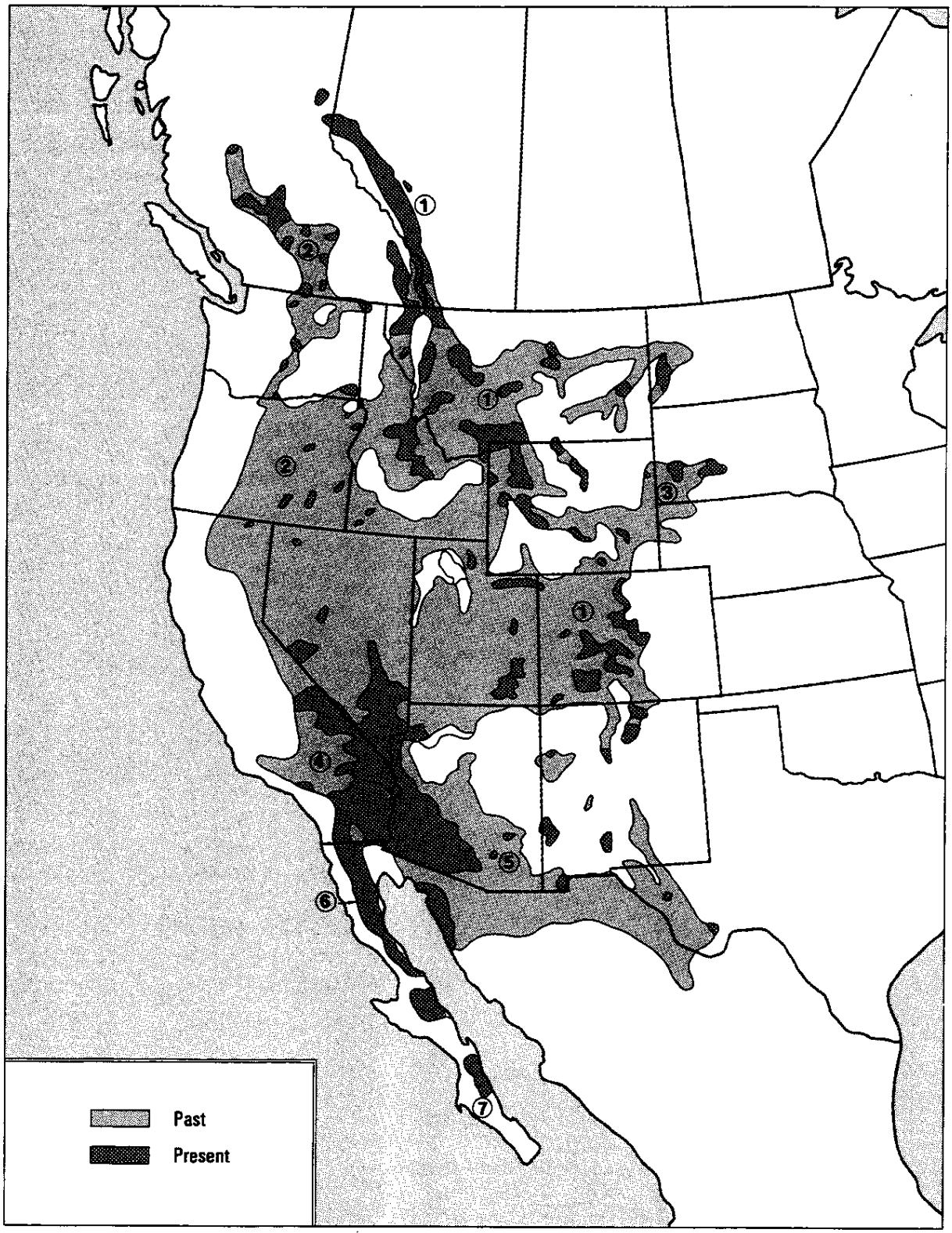


Figure 1. Historical (before 1800) and recent (1970s) distribution of bighorn sheep. 1. *Ovis canadensis canadensis*; 2. *O.c. californiana*; 3. *O.c. auduboni* (extinct); 4. *O.c. nelsoni*; 5. *O.c. mexicana*; 6. *O.c. cremnobates*; 7. *O.c. weemsi.* (Copied from Figure 35, page 168, Schmidt and Gilbert, 1978 with the permission of the Wildlife Management Institute).

management had increased estimated numbers to about 59 000 animals by 1985 (Table 1).

2.1.1 Evolution of Population Management in North America

Disease outbreaks and persistent, unregulated hunting contributed to further bighorn declines. The Badlands bighorn (O. c. auduboni) had become extinct by 1916 (Buechner 1960:2). Bighorn management programs started during the late 1800s and early 1900s in the United States with widespread hunting closures. Some states and provinces introduced game ordinances during the same period; however, the bag limits were generous (up to six sheep in Alberta) and the animals that could be taken were unspecified as to sex or age. The establishment of sanctuaries, refuges and parks, as well as intensive predator control, also began during the turn of the century. These efforts were intended to help stem the decline of bighorns and other game species. During the 1920s, bighorn trapping and transplant programs were initiated to move bighorns from overstocked refuges. Since that time, large numbers of bighorns have been successfully reintroduced from Canada to former ranges in the United States, as well as between ranges within both countries (Trefethen 1975).

Outside the refuges, hunting laws gradually changed to male-only seasons. As bighorn inventories improved, many areas formerly closed to hunting reopened during the 1950s. Hunting permits were restricted in number and were issued in conjunction with regulations on the permitted horn curl size that varied from one-half curl to full curl, depending on the state or province. In desert bighorn management, the horn curl system for regulating the size of the rams harvested has evolved to the point where legal rams are those rams that attain a horn size of not less

Table 1. Estimated populations of bighorn sheep in North America.[a]

Jurisdiction	Rocky Mountain Bighorn	California Bighorn	Desert Bighorn
Alberta	10 000		
Arizona	small pop. unknown size		4 000
Baja California			4 500-7 800
British Columbia	1 520-1 710	2 480-2 790	
California		300	4 000
Colorado	4 030		60
Idaho	2 805	530	
Montana	4 600		
Nevada	70	121-141	5 200
New Mexico	500		100
North Dakota		200-250	
Oregon	250	1 007	
Sonora			1 000
South Dakota	165		
Texas			120
Utah	200		2 500
Washington	101	550	
Wyoming	6 305		
Total	30 546-30 736	5 188-5 568	21 480-24 780
Grand Total	57 214-61 084		

[a]Estimates from Hoefs (1985).

than a specified Boone and Crockett score, e.g., 144 points in Nevada and New Mexico (Trefethen 1975). An integral part of the trophy desert ram regulation requires that all tag holders attend, before the hunt, an introductory session on aging and scoring techniques. In conjunction with trophy seasons, the jurisdictions of Alberta, British Columbia, Montana and Colorado are managing bighorn numbers by also allowing ewe hunting on a permit basis.

2.1.2 Habitat Management

In recent years the emphasis in bighorn management has shifted from managing numbers to managing habitat. The carrying capacity of a bighorn range can be reduced through overgrazing by bighorns, or by elk, deer, cattle, horses, burros and domestic sheep, alone or in combination. Aside from direct competition for food, other behavioral interactions between species may affect use of habitat by bighorns, such as their aversion to cattle (Trefethen 1975). Managing integrated (multiple species) grazing systems requires an awareness of potential disease problems plus a considerable knowledge of the food, time and space requirements of the animals. Finally, there is the difficult problem of establishing species priorities, before manipulating the animals on their habitat.

Hunting seasons and/or hunting closures have done nothing to prevent the bighorn range reductions that have resulted from overgrazing or disturbances associated with recreational, urban and industrial developments. In addition, intensive forest protection through fire prevention and suppression has resulted in forest encroachment on bighorn ranges that were formerly maintained by fire.

The key steps to management of all races of bighorn are habitat protection, maintenance and enhancement. There are a number of methods that are used or can be used to improve habitats for bighorns. Privately owned land that is critical for bighorn survival must be acquired through purchase, or protected through changes in land use agreements. In some areas, livestock numbers have been removed or reduced where lands have been acquired. In other areas, through coordination and planning, new livestock grazing systems are being applied to publicly owned bighorn ranges. In 1975, the B.C. Forest Service and the Fish and Wildlife Branch conducted the first of many planned prescribed burns on overgrown bighorn ranges (Demarchi 1976). Other range improvement methods could include chaining, slashing or logging in areas where trees have invaded grasslands. Fertilizing, planting and winter feeding may also be recommended in certain situations, keeping in mind that the most productive bighorn habitat is native range in good condition. Water hole improvement and development has been a useful technique in aiding bighorn survival on desert ranges (Trefethen 1975).

In the future, bighorn managers are faced with identifying and carefully mapping existing and potential bighorn habitats in order to integrate land management strategies with other land users. When negotiation fails and bighorn habitats are destroyed, then compensation for losses should be provided for the acquisition and management of alternative habitats; the objective is no net losses of habitat or wild sheep numbers.

2.2 Evolution of Bighorn Management in Alberta

From 1800 to 1860 bighorn sheep were found in abundance; their total

numbers on both provincial land and the land in national parks probably exceeded 10 000 (Stelfox 1971). Factors that may have restricted sizes of these early populations were severe winters, disease, predation, interspecific competition for range and/or forage, and primitive hunting by Natives. With the introduction of firearms about 1850, man attained the status of an important limiting factor. After 1880, the number of settlers, miners, explorers, lumbermen and railway workers increased rapidly, resulting in increased exploitation of wild ungulates for meat. As railroads expanded, the hunting of sheep by non-resident trophy hunters also increased. The sale of ram horns by local residents became profitable; individual heads sold for $25 to $50 (Stelfox 1971). Ram horns were used as trading items; one trading post reportedly had stored over 700 sheep skulls (Wishart 1958). In addition to hunting, range competition, with large numbers of domestic livestock introduced after 1900, may have adversely affected bighorn populations. By 1915, sheep populations had declined to 1/5-1/3 of their original numbers (Stelfox 1971). Declines were attributed to excessive and nonselective hunting with firearms by explorers, miners, railway workers and Natives. Particularly vulnerable herds (i.e., those along riverbanks and in the foothills) were the first to decline.

2.2.1 Hunting Seasons, 1877-1906

The first game hunting regulation which applied to Alberta (then part of the Northwest Territories) was evidently passed on March 22, 1877 (it conferred protection for bison). Protection for bighorns evidently first appeared in ordinance No. 11 (Nov. 19, 1887), which closed bighorn hunting during the months of February - August, inclusive (Table 2). Bag

Table 2. Bighorn hunting seasons for Alberta during 1887-1906.

Year(s)	Season dates	Bag limits	Remarks
1887-1892	Sept. 1 - Feb. 1	none	either sex
1893-1896	Oct. 1 - Feb. 1	6	either sex
1897-1898	Oct. 1 - Dec. 15	6	either sex
1899-1902	Oct. 1 - Dec. 15	3	either sex
1903-1906	Oct. 1 - Dec. 15	3	males only

limits (six bighorn sheep) were first established by "The Game Ordinance" of 1893. In 1899, bag limits were dropped to not more than three animals. The prohibition of Sunday hunting was introduced on November 21, 1903. The taking of females and young under 1 year of age was also prohibited that year (Table 2).

2.2.2 Hunting Seasons, 1907-1949

The hunting of bighorn sheep was prohibited during 1907-08 by the original Alberta Game Act of 1907. The first official season opened in September of 1909 and was province-wide. Until 1921, two sheep could be legally killed during the hunting season. In 1921, changes in the regulations were adopted (restricting the shooting to one male sheep). The protection of big game animals (including sheep) under 1 year of age and with horns less than 10 cm (4 in.) in length was also adopted that year. Then, until 1945, bighorn sheep hunting was permitted annually from September 1 to October 31, throughout the province. In 1945, the area south of the Bow River was closed to sheep hunting (because of large die-offs). In the final two years of this section's period (1948 and 1949), with sheep populations generally low throughout Alberta, the season length was reduced from two months to one month.

2.2.3 Hunting Pressure and Numbers of Sheep Harvested, 1909-1949

During the 1890s and early 1900s, illegal killing of bighorns by settlers and miners was believed to be high, as a result of the lack of enforcement and a general disregard for game laws. At that time, most mining settlements were surrounded by a wide belt of country in which all forms of big game had been extirpated (Millar 1915). Hunting by Natives,

especially the Stoney Indians, was also considerable. Before the inclusion of Stoneys under the Alberta Game Act in 1914, the Natives of this group were permitted to kill six head of big game animals throughout the year, in addition to game required for food. In 1913 alone, at least 200 sheep were killed by Stoney Indians (Millar 1915). Hence, before 1915, it appears that the unrecorded kill of sheep (those taken legally by Natives and taken illegally by others) probably exceeded the kill by licensed hunters (see following paragraph). With increased enforcement activity under the Alberta Game Act of 1907, the establishment of game preserves and the national parks, and the attempted regulation of Native hunting, the number of unrecorded kills of sheep probably began to decline after 1915.

During 1907-1950, all licensed hunters were required under the Alberta Game Act to return their big game licences, along with a statement of the number of animals they successfully hunted (Webb 1959). An average of 77 sheep kills was recorded during 1909-1924, based on a range from 40 (1909) to 110 (1915, see Table 3). Harvest estimates for the period 1925-1947 are lacking; a general game licence was valid for all species during that period, so it was not possible to determine hunting pressure on any single species. However, in 1948, game seals were sold for each big game species; 78 non-resident and 421 resident seals for sheep were issued. The non-resident sheep kills in 1948 and 1949 were 48 and 37 rams, respectively.

In general, licence sales indicate that hunting pressure and legal kills of sheep by residents were not high (Forsland 1950) and the kill by non-residents was about the same as it is today. The number of sheep seals issued in 1948 (421) probably indicates increasing interest in

Table 3. The bighorn sheep kill recorded for Alberta during 1909-1924.

Year	No. sheep	Year	No. sheep
1909	40	1917	57
1910	54	1918	76
1911	49	1919	77
1912	90	1920	76
1913	65	1921	108
1914	78	1922	92
1915	110	1923	61
1916	83	1924	62

sheep hunting by resident hunters during the period, but accurate documentation of that interest is not available.

Alberta's bighorn populations yielded many record-sized horns during this period. The horns of seven sheep taken in this period rank among the top 10 taken in North America (ranking first, second, fourth, fifth, sixth, seventh and eighth) (Nesbitt and Wright 1981). Perhaps of greater significance is the fact that, as of 1981, the horns for 60 of the top 100 rams in the record book were taken in Alberta.

2.2.4 Population Status, 1909-1949

The reduction of sheep populations that began in the 1850s continued into the early 1900s. Millar (1915) conducted a federally commissioned big game survey of the east slope of the Rockies and estimated that between 1775 and 3400 sheep remained in Alberta (including the present national parks) (Table 4). However, Millar's estimate did not include the Smoky or Peace river drainages which presently support about 10 percent of the provincial population.

Alberta's sheep populations began to increase during World War I. By the late 1920s and 1930s, they were considered in "fair supply" (Game Commissioner's Reports). Stelfox (1971) estimated the Alberta (non-park) population in 1936 to be 4000 and attributed the increase over earlier estimates to enforcement of provincial game laws and improved range conditions. Generally, park sheep populations were secure from hunting and competition from livestock and recovered more rapidly than non-park populations. Sheep in Banff and Waterton Lakes national parks had peaked, or were nearing a peak by 1936, while provincial populations were

Table 4. Estimated bighorn sheep populations in Alberta in 1915 (Millar 1915).

Locality	Not less than	Not more than
International Boundary to Crowsnest Pass	500	1000
Crowsnest Pass to Rocky Mountains Park	400	800
Rocky Mountains Park[a]	500	700
Rocky Mountains Park to head of Athabasca River	200	450
Athabasca Drainage	75	250
Brazeau Drainage	100	200
Total	1775	3400

[a]Rocky Mountains Park was a 673-km^2 (260-sq. mi.) park along the Bow Valley; later enlarged to form Banff National Park (Stelfox 1971).

still about 10 years away from a peak (Stelfox 1971).

In 1945 and 1946, when provincial populations were high, an outbreak of "infectious lungworm disease" (apparently contracted from domestic sheep) was reported in the Livingstone and Highwood ranges; it killed large numbers of sheep (Forsland 1946, 1947). Hunting was therefore prohibited in the area south of the Bow River in 1946. Similar die-offs in the national parks, corresponding roughly with periods of peak populations, were recorded in Waterton Lakes in 1937, Kootenay in 1940-1941 and Banff in 1941-1942 (Stelfox 1971). The die-offs were attributed to a lungworm-pneumonia complex, which was aggravated by poor nutrition on deteriorated ranges. Range deterioration in the parks might have resulted from overuse by synchronously high populations of elk and deer, along with fire protection policies that permitted forest encroachment on former grasslands.

In 1947, bighorn populations were still low but beginning to show the early signs of recovery. Large numbers of females and young lambs and scarcities of full grown rams were reported that year (Forsland 1948). The years of disease and decline (1945-1946) had taken their toll. By 1950, 1500 sheep were estimated on provincial lands (Stelfox 1971).

2.2.5 Licensing and Licence Fees, 1909-1949

During the period 1909-1949, the bighorn sheep hunter was required to possess either a resident Big Game Licence or a non-resident General Game Licence. In 1942, the resident Big Game Licence fee was $2 and the non-resident General Game Licence fee was $50. The latter entitled the holder to take one male mountain sheep, one mountain goat (male or

female), one male deer, one male moose, one caribou (male or female), one male elk with antlers of eight or more points (both sides), two male antelope, and (subject to Section 9(c) of the Regulations) one bear of each species (Alberta Gazette 1942). In 1943, the resident Big Game Licence fee was increased to $3 and a non-resident Big Game Licence was introduced at a fee of $100. In 1944, a $25 sheep royalty was added to the non-resident Big Game Licencing fee. In 1948, this $25 royalty was increased to $50 and a $2 royalty payable by resident sheep hunters was introduced. In 1948, except for royalties, the Big Game Licence was free of charge. Royalties were removed in 1950 and the previous resident and non-resident Big Game Licences were reintroduced.

2.2.6 Hunting Seasons, 1950-1989

The period 1950-1989 showed significant changes in provincial management policies, with corresponding changes in both bighorn sheep hunting regulations and seasons. Important changes were the introduction of 3/4- and 4/5-curl regulations for rams, non-trophy seasons, extended seasons in November, compulsory registration, restrictions on non-residents, and a waiting period for successful hunters. Before 1989, the 4/5 curl was defined as follows: "horns, one of which can be intercepted at both the front of the horn base and the tip of the horn by a straight line drawn along the front of the eye when viewed in profile." The 3/4-curl regulation had allowed hunters to take rams on which the line passed from the front horn base through the back of the eye to the horn tip. To facilitate a closer examination of management policy changes, the following discussion has been divided into separate sections on rams and non-trophy sheep.

2.2.6.1 Ram Regulations, Seasons and Harvests

From 1950 to 1956, the season for bighorns was province-wide. From 1957 to 1963, seasons were assigned to Special Areas and Big Game Zones. In 1964, a Wildlife Management Unit (WMU) system was designed and implemented. The WMU system was based on physical boundaries (natural and man-made), vegetation, soils, and the distribution and abundance of wildlife species. The province was divided into five ecologic-physiographic regions, which contained a total of 134 WMUs. The objective was to enable more careful regulation of game harvests.

Since 1950, a number of major changes in ram regulations have occurred:

(1) trophy seasons were introduced under the 3/4-curl restriction in 1956;

(2) the 3/4-curl was increased to 4/5-curl restriction in 1968;

(3) extended November ("rut") seasons were implemented from 1965 to 1969;

(4) compulsory registration of rams was introduced in 1971;

(5) restriction of non-resident sheep hunters to a draw system began in 1972; and

(6) a waiting period for successful trophy hunters of four calendar years for non-resident aliens and one calendar year for residents and non-residents was introduced in 1974.

Before 1956, Alberta's sheep population was still in a stage of recovery following the die-off of 1945-1946. Consequently, young age classes predominated. Trophy rams were scarce (Annual Reports 1947-1949) and hunters were harvesting many young rams and occasionally ewes by mistake. Records of sheep killed in the Sheep River Valley of Alberta

showed that 9 of 13 yearling rams on Wishart's (1958) study area were taken in the fall of 1955 (one year before the introduction of the 3/4-curl law). The 3/4-curl regulation generally restricted the legal kill of rams to those 4 years of age and older.

In the fall of 1965, a two-week season in November was introduced in WMUs S436 and S438 (Appendix I) in a trial attempt to improve trophy hunting. This extension was intended to take advantage of the rams that spend their summers in the national parks and traditionally migrate out onto provincial wintering ranges during the rut in November. Hunter returns revealed that the horn length of rams taken during this season averaged nearly 15 cm (6 in.) more than for those rams taken in the same areas during the regular season (Stelfox 1966). Consequently, the program was expanded in 1966 to include all of November and additional WMUs (Appendix I). Kill statistics (Table 5) for 1966 showed a sharp increase (from 228 in 1965 to 312 in 1966). In 1967, the extended season was closed to non-residents and the number of rams killed showed a corresponding decrease (Table 5). The program of extended November seasons was discontinued in 1969 when it became apparent that, in addition to harvesting seasonally migrant "park" rams, a continued harvest of minimum-sized provincial rams was also occurring. The extended season allowed no escape of legal-sized provincial rams in return for the harvesting of park rams.

The change in trophy sheep regulations to a 4/5-curl law in 1968 resulted in a drop in the sheep harvest in 1968 (from 216 to 172) despite the extended season in November. Apparently, few large rams were available when the 4/5-curl law was introduced. Furthermore, the curl laws resulted in considerable problems of hunters taking borderline rams.

Table 5. Annual licence sales and estimated kills of trophy bighorn sheep in Alberta by recreational hunters during 1950-1989.

Year	Licence sales[a]		Reported trophy sheep kill[b]		
	Resident	Non-Resident	Resident	Non-Resident	Total
1950		98	190		(190)[c]
1951		123	110		(110)[c]
1952		92	100	40	140
1953		82	90	50	140
1954		99	140	44	184
1955		144	99	45	144
1956	(620)[d]	169	70	68	138
1957	(268)	234			
1958	(772)	197			
1959	(805)	264			
1960	(1036)	282			
1961	962	277	146	72	218
1962	1121	349	131	89	220
1963	1099	493	122	123	245
1964	1055	530	111	112	233
1965	1206	625	129	99	228
1966	1326	717	176	136	312
1967	1285	483	165	51	216
1968	1305	703	132	40	172
1969	1061	694	66	65	131
1970	989	216	60	51	111
1971	1073	199	43	56	99
1972	1008	123	73	42	115
1973	1230	107	94	36	130
1974	935	88	92	35	127
1975	1420	71	130	42	172
1976	1753	76	132	22	154
1977	2126	67	130	38	168
1978	2422	75	138	41	179
1979	2763	78	160	42	202
1980	2480	81	182	46	228
1981	2678	83	191	43	234
1982	2863	91	189	41	230
1983	2978	97	211	44	255
1984	3284	93	221	41	262
1985	3245	83	206	33	239
1986	3230	87	193	26	219
1987	2420	85	181	50	231
1988	2412	91	182	47	229
1989	2370	92	181	45	226

[a]The non-resident licence sales figures are represented by the number of Big Game licences sold until the introduction of non-resident sheep licences in 1970.

[b]Annual reported sheep kills were estimated from hunter questionnaire returns and registrations beginning in 1971.

[c]Non-resident kill undetermined.

[d]For the years 1956-1960, the resident licence was a combined sheep-and-goat licence. This was replaced in 1961 by a separate resident sheep licence.

In 1974, a field guide was prepared for hunters as an aid to identifying horn size in the field.

2.2.6.2 Non-trophy Sheep Hunting Regulations

Perhaps the most significant change in Alberta's sheep management policy occurred in 1966 with the introduction of the first non-trophy season. This new season was prompted by a die-off of sheep in the Kootenay region of British Columbia, and recognition that a males-only season was not sufficient for regulating sheep populations. Alberta's sheep populations had resurged to an estimated maximum of 5500 sheep in 1966, following the die-off in 1945-1946 (Stelfox 1971). Early signs of range deterioration and below-average lamb production in 1965 further suggested overpopulation.

The non-trophy hunt in 1966 allowed the shooting of any sheep with horns $\leq$ 30.5 cm ($\leq$ 12 in.) in length under a permit system. By regulating the numbers in the nursery herds, it was reasoned that sheep populations could be stabilized to prevent another "boom and bust" as occurred in the 1930s and '40s. However, in 1967, yearling rams constituted 31 percent of the non-trophy kill; it became apparent that hunters were removing a significant number of potential trophies. Consequently, non-trophy regulations were changed in 1968 to permit the harvesting of ewes and lambs only.

2.2.7 Hunting Pressure, 1950-1989

As with other big game species, improved access in mountainous areas allowed hunter numbers and sheep harvests to increase. Compared to the period of 1915-1924 (i.e., the period following the years of high illegal kill) when ram harvests averaged 80 yearly, the period 1950-1978 produced

an increase to about 175 rams per year. Since 1978, that total has risen, peaking at 262 in 1984, and averaging 230 in recent years (Table 5).

Restrictions of licence sales and seasons have reduced the non-resident trophy kill to about 16 percent of the total kill (Figure 2). The success rate of non-resident hunters has always been higher than that of resident hunters. Furthermore, the non-resident hunter success rate has increased from approximately 20 percent, which occurred before instituting the permit system, to about 50 percent. In contrast, success by residents has decreased, from a rate of 10 to 12 percent during 1964-1967 to 6 to 8 percent in recent years. The high success of non-resident hunters is attributed to their requirement to have guides and outfitters, whereas residents are not required to use such services and rely largely on their own skills.

The number of non-trophy sheep licences issued between 1967 and 1981 averaged 376 with an average kill of 121 (Table 6). During 1981-1986, the number of non-trophy sheep licences issued more than doubled (1369 in 1986). This increase in licence allocation was warranted by bighorn research on Ram Mountain, where harvest rates of 10 percent of the total winter population were shown to stabilize and maintain a highly productive herd (Jorgenson and Wishart 1982). An increase in the provincial population in the early 1980s also contributed to the higher number of licences issued. With the increased licence allocation, the kill estimate increased to 321 animals in 1986. More recent decreases in the provincial sheep population have resulted in reduced numbers of non-trophy licences.

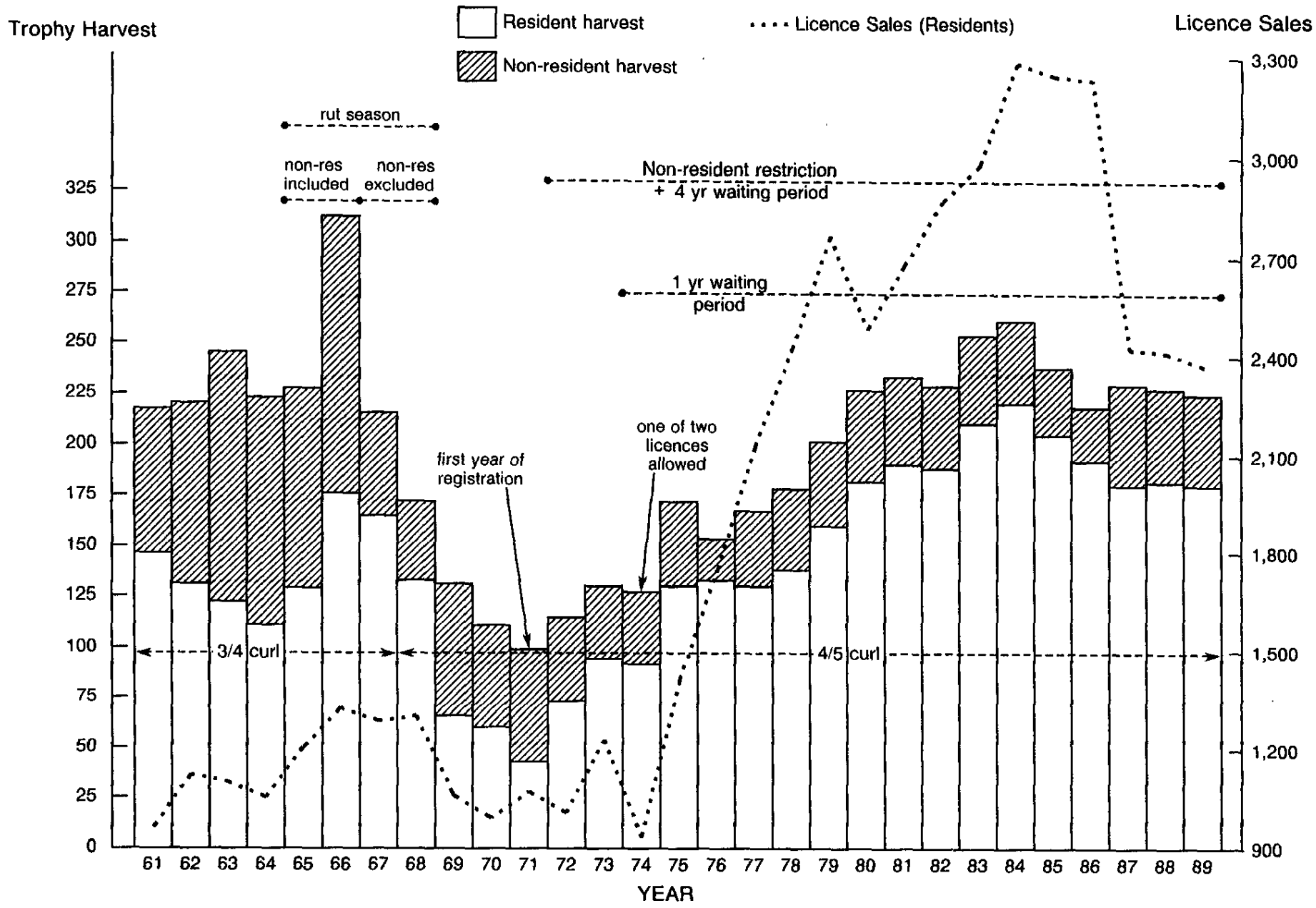


Figure 2. Summary of annual harvests of trophy rams in Alberta during 1961 – 1989.

Table 6. Annual licence sales and recorded non-trophy sheep kills in Alberta during 1966-1989.

Year	No. permits issued	Non-trophy sheep killed	Hunter success (%)
1966	138	64	46
1967	339	119	35
1968	374	109	29
1969	371	138	37
1970	314	90	29
1971	309	100	32
1972	329	100	30
1973	299	93	31
1974	280	69	25
1975	420	151	36
1976	440	132	30
1977	423	140	33
1978	435	136	31
1979	378	91	24
1980	436	191	44
1981	495	113	23
1982	792	270	34
1983	1007	221	22
1984	1131	387	34
1985	1044	276	26
1986	1369	321	23
1987	954	271	28
1988	491	132	27
1989	291	91	31

2.3 Biology

2.3.1 Habitat Requirements

Bighorn sheep currently inhabit the Rocky Mountains but historically used the rugged river valley areas of badlands east of the mountains, as well. They are generally restricted to semi-open grassy slopes adjacent to precipitous terrain, with rocky slopes, ridges and cliffs. Such habitat offers abundant forage, accessible escape terrain, and relatively little competition from other ungulates. Bighorns typically occupy four distinct, though often overlapping, seasonal ranges: winter ranges, spring or lambing areas, summer ranges, and fall or rutting areas. Rams generally occupy their own ranges separate from ewe groups, except during the rut.

The capacity of a range to support bighorn sheep is governed by the amount of food available during the season of greatest food scarcity. Bighorns are not well adapted to deep or crusted snow and are forced to winter within the confines of southern exposures or windblown slopes next to escape terrain. Such characteristic winter ranges are therefore most critical to the survival of provincial herds.

Winter harassment increases energy expenditures and may result in greater than normal winter weight losses, which can increase mortality and reduce productivity. Persistent harassment may result in range abandonment, and could also limit range expansion through the denial of food, water or secure escape terrain on potential sheep ranges.

2.3.2 Parasites and Diseases

The Rocky Mountain bighorn is known to have 51 species of external

and internal parasites, of which 36 are known to be parasites of domestic sheep and 18 to be parasites of cattle in North America (Becklund and Senger 1967). The importance of multiple parasitism as a debilitating factor in bighorns is not known.

Historically, bighorn populations have suffered catastrophic die-offs throughout their North American range. The cause of death has invariably been diagnosed as pneumonia, with other factors (lungworms, harassment, overcrowding, domestic livestock) acting as stressors (Stelfox 1976). Lungworms infect all bighorn herds to varying degrees and can undergo transplacental transmission. High lamb mortality from lungworms has been well documented from Colorado. Treatment with antihelminthic drugs can reduce lungworm infection and increase lamb survival but reinfection necessitates constant retreatment. The inaccessibility of most bighorn herds also makes treatment an impractical solution. There is still much to be learned about the biology of lungworms, the intermediate snail hosts, and the role of lungworms in respiratory diseases of bighorn sheep.

The shedding of larval lungworms in bighorn feces does not appear to be directly related to infection levels of adult worms in the lungs. Therefore, fecal collections cannot be used to assess lungworm loads and predict possible pneumonia die-offs (Festa-Bianchet 1991). This absence of a relationship is likely a result of the large seasonal and daily variations in larval output from adult sheep. Larval outputs may, however, be related to physical condition (Festa-Bianchet and Samson 1984; Festa-Bianchet 1987). To be of any possible value, field collections of fecal samples must ensure collection of multiple samples from the same individuals over a prescribed time period, preferably in

March or April. Further research is needed in this area.

Recent studies have demonstrated the potential for disease transmission between healthy domestic sheep and bighorn sheep (Foreyt and Jessup 1982; Onderka et al. 1988; Onderka and Wishart 1988). In these cases, transmission of Pasteurella hemolytica from domestic sheep to bighorns occurred, with 100 percent mortality resulting. While these studies used animals in confinement, they did demonstrate that disease transmission can occur. Domestic sheep contact has also been implicated in other bighorn die-offs in British Columbia and the United States. For these reasons, domestic sheep should not be allowed to graze in areas where they may come in contact with bighorns.

When pneumonia die-offs have occurred in bighorns, mortality has typically occurred over one to two months and affected 10 to 80 percent of the herd. Since 1978, there have been three die-offs documented in Alberta (Westcastle-Yarrow Creek herd once, Sheep River twice). Population recovery has usually been slow because of continued high mortality of lambs in succeeding years. It appears to take at least five years, following any major die-off, before improved lamb survival can effect any significant increase in herd size.

2.3.3 Population Characteristics

Considerable research has been conducted on the population dynamics of bighorn sheep at Ram Mountain, Alberta. Much of that information has been incorporated where appropriate into this management plan. The premise of the Ram Mountain study has been that population characteristics (lamb/ewe ratios, age/sex structure, growth characteristics) are indicators of herd status and reflect range

conditions. Geist (1971) concluded that populations which had exceeded their range capacity generally exhibited slow growth rates, low productivity, low survival and an old age structure, while the opposite was true of expanding herds that were below capacity. However, carrying capacities of most of Alberta's bighorn ranges are unknown at the present time. Quantitative range assessments have been conducted only on the Ribbon Creek (Mt. Allan herd) winter range (Jacques 1976).

The Ram Mountain research has shown that a healthy, vigorous population can be maintained by keeping population levels below capacity through annual cropping of both sexes. Loss of potential breeders is compensated for by high productivity, breeding by yearling ewes, and high survival of remaining animals (Jorgenson and Wishart 1985). Orphaning of lambs in early September did not compromise the lambs' survival or growth rates. For non-trophy sheep, annual harvest rates have been determined that result in population stability. Such rates may be applied to any herd with population characteristics similar to the Ram Mountain herd. Adjustments in harvest rates are necessary where productivity and mortality rates are thought to differ significantly from those at Ram Mountain.

At Ram Mountain, stability in herd size can be achieved when the harvest rate of non-trophy animals (ewes and lambs) is 10 percent of the total winter population (including rams) (Jorgenson and Wishart 1982), or 7 percent of the total preseason population (including rams). Surveys for bighorns are typically conducted in winter on post-hunt populations that have already experienced some winter (natural) mortality. To estimate annual preseason populations, it is necessary to estimate total winter mortality, summer productivity and summer mortality. These data

are unavailable for any population except Ram Mountain. Basing harvests on total winter herd size (including rams) assumes that rams are equally visible during surveys as ewes and lambs, which may or may not be true. To avoid this assumption of equal visibility, an equivalent harvest rate can be calculated (based on Ram Mountain data), using the size of the ewe and yearling ram component of winter surveys (yearling rams are included since they are difficult to distinguish from adult ewes during aerial surveys). This equivalent harvest rate amounts to 18 percent, which should be used in determining harvest goals and setting permits where non-trophy seasons exist, because the calculation of this rate avoids all but the inherent survey error.

However, such harvest rates are appropriate only where survival rates and productivity are high and at similar levels to the population modelled at Ram Mountain. Annual overwinter survival rates should be at least 75 percent for lambs, 90 percent for ewes, and 70 percent for rams. In addition, predation rates should be low (as they are at Ram Mountain) and lamb:"ewe" ratios (ewes are $\geq$ 1-year-old) should be $\geq$ 40 lambs:100 ewes. If these criteria do not apply to the population in question, then the harvest rate should be adjusted downward accordingly.

Population growth in bighorn populations can be very rapid under ideal circumstances--with doubling theoretically occurring approximately every 2.5 years (Buechner 1960; Woodgerd 1964). Such growth, however, would require the following: (1) one lamb per ewe per year; (2) birth of first lamb when ewe is 2 years of age; (3) a negligible number of ewes living beyond breeding age; (4) an equal ratio of rams to ewes; and (5) no mortality. Such criteria of course do not apply to actual bighorn herds. At Ram Mountain where overall survival rates (which also

incorporate effects of hunting) are relatively high (75 percent of lambs, 90 percent ewes, 70 percent rams) and lactation rates (proportion of ewes that give birth) are high (about 91 percent for ewes > 2 yrs), it has taken about 8.5 years for the population to double. This observed doubling rate is probably more typical of Alberta populations and could, in fact, be more rapid than some actual situations where predation rates are higher and productivity may be lower. Moreover, any harvest of non-trophy animals could conceivably delay attainment of population goals within a specified time period.

Lamb:ewe ratios and yearling:ewe ratios are generally used as indicators of annual production, but these must be carefully interpreted since non-productive individuals (yearlings and 2-year-olds) cannot be distinguished from older, sexually mature animals during aerial surveys. As a result, such individuals are included in the ewe component of the ratios. Annual changes in lamb survival can significantly influence the number of yearlings in the population and consequently raise or lower lamb production estimates. For this reason, distinguishing yearlings during surveys should be considered when monitoring herds that are experiencing or recovering from die-offs.

Lamb:ewe ratios are determined during winter and include only lambs seen in the field. There is no information obtained regarding neonatal, summer or overwinter lamb mortality. Inferences, therefore, cannot be made regarding conception rates. At Ram Mountain, annual lactation rates between 1975 and 1988 averaged 91 percent (range 81-100) for ewes 3 years of age or more, yet lamb production (lambs observed in the field) averaged 79 percent (range 59-91) or 79 lambs:100 ewes. The difference was attributed to neonatal mortality. If nonproductive yearling and

2-year-old ewes were included with the reproductively mature ewes (as they are during surveys), then the average annual productivity declined to 55 lambs:100 ewes (range 38-69). Where all ages of ewes are included, a low lamb:ewe ratio in any given year invariably will mean lower recruitment; provided ratios are not consistently low (< 40 lambs:100 ewes) on an annual basis, herd stability or growth should not be jeopardized.

Severe weather conditions during lambing will increase neonatal mortality; however, conditions must be severe throughout the entire lambing period, not just a portion of it. In 15 years of study at Ram Mountain, only one year (1990) had conditions severe enough to affect lamb mortality significantly. In that year, 31 percent of the 54 ewes that gave birth experienced neonatal losses. Thus, consideration should be given to reducing non-trophy harvests following prolonged severe weather in springtime.

Mortality rates of bighorns vary with sex and age. Lambs have higher overwinter mortality than older individuals, and ewes have lower mortality than rams. A relatively steady death rate for rams from 1 to 8 or 9 years of age has been shown for Ram Mountain and also reported by Cowan and Geist (1971). Ewes, on the other hand, experience little mortality after the age of 1, but mortality increases at 8 or 9 years. Hunting further increases the rate of loss in rams. At Ram Mountain, hunting that annually took an estimated 6 percent of rams > 1 year of age resulted in an increase in mortality, such that a hypothetical population of 100 male lambs would be reduced to 2 or 3 after 10 years. Rams in Alberta can attain legal size by 4 years of age; however, the average age of harvested rams is 6 years. Because of faster growth in sheep south of

the Bow River, the average age at which rams attain legal status is lower than it is for northern rams. In slower-growing (northern) populations, such as the one at Ram Mountain, natural and hunting mortality together result in few rams living long enough to grow large horns. In the last 14 years at Ram Mountain, no full curl rams have been seen.

The actual percentage of trophy rams taken annually is unknown for most herds. At Ram Mountain, on average, 37 percent of available rams are taken each year by hunters. Harvest rates are likely higher in other parts of the province where access is easier. The absence of many very large trophies being registered on an annual basis in Alberta is indicative of heavy harvests on available rams.

Geist (1971) and Heimer et al. (1984) have indicated that heavy harvests of mature rams may affect the survival of younger rams. Lower survival of young rams, compared to that of ewes, appears to occur in the hunted Ram Mountain population, but the causes of such mortality are unknown. Harvest of all available trophy rams each year is not advisable; however, additional research is needed to establish the acceptable level. In the interim, a harvest of 50 percent of available trophy rams will be used as an arbitrary guideline.

Cowan and Geist (1971) predicted that four or five mature rams could be produced annually from 100 bighorns in the field. This is consistent with what has been found at Ram Mountain. In southern Alberta, where growth rates are faster, that number would increase to seven to eight trophies per 100 bighorns. Post-hunt populations in Alberta typically consist of about 4 percent trophy rams. Combined with the annual recruitment of trophies, the number of trophy rams annually available in

each population would approximate 8 percent of the preseason population in northern Alberta and 10-12 percent in southern Alberta. These percentages will vary locally, particularly in areas where rams move out of the national parks onto provincial lands and make up a portion of the harvest. In such areas, the availability of these rams for harvest is highly dependent on weather conditions. Often these rams are also products of nursery herds that reside in the parks and which are not considered when estimating sizes of local provincial populations. For these reasons, some provincial herds of relatively small size have produced unexpectedly high harvests of trophy rams. The opposite can also occur; large provincial populations may have relatively low trophy harvests because of some rams that evidently seek refuge in the parks and only come out during the rut.

2.3.4 Census

Bighorn sheep populations have been estimated through the use of time-lapse photography, watercraft, fixed-wing aircraft and helicopter surveys. Intensive and repeated ground counts have also been used on small study areas. Helicopters have proven to be invaluable as a rapid, though expensive, method of providing superior estimates of numbers and age-classes over extensive areas. However, age classification of ewes and yearlings is difficult from the air, though lambs and the various horn-classes of rams older than 1 year are readily identified. With Alberta bighorns, the opportune period for surveys is during December-March, when all sex and age classes are concentrated on the winter ranges.

The accuracy of aerial surveys for counting bighorn populations has

never been experimentally determined; however, at Ram Mountain where actual numbers are known, aerial surveys (1975-1982) have never accounted for more than 55 percent of the sheep actually present. Ideal survey conditions (i.e., clear, calm, with fresh snow cover [> 10 cm]) are critical for obtaining useful population data. When conditions are marginal, surveys should not be flown. In all circumstances, careful interpretation of survey results is required.

2.4 Current Status

2.4.1 Supply

In contrast to several other wildlife species, the numbers and distribution of bighorns in Alberta are known fairly accurately through surveys of key winter ranges. Seasonal distribution at other times of the year is known only for a few herds that have been intensively studied. Outside the national parks, extensive records of bighorn numbers on winter ranges have been collected systematically since 1968. Most of the major wintering areas have been identified (Appendix II), although they have not yet been mapped precisely. During surveys, areas that traditionally winter significant sheep populations are selected for coverage. Areas that do not support significant wintering herds (i.e., herds < 20 animals) or that support herds only sporadically, are eliminated from regular coverage.

Considerable year-to-year variation in sheep numbers has been observed on the various winter ranges (Cook 1978). Such variations require careful interpretation, particularly where winter ranges are not clearly delineated by any physical barriers. Bighorns exhibit high

fidelity to their home ranges (Geist 1971; Festa-Bianchet 1986a,b), but the timing of movement to winter ranges can be greatly influenced by weather. When snow depths and temperatures are less severe, bighorns tend to be less concentrated and more widely dispersed over their winter range. Ground counts of certain intensively studied populations have generally exceeded, by 10-50 percent, the maximum numbers obtained from aerial surveys.

Ideally, current population estimates for any WMU should be obtained by using the maximum count from several replicate surveys; however, replicate surveys should be flown over a short time span, preferably one winter. Replicate surveys in Alberta tend to be conducted once every two years when possible; therefore, too much time passes before enough replicates are done. The size of populations can change rapidly when die-offs occur. For example, the major die-off in the Westcastle-Yarrow Creek area of southwestern Alberta reduced that population by about 75 percent. The die-off was rapid, occurring primarily over one winter, but was followed by five years of poor lamb survival and low recruitment. Such population changes could go undetected with infrequent surveys.

The potential supply of bighorns in Alberta can be estimated by looking at the maximum count from all the replicate surveys of key winter ranges conducted since 1968 (Table 7). Some of these WMUs have undergone population declines since maximum counts were made (e.g., WMUs 400, 404). Only the major wintering areas are surveyed, which results in the exclusion of some sheep from some WMUs that contain several small areas harboring small populations (< 20 bighorns).

The current (1989) supply of bighorns was estimated using the most

Table 7. Maximum counts of bighorn sheep on winter ranges in Alberta (excluding national parks) during 1968-1990.

Region	WMU[a]	Mountain complex		No. bighorns	
Edson	446	Sheep Creek	('71)[b]	32	
	445	Torrens	('88)	120	
	444	Stearn	('73)	287	
	442	Swift-Horn	('68)	135	
	442	Triangle	('75)	123	
	442	Monoghan	('69)	151	
	440	Rocky Pass	('80)	89	
	440	Berland	('80)	159	
	440	Hayden	('72)	75	
	439	Solomon	('67)	93	
	438	Folding Mountain	('82)	96	
	438	Whitehorse Creek	('88)	350	
	437	Redcap Mountain	('82)	200	
	436	Ruby Creek	('75)	28	
				1938	Subtotal
Rocky Mountain House	328	Shunda	('75)	47	
	434	Chungo-Blackstone	('82)	131	
	434	George Creek	('82)	175	
	432	Job-Coral	('75)	177	
	430	Bighorn	('75)	200	
	429	Ram Mountain	('89)	225	
	428	N. Ram	('75)	76	
	426	W. Rabbit	('82)	197	
	422	Hummingbird	('82)	240	
	420	Clearwater	('80)	250	
	418	Ya Ha Tinda	('82)	296	
	416	Sheep Creek	('86)	105	
	414	Burnt Timber	('71)	38	
				2157	Subtotal
Calgary	412	Black Rock-Orient Pt.	('79)	66	
	411	Ghost	('88)	97	
	410	Bow	('89)	125	
	408	Kananaskis-Wind Ridge	('83)	290	
	406	Sheep-Elbow	('83)	360	
	404	Highwood	('83)	202	
				1140	Subtotal
Lethbridge	306-402	South Livingstone	('88)	56	
	308-402	North Livingstone	('88)	39	
	402	Cabin Ridge	('88)	57	
	400	Westcastle-Yarrow Ck.	('79)	389	
				541	Subtotal
Total				5776	

[a]WMU = Wildlife Management Unit
[b]Year of maximum count in parentheses.

recent survey results, carefully interpreted by local biologists (Table 8). The preseason estimates used winter counts with subsequent application of estimates of overwinter mortality, spring productivity, and summer mortality. The WMUs have been grouped in some instances into Sheep Management Areas (SMAs) (see Figure 3). This grouping eliminates the need to make adjustments for problems of sheep movements across the numerous boundaries caused by the smaller WMUs. The total provincial population estimate (preseason 1989) was 5215 bighorns (Table 8).

2.4.2 Use

Use of the bighorn resource generally falls into three categories: sport hunting (see Tables 5 and 6), subsistence hunting, and non-consumptive use. In 1989, about 2400 licences were sold to hunters to harvest trophy rams. The demand for trophy sheep hunting (as indexed by licence sales) has declined 28 percent since 1984, possibly attributable in part to a licence fee increase in 1987 (Appendix I). An additional 291 permits were issued to hunt non-trophy sheep in 1989. The demand for non-trophy hunting exceeds the supply. For example, only 19 percent of 1542 applicants were successfully drawn in 1989 (27 percent of 1889 in 1988, 54 percent of 1817 in 1987). This demand, however, is not evenly distributed; some areas (the least accessible, northern areas) are undersubscribed, while other areas are considerably oversubscribed (Table 9).

The approximate 2700 resident hunters licensed in 1989 spent more than 21 000 recreation-days hunting and generated about $160 000 in licence sales alone (Wildlife Certificate and licence fees). Non-residents purchased 92 trophy sheep licences and contributed to the

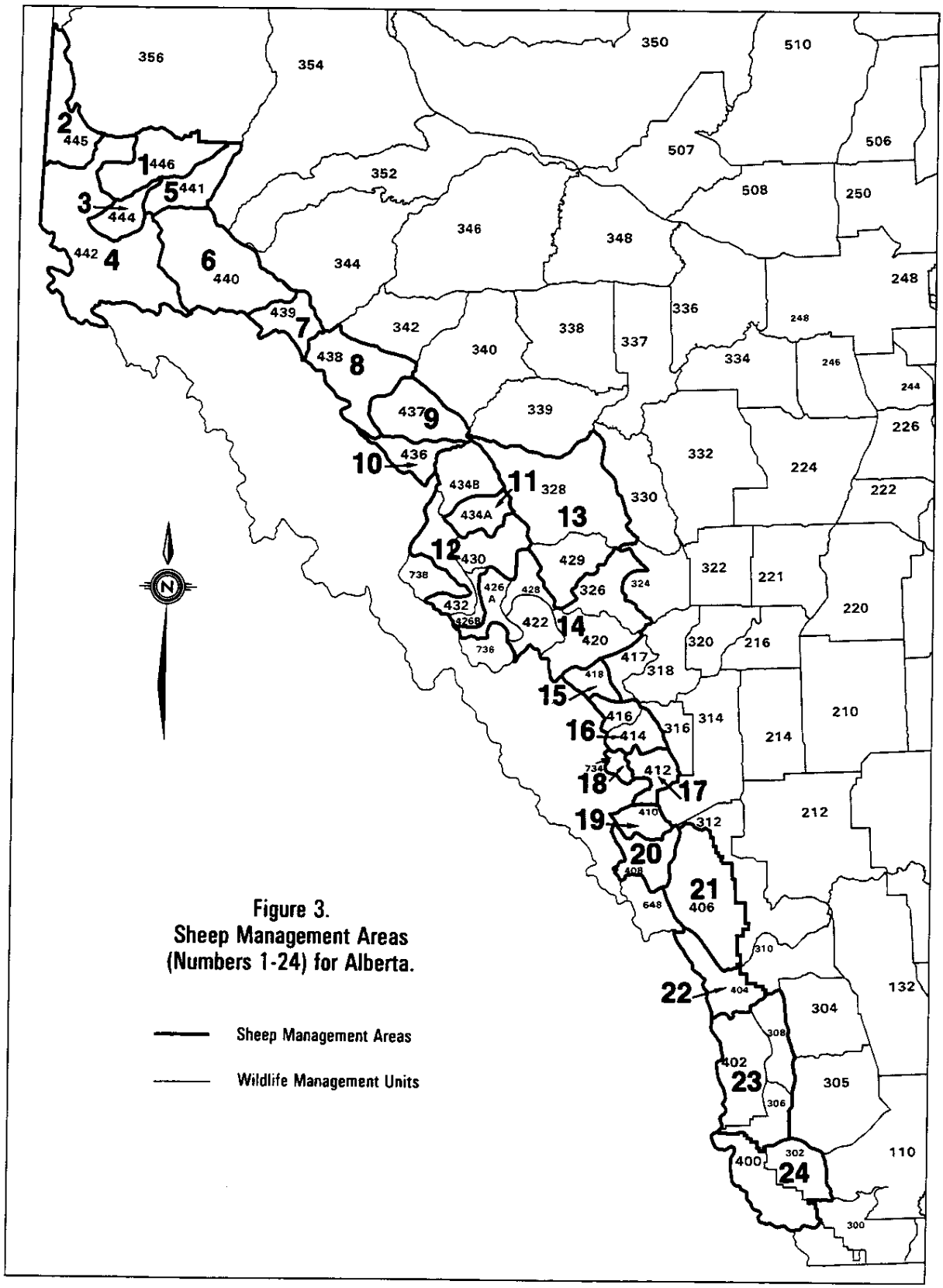


Figure 3.
Sheep Management Areas
(Numbers 1-24) for Alberta.

Sheep Management Areas

Wildlife Management Units

Table 8. Sheep Management Areas (SMAs), winter ranges and estimated preseason populations of bighorn sheep in Alberta, 1989.

Sheep Management Area	Wildlife Management Unit	Major winter ranges	Total no. winter ranges	Preseason population
1	446	Sheep Creek	3	20
2	445	Mt. Torrens	1	115
3	444	Mt. Stearn	2	235
4	442	Swift-Horn, Triangle, Monoghan	6	260
5	441	Nil	1	20
6	440	Hayden, Rocky Pass, N. Berland, Moon & Planet, Mumm-Collie	5	215
7	439	Solomon Creek	2	40
8	438	Folding Mountain, Whitehorse Creek	2	420
9	437	Redcap	1	120
10	436	Ruby Creek	4	40
11	434A	Wapiabi, George Creek	3	135
12	434B, 432, 430, 426B	Chungo-Blackstone, Coral & Job Creek, Front Range, Bighorn, Cline Pt.	5	360
13	429, 328	Ram Mtn., Shunda	4	225[a]
14	428, 426A, 422, 420, 326	N. Ram, Whiterabbit, Hummingbird, Clearwater	7	620
15	418A, 418B, 418C	Barrier Mtn., Eagle-Bighorn Scalp Creek east & west	4	360

[a]From research activities involving ground counts and known to be more accurate than aerial results.

(continued)

Table 8 (concluded)

Sheep Management Area	Wildlife Management Unit	Major winter ranges	Total No. winter ranges	Preseason population
16	414, 416	Burnt Timber	3	160
17	412	Black Rock Mtn. Orient Pt., End Mtn.	4	170
18	734	Ghost Wilderness	1	110
19	410	Mt. Laurie, Mt. Charles-Stewart	3	170
20	408A, 408B	Evans-Thomas, Pigeon-McGillivray, Ribbon Creek-Mt. Allan Wind Ridge	4	320[a]
21	406A, 406B	Mt. Head, Gibraltar, Forget-me-not, Mt. Burns, Mt. Ware, Sheep River	9	415
22	404A, 404B	Cataract Creek, Plateau Mtn., Mist Mtn.	3	110
23	400, 308, 306	South Livingstone, North Livingstone, Cabin Ridge	7	250
24	400A, 400B, 302	Prairie Bluff-Yarrow Creek, Table-Castle Mtn. Barnaby Ridge Crowsnest Pass	5	325
Totals			89	5215

[a]From research activities involving ground counts and known to be more accurate than aerial results.

Table 9. Success of hunters who applied for non-trophy sheep licences at being drawn in 1988, according to zone or Wildlife Management Unit (WMU).

Zone or WMU[a]	Licences available[b]	Applicants	Percent applicants successfully drawn
A02	25	124	20
A04	5	85	6
A06	10	50	20
A08	10	37	27
A18	5	62	8
A22	15	64	23
A26	21	21	100
A28	5	7	43[c]
A34	5	34	18[c]
A37	5	42	12
B04	5	75	7
B06	15	100	15
B08	20	131	14
B18	5	72	7
B34	5	19	21[c]
B37	10	48	21
306	15	74	19[c]
308	15	81	19
326	5	22	23
328	5	10	50
410	25	175	14
412	7	26	27[c]
414	5	9	56
416	5	62	8
420	15	48	31
430	5	31	13[c]
432	5	22	23
436	5	19	26
438	40	117	33[c]
439	5	7	43[c]
440	40	45	89
442	70	62	100
444	60	58	98
445	20	21	86

[a]Three-digit numeric codes are WMU numbers. Alpha-numeric codes indicate special Non-trophy Sheep Hunting Areas (see Annual Bulletin "Special Licence and Authorization Draws: Information and Instructions").

[b]Of the total 510 licences available, rejections reduced the actual number issued to 491.

[c]Because of irregularities in some applications, numbers of applicants drawn sometimes differed from numbers of licences available. Therefore, the percent applicants successfully drawn sometimes differ from the quotient obtained by dividing licences available by numbers of applicants.

outfitting and guiding industry about $690 000 (average income to the industry per non-resident licencee is estimated at $7500).

Subsistence hunting is estimated to account for a very small proportion (< 5 percent) of the bighorn harvest and is essentially an opportunistic harvest, restricted to very accessible herds.

Nonconsumptive use is difficult to assess. However, in a random sample questionnaire taken in 1976, bighorn sheep were ranked as sixth of all animals in the like-to-see category (Phillips et al. 1977). A wildlife viewing and interpretive site has been established in the Sheep River Wildlife Sanctuary, which is situated southwest of Calgary. Opportunities to establish viewing sites in other parts of the province doubtless exist.

2.5 Summary and Management Issues

Bighorns occupy habitat formerly unexploited by man; however, that has changed quite rapidly since European settlement. Relatively recent recreational activities (use of all-terrain vehicles, cross-country skiing, mountain biking, heli-hiking) have greatly increased access into previously undisturbed sheep ranges. Not only are new areas being exposed, but an increasing number of people are engaging in outdoor pursuits. Disturbance and subsequent abandonment of critical ranges (lambing areas, winter ranges) can sometimes lead to major reductions in sheep numbers.

Recreational and industrial developments in mountainous terrain require close scrutiny to minimize negative impacts on bighorns. Detailed knowledge exists for only a few bighorn herds (Sheep River, Ram

Mountain, Mount Allan, Redcap Mountain). If negative impacts from developments are to be lessened, more extensive background data on bighorns (population health, movements, critical ranges) are required, before developments are initiated.

Evidence is growing of a link between major bighorn die-offs and contact with domestic livestock (principally domestic sheep) grazing on low-elevation winter ranges for bighorns. These die-offs can dramatically reduce whole populations.

Consumptive use of the bighorn resource has increased several-fold from the early 1960s (Tables 5, 6), but has actually declined in recent years. Increases in demand may occur, in future, with further increases in human populations. Current and projected status in terms of supply and demand for bighorns can be summarized as follows:

1. The current demand for trophy rams, based on licence sales during the 1980s, is almost double that of the 1970s. However, the current harvest level (7 percent success) can be accommodated by the existing bighorn population. Likewise, interest in hunting non-trophy sheep has grown greatly in recent years. The current demand for non-trophy sheep exceeds the supply available in accessible populations.
2. Current resident use can be maintained without affecting bighorn populations provided that success rates do not increase, the present 4/5-curl regulation is retained, the total sheep population does not decline further, and the number of hunters does not increase significantly.
3. Potential increases in resident hunting of trophy rams cannot be met by the presently accessible sheep population without further decline in the hunter success rate (i.e., below 7 percent). Population goals

for our bighorn herds, if reached, would almost meet the projected demand of trophy sheep hunters, and would meet the forseeable demand for non-trophy sheep. However, there is a potential for loss of sheep hunting as a result of area closures arising in response to recreational and industrial conflicts. Such closures would widen the gap between the current supply and future demands.

A number of alternative approaches could be used to reconcile these supply-and-demand issues, as follows:

1. Reduce the number of sheep hunters.
2. Increase the current population accessible to the hunter by opening some of the closed areas on a limited basis, and/or providing special extended seasons (rut seasons) to harvest sheep that seek refuge in the national parks during the regular season.
3. Increase sheep populations through habitat enhancement and development techniques.
4. Transplant bighorns onto historical ranges along some of the major rivers on the prairies (requires isolation from domestic sheep).
5. Accept reduced hunter success rates.

Nonconsumptive use of the bighorn resource is growing in demand. So far, few opportunities have been provided on provincial lands to view and/or photograph bighorns. The demand for this type of recreation must be assessed, to ensure that adequate opportunities are provided. It is conceivable that the sport of hunting bighorns may be reduced in future through social/political pressures, regardless of how biologically sound low levels of harvest may be. This is because of objections to trophy hunting by some nonhunting publics, increased demand for

nonconsumptive uses of wildlife, and increasing preservation sentiments among nonhunting publics.

3.0 MANAGEMENT PLAN

3.1 Policy Framework

The Fish and Wildlife Policy for Alberta (Fish and Wildlife Division 1982) establishes policy goals for the administration of wildlife resources in Alberta. These policy goals provide a framework for the formation of specific bighorn sheep management plan goals. Particularly germane policy goals are set out under five general categories.

3.1.1 Resource Protection

"1) ... The primary consideration of the Government is to ensure that wildlife populations are protected from severe decline and that viable populations are maintained ...."

3.1.2 Resource Allocation

"2) ... (a) The wildlife resource, as a Crown resource, will be utilized in a manner which contributes the most benefit to the citizens of Alberta.

"2) ... (e) Wildlife will be allocated through a defined process whereby specific resources are deployed to specified uses in order to achieve stated public benefits.

"11) The Division [Services] may allocate live wildlife for various uses such as game farming, game ranching, education or science and zoological displays, in conformity with other aspects of the Wildlife Policy.

"17) Wildlife must be allocated among different primary users in response to government policy. Until such time as supply and demand can be better rationalized, the following interim allocation guidelines will prevail in order of priority:

...(b) Resident recreational use of game will have precedence over non-resident use. Wildlife stocks not fully allocated or utilized to higher priority uses may be allocated commercially to non-residents.

"18) The allocation of wildlife stocks to the different primary uses does not imply that other uses cannot occur within areas where such uses are entitled.

"22)[(b)(ii)] ... (a) Formally allocating wildlife to tourist lodge and/or outfitter use."

3.1.3 Recreational Use

"8) A variety of wildlife recreational opportunities, in addition to hunting, will be available for the benefit and enjoyment of Albertans.

"21) A variety of hunting opportunities will be available for the recreational benefit and enjoyment of Albertans ..."

3.1.4 Commercial Use

"22) The Division [Fish and Wildlife Services] will encourage an environment that promotes the growth of the tourist industry...."

3.2 Management Goals and Objectives

3.2.1 Resource Protection

Goal (Paramount): To ensure that viable populations of bighorn sheep are maintained.

Objective: Maintain the viability of all existing wintering populations of bighorns (see Figure 3, Table 8, Appendix II). This will be achieved by protecting populations from overharvest, illegal hunting, disturbance and disease, and by securing and maintaining all of the known wintering areas (Appendix II), whether surveyed or not.

3.2.2 Resource Allocation

Goal: To maximize benefits to Albertans through the optimum allocation of the bighorn sheep resource.

Objectives (by the year 2000):

a. Provide the opportunity for 3540 residents to hunt 22 020 days and take 248 trophy sheep and 1830 residents to hunt 5040 days and take 480 non-trophy sheep.

b. Provide the opportunity for 1.5 million Albertans to spend 80 million days on directly related, nonconsumptive wildlife activities.[1]

[1] "Nonconsumptive" goals and objectives are not developed by species.

c. Provide the opportunity for outfitter-guides to contract non-resident trophy bighorn sheep hunters to take up to 41 trophy sheep annually, consistent with policy.

d. Provide an opportunity for Treaty Indians (in accordance with Paragraph 12 of the Natural Resources Transfer Agreement) and other Albertans (in accordance with the provisions of a subsistence hunting licence) to meet their subsistence food needs.

e. Promote and encourage scientific and educational activities that will enhance knowledge of bighorn sheep.

3.2.3 Recreational Use

Goal: To maximize the recreational benefits and enjoyment to Albertans from the bighorn sheep resource through the provision of a variety of types and amounts of recreational opportunities.

Subgoals:

1. Maintain the current opportunity for Albertans to hunt "trophy"[2] bighorn sheep, and as part of the population management strategy for maximizing the production of trophy rams, provide the maximum opportunity for residents to hunt "non-trophy"[3] bighorn sheep.

---

[2] 4/5-curl rams or larger.
[3] Female bighorn sheep and any male bighorn sheep under the age of one year.

2. Provide a variety of opportunities to all Albertans for directly related nonconsumptive wildlife activities[4] such as viewing, photographing, studying, feeding and making habitat improvements.

Objectives (by the year 2000):

a. Provide the opportunity for 3540 residents to hunt 22 020 days and take 248 trophy sheep and 1830 residents to hunt 5040 days and take 480 non-trophy sheep annually.

b. Provide the opportunity for 1.5 million Albertans to spend 80 million days on directly related nonconsumptive wildlife activities.

3.2.4 Commercial Use

Goal: To optimize the economic benefit to Alberta from the commercial use of the bighorn sheep resource.

Objectives:

1. To optimize the economic benefits to Alberta from the outfitting and guiding supplied to non-resident hunters of bighorn sheep.
2. To optimize the economic benefits to Alberta from trail riding and other commercial endeavors that use the bighorn sheep resource, wherever such activities do not jeopardize that resource.

---

[4]"Nonconsumptive" goals and objectives are not developed by species.

3.2.5 Populations and Habitat

Goal: To ensure that populations and habitats are managed to meet the resource requirements of the recreational and economic goals and objectives.

Objectives (by the year 2000):

a. Increase the preseason population of bighorn sheep from the current estimate of 5215 to 6900 (Table 10).

b. Maintain the 89 known winter ranges for bighorns (Appendix II, Table 8) and associated summer ranges.

3.3 Management Strategies

3.3.1 Population Allocation

At least 80 percent of the harvestable surplus of trophy rams will be allocated to recreational hunting by residents (256 trophy sheep).

Provincially, a maximum of 20 percent of the harvestable surplus of trophy rams may be allocated to the outfitting-guiding industry (i.e., 41 trophy sheep to non-resident/alien hunting).

Non-trophy sheep hunting will be restricted to residents in all regions unless there is an undersubscription for, or failure to use more than 50 percent of the available permits for three consecutive years. Where resident demand can be shown to be insufficient to meet management objectives, consideration will be given to allowing non-residents/aliens to participate in the non-trophy sheep draw.

Non-resident (rifle) hunting for trophy sheep and hence outfitting

Table 10. Current (1989) and future (year 2000) population and harvest objectives for trophy and non-trophy bighorn sheep in Alberta.

Sheep Mgmt. Area	Preseason population 1989	Hunter recreation days 1989	Mean Harvest/year (1985-1989) Trophy Sheep Resident	Trophy Sheep Non-resident	Trophy Sheep Total	Non-trophy (resident)	Preseason population objective year 2000	Harvest goal year 2000 Trophy Sheep Resident	Trophy Sheep Non-resident	Trophy Sheep Total[a]	Non-trophy[b] (resident)	Recreation-days goal year 2000
1	20	46	1	0	1	0	20	1	0	1	0	89
2	115	171	2	2	4	3	175	5	2	7	12	745
3	235	344	8	1	9	4	350	11	3	14	24	1 490
4*	260	672	6	4	10	6	400	12	4	16	28	1 701
5	20	0	0	0	0	0	20	1	0	1	0	88
6*	215	477	8	4	12	8	350	11	3	14	30	1 552
7*	40	186	1	2	3	0	45	2	2	4	3	386
8*	420	1 395	21	3	24	22	600	19	5	24	42	2 564
9	120	0	0	0	0	12	250	0	0	0	17	175
10*	40	270	6	0	6	4	45	2	0	2	3	209
11	135	0	3	4	7	3	200	6	2	8	14	851
12*	360	884	19	7	26	16	470	15	4	19	33	2 027
13	225	152	4	0	4	0	150	6	0	6	10	636
14*	620	1 175	26	8	34	31	780	25	6	31	55	3 319
15*	360	1 003	5	0	5	12	440	14	4	18	31	1 918
16*	160	366	6	1	7	9	220	7	2	9	15	954
17	170	182	6	0	6	1	230	10	2	12	16	1 230
18	110	249	0	0	0	0	110	0	0	0	0	0
19	170	1 987	10	3	13	12	200	8	2	10	14	1 032
20	320	1 475	14	0	14	24	320	16	0	16	22	1 647
21	415	1 376	15	0	15	13	550	28	0	28	39	2 888
22	110	1 227	9	0	9	23	300	15	0	15	21	1 548
23	250	3 905	10	0	10	13	275	14	0	14	19	1 439
24	325	3 782	12	0	12	0	400	20	0	20	28	2 064
TOTAL	5 215	21 324	192	39	231	217	6 900	248	41	289	476	30 552

*SMA where availability of rams is influenced by national parks.

[a]Based on 4 percent of preseason population for SMAs 1-16, inclusive, and 5 percent for SMAs 17-24.

[b]Based on 7 percent of preseason population.

activities will be directed to more remote areas of the province (north of the Bow River) to reduce conflict with resident hunters.

Opportunities for viewing and photographing sheep will be made available to interested Albertans through outfitting, backpacking and other viewing ventures, where such activities will not adversely affect the sheep populations.

The majority of nonconsumptive use of bighorn sheep will be accommodated by wilderness areas, national and provincial parks, and wildlife sanctuaries.

3.3.2 Population Management

3.3.2.1 Trophy Sheep

Adult male sheep will be hunted at a level of maximum sustained yield for trophy animals. A trophy sheep will be defined as follows, as contrasted to an earlier definition on page 18: "a sheep that bears at least one horn which, when viewed in profile, is of sufficient size that a straight line drawn from the most anterior point of the horn's base to the tip of the horn passes in front of the eye." The harvest level of trophy rams will be generally limited to 50 percent of the total number of trophy rams available and shall not be allowed to exceed 70 percent. At normal recruitment rates, the trophy ram harvest should not exceed 4 percent of the total preseason sheep population in the north and 5 percent in the south.

Special trophy seasons in November will be considered, for selected SMAs, to harvest some of the adult rams that migrate out of the national parks and wilderness areas during the rut. Hunting of rams under any of these special seasons will be done by permit only and limited to full

curl rams, in order to prevent overharvest of adult rams that reside on provincial land year-round.

Should a demand exist for larger-horned trophy rams, consideration would be given to increasing the minimum size restriction from 4/5 curl to full curl. This would only be practical south of the Bow River and would not significantly affect the number of available rams.

3.3.2.2 Non-trophy Sheep

The harvest of non-trophy sheep will not exceed 15 percent of the preseason population of yearlings plus ewes or 18 percent of the winter population of yearlings and ewes at proposed population levels. A non-trophy sheep is defined as "a female mountain sheep and includes a male mountain sheep under the age of one year." Where sheep populations exceed the population goals and population reduction is sought, the non-trophy sheep harvest may be increased to as high as 30 percent of the preseason ewe-and-yearling component.

3.3.3 Population Inventory

Bighorn sheep winter ranges will be surveyed, when appropriate survey conditions prevail, by rotary-wing aircraft during the December-March period and on the basis of SMAs.

Only those SMAs whose populations meet the following criteria will be surveyed:

i) the population is subject to trophy and/or non-trophy hunting,

ii) the population can be surveyed on fairly well-defined winter ranges and is not widely dispersed, and

iii) the winter population is larger than 20 animals.

For those SMAs meeting the above criteria, enough winter ranges

should be surveyed to account for approximately 80 percent of the total sheep population within each SMA, based on historic population information.

Winter ranges will be surveyed on a two-year rotational basis, so that annually a portion of the ranges in the north and south are surveyed (Table 11).

Because of the clumped distribution of bighorn sheep, aerial surveys must include entire winter ranges.

Any population that experiences a die-off should be surveyed several times during the year in which the die-off occurs, to determine the extent of mortality; thereafter, surveys should be done annually until winter lamb:ewe ratios reach acceptable levels.

3.3.4 Hunter Harvest and Effort

The sheep horn plugging and compulsory registration program for trophy sheep will be continued. All trophy sheep heads should be registered within 14 days of the close of the season or 30 days of being shot. All registration forms must be submitted to the Wildlife Management Division no later than December 31.

The total bighorn sheep harvest and hunter effort will be estimated annually through a voluntary hunter survey program.

3.3.5 Hunting Seasons

Trophy sheep hunting seasons for residents will normally open no earlier than August 25 and close on or before October 31; season openings in the southernmost SMAs (19-24) will normally open the day

Table 11. Timing of survey occurrence for provincial winter ranges of bighorn sheep in Alberta.

Region	Sheep Management Area	Wildlife Management Unit	Winter range
Year 1			
	2	445	Mt. Torrens
	3	444	Mt. Stearn
	4	442	Swift & Horn creeks
			The Triangle
			Monoghan
EASTERN SLOPES	6	440	Hayden Ridge
			Rocky Pass
- Edson			N. Berland
			Moon & Planet creeks
			Mumm & Collie creeks
	7	439	Solomon Creek
	8	438	Folding Mtn.
			Whitehorse Creek
	9	437	Redcap
	17	412	Blk. Rock Mtn.
			Orient Point
			End Mtn.
	19	410	Mt. Laurie
			Mt. Charles Stewart
	20	408	Wind Ridge
			Pigeon-McGillivray
EASTERN SLOPES			Ribbon Creek-Mt. Allan
			Evans-Thomas
- Calgary	21	406	Forget-Me-Not
			Mt. Burns
			Mt. Ware
			Sheep River
			Gibraltar Mtn.
			Mt. Head
	22	404	Mist Mtn.
			Cataract
			Plateau Mtn.
Year 2			
EASTERN SLOPES	11	434A	Wapiabi, George Creek
- Rocky	12	434B	Chungo-Blackstone
		432	Coral & Job creeks

Table 11. (concluded)

Region	Sheep Management Area	Wildlife Management Unit	Winter range
Year 2, continued			
		430	Front Range-Bighorn
EASTERN SLOPES		426B	Cline Point
	13	429	Ram Mtn.
- Rocky		428	Shunda Mtn.
	14	428	N. Ram
		426A	Whiterabbit
	15	418	Eagle-Bighorn
			Scalp Creek (East)
			Scalp Creek (West)
			Barrier Mtn.
	16	414	Burnt Timber
	23	402-306	South Livingstone
		402-308	North Livingstone
		402	Cabin Ridge
SOUTHERN	24	400	Prairie Bluff-Yarrow Ck.
		400	Table - Castle Mtn.
		400	Barnaby Ridge
		400-306	Crowsnest Pass

following Labour Day.

Wherever trophy sheep hunting seasons occur for non-residents, they will normally open one week after those for residents, and close on or before October 15.

Special trophy seasons (full curl) for residents during the rut will commence no earlier than November 1 and end no later than November 30.

Non-trophy sheep hunting will commence one week later than trophy sheep hunting, and close no later than October 31.

Archery-only seasons in WMU 410 for trophy and non-trophy sheep will commence no sooner than the day following Labour Day and close no later than November 30.

Non-trophy seasons will be closed in SMAs that experience die-offs; the closure will last for a minimum of five years.

3.3.6 Licensing

3.3.6.1 Resident Recreational Hunting

All trophy sheep will be hunted by residents with a general licence, except in WMU 410 and where special seasons are instituted (no restriction on number of licences available), until the annual resident and non-resident harvest of rams exceeds 300 animals (based on a provincial population of 6900 sheep) or resident hunter success declines below 5 percent for two consecutive years. Depending on the cause of reduced resident success, different steps will be taken to restore success rates to previous levels.

If the cause of the reduced success is a large increase in the number of resident hunters, consideration will be given to placing additional restrictions on the number of big game licences that a hunter

who purchases a trophy sheep licence can hold.

If the cause is a decline in sheep populations, consideration will be given to reducing the non-resident allotment. Those WMUs with the highest number of hunting days per ram for residents would receive initial consideration.

Additional options that could be considered to reduce the number of sheep hunters or increase the number of rams available to residents include the following:

--longer waiting periods for licence purchase for successful hunters;

--higher licence fees;

--limited-entry draw;

--limit on the number of trophy rams per hunter in a lifetime.

Non-trophy resident licences will be issued by means of a random selection process.

The number of special non-trophy sheep licences per WMU will be determined by the following formula:

$$\text{No. Permits} = \frac{\text{Harvest Rate (\%) x Winter ewe + yearling pop'n estimate}}{\text{Hunter Success Rate (\%) for that WMU}}$$

The harvest rate shall not exceed 18 percent unless a population reduction is sought. The success rate employed will be the average of the preceding five years.

3.3.6.2 Non-Resident Trophy Sheep Hunting

All non-resident/alien trophy sheep licences will be issued through specified trophy sheep outfitters.

All non-resident/alien hunters wishing to hunt bighorn sheep will be required to hunt with a licensed sheep outfitter.

The four-year waiting period for successful non-resident/alien trophy sheep hunters will be continued to provide optimum hunter opportunity for non-Albertans.

3.3.6.3 Collection

All scientific studies or collections of sheep for research will be authorized through a collection permit issued by the Fish and Wildlife Services.

To prevent injury to animals or excessive harassment, only persons experienced in bighorn sheep capture will be authorized to capture them.

3.3.7 Control of Unlicensed Harvest

Native harvest of trophy bighorn sheep should be monitored through the compulsory registration process.

Bighorn sheep herds should be protected from illegal harvest by closing motorized vehicle access to any sheep range where the animals are particularly vulnerable. Where this is impractical, road corridor sanctuaries may be established.

All trophy sheep heads will require a permanent identification plug, the number of which will be recorded on the registration form. This plug will discourage illegal traffic in ram heads.

Because of the importance of and the demand for trophy sheep, enforcement effort should be concentrated along major access routes and into occupied sheep range during September-October, and during the rut in November-December.

3.3.8 Habitat Management

Habitat protection should be secured for the 89 bighorn sheep wintering areas currently identified in the province. Industrial or recreational development or activities of any kind will not normally be permitted on winter ranges during the period of occupancy by bighorns.

A comprehensive examination of wintering areas in all regions will be carried out, and strategies developed for habitat improvement or stabilization in each wintering area.

All significant summer ranges, rutting areas, lambing grounds and mineral licks should be identified. Potentially disruptive human activities should not be permitted. Mitigative measures should be developed to prevent industrial or recreational disturbance when these areas are being used by sheep.

Reclamation of disturbed sites (e.g., roads, mine sites, and drilling sites for oil and gas) on sheep ranges should be mandatory.

Overcrowded sheep ranges or ranges that have diminished in quality as a result of forest encroachment will be upgraded through prescribed burning, slashing, and reseeding, as required.

Areas that exhibit persistent disease occurrence in bighorns will be assessed to determine the causative factors and identify remedial actions.

Unlawful grazing of domestic livestock on bighorn range will be reported to the appropriate agency for action.

The grazing of domestic sheep on public lands within 5 km of any occupied bighorn sheep range will be discouraged.

All currently unknown critical summer ranges, lambing grounds, rutting areas and mineral licks will be identified and prioritized for

protection according to the imminence of recreational and commercial use and threat of disturbance.

Access should be closed or alternate routes developed for hiking, trail riding, or vehicular access, where such activities will disrupt normal sheep use of critical summer or winter ranges.

Operating guidelines/regulations will be developed for industrial activity such as oil and gas development and seismic operations where these activities will affect sheep herds. Industrial activity should not be allowed within 1 km of lambing areas or winter ranges during the relevant seasons.

3.3.9 Extension

An educational program should be developed to inform those interested in the history, habitat requirements, and management of bighorn sheep.

3.3.10 Research

Research will be encouraged to do the following:

a) study the ecology of bighorn sheep;

b) determine the effects that recreationists have on bighorn sheep behavior and habitat use, so that potentially stressful situations can be prevented;

c) develop methods for assessing carrying capacities of major wintering ranges;

d) assess the effectiveness of habitat improvement techniques; and

e) determine the potential for disease transmission between domestic livestock and wild bighorns.

3.3.11 Population Monitoring

Incisor bars from hunter-harvested sheep should be analyzed for age determination at least every five years for sheep herds within each SMA. Herds should be sampled over at least a two-year period to ensure adequate samples.

4.0 MANAGEMENT PLAN APPLICATION

4.1 Provincial Summary

The provincial population of bighorn sheep (outside of national parks) is estimated (preseason 1989) to be about 5215 animals. Population increases are desirable in some areas, which would bring the provincial total to 6900. At that population level, most herds would be at the suspected carrying capacity of their respective ranges. Further research is required to better determine carrying capacity and assess whether population goals could be increased without risking the disease outbreaks that have plagued southern Alberta bighorns at high population densities.

Of the existing 5215 bighorns, approximately 500 are unavailable to recreational hunters in September and October because they spend the summer and autumn in the national parks and provincial wilderness areas. Many of these are mature rams that seek the protection afforded by these areas. Thus, the huntable population of sheep is approximately 4700 animals, of which about 380 would be 4/5-curl rams. With a special (full curl) season during November in selected SMAs an additional 30 full-curl rams could be made available to Alberta hunters (refer to Section 3.3.2.1).

The harvest of trophy rams under a general licence system has nearly reached the level of maximum annual production. If the demand for trophy sheep licences continues to increase, sheep hunters will have to be satisfied with lower success rates, or alternative methods of licence distribution will have to be employed. The 4/5-curl rule for rams should

be maintained to provide a trophy of high quality, although consideration should be given to 7/8-curl or even full-curl criteria, as the need arises. Non-trophy sheep hunting will continue to be provided as a supplementary benefit of a maximum sustained yield harvest of trophy animals.

If sheep hunting is to be maintained as a significant recreational activity, programs must be developed to protect and maintain sheep habitat, particularly winter ranges. Further, as the value of trophy rams increases and the sale of wildlife or parts of wildlife becomes legalized, strong legal deterrents and public education programs are necessary to curb the illegal killing of sheep. The monitoring of lungworm and pneumonia infections is relevant to the attainment of sheep population goals; monitoring infections can help in the determination of the quality of summer and winter ranges. Such monitoring may also be central to development of mitigative measures designed to spatially segregate bighorns and domestic sheep.

Nonconsumptive uses will be increasingly recognized in future allocations of bighorn resources. Hunting opportunities are likely to be lost in areas where recreational or industrial developments encroach on sheep ranges. In such cases, resource protection may be ensured through the provision of viewing opportunities. Public education programs are vitally important if habitats and populations are to be maintained.

Bighorn sheep range in Alberta is essentially administered by two different regions within the Fish and Wildlife Services. The Eastern Slopes Region (composed of the Edson, Rocky Mountain House and Calgary subregions) is responsible for the northern ranges (about 80 percent of Alberta's sheep habitat). The remaining 20 percent is administered by

the Southern Region.

4.2 Regional Perspective

4.2.1 Eastern Slopes

4.2.1.1 Edson Subregion

The Edson subregion includes the Willmore Wilderness Area, one of the few remaining wilderness areas where a top-quality hunting experience can be obtained for hunting of trophy sheep. The current (preseason 1989) sheep population in this subregion is 1485 animals; the harvest averages 69 trophy sheep and 35 non-trophy sheep. Currently (1989), 3560 recreation days are realized from sheep hunting. The goals for the year 2000 are a preseason population of 2255 sheep, harvests of 64 trophy sheep for residents, 19 trophy sheep for non-residents, and 159 non-trophy sheep for residents. Total recreation-days provided will be 9887.

Hunting pressure by licenced guides and outfitters will be directed toward this subregion (to the extent possible), because it is used less by residents in comparison to other sheep hunting areas. The Willmore Wilderness Park Act prohibits access by motorized vehicles and therefore lends itself to hunting by horseback or on foot, in a pristine setting, with less competition from other hunters or recreationists. Access into sheep range is difficult after October as a result of snow accumulations; late season hunting success is affected accordingly.

Many of the SMAs in this region are adjacent to national parks and the trophy harvest is greatly affected by seasonal movements of rams out of the parks during the hunting season. Availability of rams is thus

difficult to predict on an annual basis; there can be large variations in the annual harvest.

The southern portion of the Edson subregion (WMU 438) features open pit coal mining and quarry operations with associated access. The vulnerability of bighorn sheep to hunting is somewhat reduced by controlled access on leased lands. Reclamation of disturbed sites must be encouraged to maintain sheep population goals. Control of road access and habitat improvement on critical sheep ranges are management priorities.

4.2.1.2 Rocky Mountain House Subregion

Rocky Mountain House is the largest of the subregions with 12 WMUs in which recreational sheep hunting occurs. Currently there are 1860 sheep in this area; harvests average 83 rams and 70 non-trophy animals. Approximately 3580 recreation days are provided. The presence of adjacent national parks can have a great influence on the annual availability of trophy rams. A large proportion of this subregion is subject to the Nordegg-Red Deer River Integrated Resource Plan.

The goals for this region are 2260 bighorns (preseason in the year 2000) and an annual harvest of 73 rams for resident hunters, 18 rams for non-resident hunters, and 158 non-trophy animals (for residents). The recreation goal is to provide over 9700 hunting days annually. Non-resident/alien hunting will be directed toward the more remote areas of this subregion. Access in this subregion is plentiful because of the development of roads for forestry and gas and oil exploration. Some vehicular access into critical wildlife habitat has been curtailed through road closures. This practice, as well as designating access

routes, should be continued to ensure the security of all major sheep winter ranges and lambing areas. Habitat improvement programs such as burning and slashing should be established in this subregion, in order to promote survival of lambs; future logging programs may aid this objective. The harvest of trophy sheep should be closely monitored to ensure that all trophy rams are not removed from individual populations, because this would permit young rams to become active as breeders and increase natural mortality of younger rams.

Monitoring of disease in bighorns should be carried out in the area from the North Saskatchewan River to the southern boundary of the Rocky Mountain House subregion.

4.2.1.3 Calgary Subregion

This subregion receives a great deal of hunting pressure on sheep because of its proximity to Calgary; it likewise has high demand for nonconsumptive uses. Some of the best sheep range in the province lies here, because chinooks maintain forage availability on winter ranges. This results in better quality diets and longer growing seasons for sheep, which produce higher quality (larger) trophy rams at a younger age. Accordingly, this is one of the few areas of the province where a full-curl restriction could be implemented without significantly impacting trophy harvests. Such a restriction on rams may be required in the future, because of intense hunting pressure.

There are six SMAs within the Calgary subregion; the total population is 1295 bighorn sheep. Included is the Ghost River Wilderness Area (SMA 18), which contains an unhunted, overwintering population of about 110 sheep, which may provide adult rams for harvest in adjacent SMAs. Current harvests have averaged 57 rams and 73 non-trophy sheep, with 6500

hunting recreation-days expended in this subregion.

The population goal for the year 2000 (preseason) in the Calgary subregion is 1710 bighorn sheep; this will provide a trophy sheep harvest of 77 rams for residents, 4 rams for non-residents and 112 non-trophy sheep for residents. The projected amount of hunting that will be provided is 7115 recreation-days.

The Canmore bowhunting area (WMU 410) for trophy sheep is found within this subregion. This area provides unique opportunities for sheep hunting, and produces an annual harvest of about 10 rams. A three-month hunting season produces local trophies as well as a limited harvest, during the rut in early November, of large rams that venture out of Banff National Park and the Ghost River Wilderness Area. This bowhunting opportunity should be tempered with access restrictions to prevent landowner/hunter conflicts in the settled portions of the Canmore corridor. A special draw for bowhunters was implemented in 1990 to alleviate apparent conflicts with landowners. This draw applies only to the last four weeks of the season.

In this subregion, special emphasis should be placed on control of vehicular access, and prevention of sheep disturbance and direct habitat loss that arises from recreational activity and development and industrial activity. Of special concern is downhill ski development, and quarrying activity in the Canmore corridor. Winter range reclamation and mitigative measures should be enacted as required when displacement of sheep occurs because of construction, ski hill maintenance, and skiing activity. All access restrictions and habitat management will conform to the Kananaskis Country Integrated Resource Plan. Bighorn sheep habitat protection is important because of the high demand by other resource

users. The Sheep River Wildlife Sanctuary is heavily used for bighorn viewing. Disease control is also necessary; special attention is required for bighorn sheep range to be segregated from situations of cattle grazing or domestic sheep husbandry.

4.2.2 Southern Region

The Southern Region administers a small but important component of bighorn sheep range. This population has now largely recovered from an outbreak of bacterial pneumonia which reduced the herd by about 75 percent in 1982-1983. Currently, there are 575 bighorn sheep estimated for this region. The current annual harvest averages 22 rams and 13 non-trophy sheep, from 7690 days of recreational hunting.

The goal for the year 2000 is for a regional population of 675 sheep (preseason) and a harvest of 34 trophy and 47 non-trophy sheep (by residents only). Approximately 3503 recreation days will be provided.

Wintering areas in WMUs 400 and 402 provide excellent forage for bighorn sheep, resulting in large-horned rams. Good access and large numbers of hunters ensure that most available rams are being cropped as soon as they reach legal size (about 4 years of age). This reflects the high vulnerability of sheep in this region. A full-curl restriction could be considered for this region. Further, vehicle access control and ATV restrictions are essential to prevent disturbance of animals, erosion and illegal hunting.

Mineral and coal recovery, oil and gas development, and limited forestry cutting are potential industrial activities for which mitigative measures should be designed. Restrictions on cattle grazing or domestic sheep husbandry are required to reduce the possibility of disease

outbreak.

Non-residents/aliens will not be allowed to hunt in this region because of the high demand for trophy sheep by resident hunters.

5.0 LITERATURE CITED

Becklund, W.W., and C.M. Senger. 1967. Parasites of Ovis canadensis in Montana with a check list of the internal and external parasites of the Rocky Mountain bighorn sheep in North America. J. Parasitol. 53:157-165.

Buechner, H.K. 1960. The bighorn sheep in the United States, its past, present and future. Wildl. Monogr. 4:174 pp.

Cook, A. 1978. Aerial sheep survey of the Edson, Red Deer and Calgary regions using the revised winter range technique. Typewritten progress report in files of Alberta Fish and Wildlife Division, Edmonton, Alberta. 100 pp.

Cowan, I.McT. 1940. Distribution and variation in the native sheep of North America. Amer. Midl. Natur. 24:505-580.

_____, and V. Geist. 1971. The North American Wild Sheep. Pages 58-83 in North American Big Game. The Boone and Crockett Club, Pittsburgh, Pennsylvania.

Demarchi, R.A. 1976. Our mountain sheep, their present status and future prospects. B.C. Outdoors 32(6):36-39.

Festa-Bianchet, M. 1986a. Seasonal dispersion of overlapping mountain sheep ewe groups. J. Wildl. Manage. 50:325-330.

_____. 1986b. Site fidelity and seasonal range use by bighorn rams. Can. J. Zool. 64:2126-2132.

_____. 1987. Individual reproductive success of bighorn sheep ewes. Ph.D. thesis, Univ. of Calgary, Calgary, Alberta. 229 pp.

_____. 1991. Numbers of lungworm larvae in feces of bighorn sheep: yearly changes, influence of host sex, and effects on host survival. Can. J. Zool. 69:547-554.

_____, and J. Samson. 1984. Lamb survival in relationship to maternal Protostrongylus spp. L1 output in Rocky Mountain Bighorn Sheep. Bienn. Symp. North. Wild Sheep and Goat Council, 4:364-371.

Fish and Wildlife Division. 1982. Fish and Wildlife Policy for Alberta. Dept. of Energy and Natural Resources, Edmonton, Alberta. 24 pp.

Foreyt, W.J., and D.A. Jessup. 1982. Fatal pneumonia of bighorn sheep following association with domestic sheep. J. Wildl. Dis. 18:163-168.

Forsland, D. 1946-1950. Annual reports of Fish and Game Commissioner for fiscal years 1945-1950. Alberta Dept. of Lands and Mines (Forests), Edmonton, Alta. King's Printer, Edmonton, Alberta.

Geist, V. 1971. Mountain sheep - a study in behavior and evolution. Univ. Chicago Press. Chicago, Ill. 383 pp.

Gudmundson, L. 1988. Southern region bighorn sheep survey. Alberta Fish and Wildlife Division, Edmonton. 30 pp. (mimeo).

Heimer, W., S.M. Watson and T.C. Smith. 1984. Excess ram mortality in a heavily hunted Dall sheep population. Bienn. Symp. North. Wild Sheep and Goat Council, 4:425-432.

Hoefs, M. (ed). 1985. Wild Sheep: Distribution, abundance, management and conservation of the sheep of the world and closely related mountain ungulates. Northern Wild Sheep and Goat Council. Whitehorse, Yukon. 218 pp.

Hopwood, V.G. 1971. David Thompson's Travels in western North America, 1784-1812. MacMillan of Canada, Toronto. 342 pp.

Jacques, D.R. 1976. Winter alpine-subalpine wildlife habitat in southern Rocky Mountains. Environmental Sciences Centre, Kananaskis, Univ. of Calgary, Calgary, Alberta.

Jorgenson, J.T. and W.D. Wishart. 1982. Ram Mountain Bighorn Sheep Study Progress Report. Alta. Fish and Wildlife, Edmonton.

_____. 1985. Ram Mountain Bighorn Sheep progress report. Alta. Fish and Wildlife, Edmonton.

Millar, W.N. 1915. The big game of the Canadian Rockies. Conservation of fish, birds and game. Proceedings of Committee Meeting, Nov. 1-2, 1915. The Methodist Book and Publishing House, Toronto. pp. 1-0-124.

Nesbitt, W.H. and P.L. Wright, (eds.). 1981. Records of North American big game. The Boone and Crockett Club, Alexandria, Va. 409 pp.

Onderka, D.K., and W.D. Wishart. 1988. Experimental contact transmission of Pasteurella haemolytica from clinically normal domestic sheep causing pneumonia in Rocky Mountain bighorn sheep. J. Wildl. Dis. 24:663-667.

_____, S.A. Rawluk, and W.D. Wishart. 1988. Susceptibility of Rocky Mountain bighorn sheep and domestic sheep to pneumonia induced by bighorn and domestic livestock strains of Pasteurella haemolytica. Can. J. Vet. Res. 62:439-444.

Phillips, W., D. DePage and L. Ewanyk. 1977. A socioeconomic evaluation of the recreational use of fish and wildlife resources in Alberta with particular reference to the Athabasca oil sands area. Vol. IV. Nonconsumptive recreational use of fish and wildlife. 220 pp.

Schmidt, J.L., and D.L. Gilbert. (eds.). 1978. Big game of North America. Wildlife Management Institute. Stackpole Books, Harrisburg. 494 pp.

Seton, E.T. 1929. Lives of game animals. Vol. 3. Doubleday, Doran and Co. New York. 780 pp.

Stelfox, J.G. 1966. Bighorn and Rocky Mountain goat populations, reproductions, harvests and proposed 1966 season, June 22, 1966. Typewritten progress report in files of Alberta Fish and Wildlife Division, Edmonton, Alta. 49 pp.

_____. 1971. Bighorn sheep in the Canadian Rockies: A history 1800-1970. Can. Field-Nat. 85(2):101-122.

_____. 1976. Diseases and parasites of bighorn sheep in Canadian National Parks, 1966-1972. Can. Wildl. Ser. Rep. 132 pp.

Trefethen, J.B. (ed.). 1975. The wild sheep in modern North America. Boone and Crockett Club, The Winchester Press. New York. 302 pp.

Webb, R. 1959. Alberta's big game resources. Alberta Fish and Wildlife Division. Queen's Printer. Edmonton, Alberta. 31 pp.

Wishart, W.D. 1958. The bighorn sheep of the Sheep River valley. Unpub. M.S. thesis, Univ. of Alta., Edmonton, Alta. 66 pp.

_____. 1977. A Summary of Non-trophy sheep seasons 1966-77. Fish and Wildlife mimeo. report.

Woodgerd, W. 1964. Population dynamics of bighorn sheep on Wildhorse Island. J. Wildl. Manage. 28:381-391.

Appendix I. Hunting seasons and licence fees for trophy bighorn sheep in Alberta during 1964-1989.

Year	Hunting seasons: Residents[a] Season dates	Days Open	Areas open	Non-residents[a] Season dates	Days open	Areas open	Licence Fees[b] Resident	N.R./ N.R.A.[a]
1964	S1-031	53	F300, 302, 306-310, 326, 328, S400-444	same[c]	same	same	$ 7.50	$50/100
1965[d]	S1-030	52	F300, 302, 306-310, 326, 328, S400-444	same	same	same		
	S1-N13	64	S436,438	same	same	same		
1966[d]	S1-029	50	F300, 302, 306, 308, S400-410, 417, 418, 426	same	same	same		
	S1-N30	78	F326, 328, S412-416, 420-424, 428-444	same	same	same		
1967[d]	S1-031	52	F302, 306-310, 326-328, S400-444	same	same	same		$75/150
	N1-D2	+28	S412-424, 428, 430-434, 440-444	residents only				
	N10-D2	+19	S436-439	residents only				
1968[d]	A31-031	53	F302, 306, 308, S400-444, Big Game Zones 1 and 5	same	same	same		
	N1-N30	+26	S412-424, 430-434, 440	residents only				
	N7-N30	+21	S436-439	residents only				

Appendix I (cont'd)

	Hunting seasons						Licence Fees[b]	
	Residents[a]			Non-residents[a]				
Year	Season dates	Days Open	Areas open	Season dates	Days open	Areas open	Resident	N.R./ N.R.A.[a]
1969[e]	A30-N1	54	F302, 306, 308, S400-439, 441, 446	same	same	same	$ 7.50	$75/150
	A30-N1	64	S440, 442, 444, 445	same	same	same		
1970	A29-031	55	F302-308, 328, S400-408, 412-436, 438, 439, 441, 446	same	same	same	$10	$200
	A29-031	64	S440, 442, 444, 445	same	same	same		
	A29-D12	91	S410	same	same	same		
1971	A28-023	49	F302-308, 328, S400-408, S412, 436, 438, 439, 441, 446	same	same	same		
	A28-023	57	S440, 442, 444, 445	same	same	same		
	A28-D11	91	S410	same	same	same		
1972[f]	A26-028	55	F302-308, 328, S400-408, S412-436, 438, 439, 441, 446	same	same	S412, 418-422, 428, 430-436, 438, 439		
	A26-028	64	S440, 442, 444, 445	same	same	S440, 442, 445		
	A26-D9	91	S410	same	same	same		
1973	A24-027	56	F302-308, 328, S400-408, 412-422,426-430, 432-436, 438, 439, 441, 446	S1-020	43	S412-416, 420, 422, 426, 428, 430-434, 438, 439		

Appendix I (cont'd)

Year	Hunting seasons: Residents[a] Season dates	Days Open	Areas open	Non-residents[a] Season dates	Days open	Areas open	Licence Fees[b] Resident	N.R./ N.R.A.[a]
1973	A24-027	65	S440, 442, 444, 445	S1-020	50	S440, 442	$10	$200
	A24-01	83	S410	S1-020	43	same		
1974	A23-026	56	F302-308, 328, S400-408, 412-422, 426-430, 432-436 438, 439, 441, 446	A31-019	43	S412, 416, 420 422, 426, 428 430-436, 438, 439		
	A23-026	64	S440, 442, 444, 445	A31-019	50	S440, 442, 445		
	A23-N30	82	S410	A31-019	43	same		
1975	A22-N1	62	F302, 306, 308, 328, S410-422, 426, 428-430, 432-436, 438, 439, 441, 446	A29-018	44	S410, 412, 420, 422 422, 426, 428, 430-434, 438, 439		
	A22-N1	72	S440, 442, 444, 445	A29-018	51	S440, 442, 445		
1976	A20-030	62	F302, 306, 308, 328, S412-422, 426, 428-430, 432-436, 438, 439, 441, 446	A27-016	44	S416, 420, 422, 426, 428, 430-434, 438, 439		
	A20-030	72	S440, 442, 444, 445	A27-016	51	same		

Appendix I (cont'd)

	Hunting seasons							
	Residents[a]			Non-residents[a]			Licence Fees[b]	
Year	Season dates	Days Open	Areas open	Season dates	Days open	Areas open	Resident	N.R./ N.R.A.[a]
1976	A20-N30	88	S410	A27-N30	70	same	$10	$200
1977	A19-029	62	F302, 306, 308, 328, S412-422, 426, 428-430, 432-436, 438, 439, 441, 446	A26-015	44	S416, 420, 422, 426, 428, 430-434, 438 439		
	A19-029	72	S440, 442, 444, 445	A26-015	51	same		
	A19-N30	88	S410	A26-N30	70	same		
1978	A25-031	58	F302, 306, 308, 328, S400-408 412-422, 426, 428-430, 432-436 438, 439, 441, 446	S1-021	44	S416, 420, 422, 426, 428, 430-434, 438, 439		
	A25-031	68	S440, 442, 444, 445	S1-021	51	same		
	A25-N30	84	S410	S1-N30	70	same		
1979	A25-031	58	F302, 306, 308, 328, S400-408 412-422, 426, 428-430, 432-436, 438, 439, 441, 446	S1-020	43	S416, 420, 422, 426, 428, 430-434, 438, 439		
	A25-031	68	S440, 442, 444, 445	S1-020	50	same		
	A25-N30	84	S410	S1-N30	69	same		

Appendix I (cont'd)

Year	Hunting seasons						Licence Fees[b]	
	Residents[a]			Non-residents[a]				
	Season dates	Days Open	Areas open	Season dates	Days open	Areas open	Resident	N.R./ N.R.A.[a]
1980	A25-N1	60	F302, 306, 308, 328, S400, 402, 412-422, 426, 428-430, 432-436, 438, 439, 441, 446	S1-018	42	S416, 420, 422, 426 428, 430-434, 438 439	$10	$200
	A25-N1	69	S440, 442, 444, 445	S1-018	48	same		
	S3-N1	51	S404, 406, 408	residents only				
	S3-N29	76	S410	S10-N29	70	same		
1981	A24-031	60	F302, 306, 308, 328, S400-402, 412-422, 426, 428-430, 432-436, 438, 439, 441, 446	S1-017	41	S416, 420, 422, 426 428, 430-434, 438 439	$10	$125/ 250
	A24-031	69	S440, 442, 444, 445	S1-017	47	same		
	S2-031	52	S404, 406, 408	residents only				
	S2-N28	76	S410	S9-N28	70	same		
1982	A25-030	58	F328, S412-422, 426, 428-430, 432-436, 438, 439, 441, 446	S1-016	40	S414, 416, 420, 422, 428, 430-436, 438	$20	$200
	A25-030	67	S440, 442, 445	S1-016	46	same		
	S1-030	52	F302, 306, 308, S400-406, 408	residents only				
	S1-N27	76	S410	S8-N27	70	same		

Appendix I (cont'd)

Year	Hunting seasons: Residents[a] Season dates	Days Open	Areas open	Non-residents[a] Season dates	Days open	Areas open	Licence Fees[b] Resident	N.R./ N.R.A.[a]
1983	A24-029	58	F328, S412-422, 426, 428-430, 432-436, 438, 439	S1-015	39	S412-422, 426, 428 430, 432-436, 438, 439	$20	$125/250
	A24-029	67	S440, 442, 445	S1-015	45	same		
	S1-D3	75	S410	S7-D3	70	S410		
	S1-029	51	F302, 306, 308, S400-406, 408	residents only				
1984	A27-031	57	F328, S412-422, 426, 428-430, 432-436, 438, 439	S1-015	38	S412-422, 426, 428, 430, 432-436, 438, 439		
	A27-031	66	S440, 442, 445	S1-015	45	S440, 442, 445		
	S1-031	52	S400-406, 408	residents only				
	S1-D1	79	S410	S7-D1	74	S410		
1985	A26-031	58	F328, 326, S412-422, 426, 428-430, 432-436, 438	S1-015	38	S412-422, 426, 428, 430, 432-436, 438, 439	$20	$250
	A26-031	67	S440, 442, 445	S1-015	45	S440, 442, 445		
	S3-031	60	S400-406, 408, F302, 306, 308	residents only				
	S3-N30	86	S410	S9-N30	81	S410		

Appendix I (cont'd)

Year	Hunting seasons						Licence Fees[b]	
	Residents[a]			Non-residents[a]				
	Season dates	Days Open	Areas open	Season dates	Days open	Areas open	Resident	N.R./ N.R.A.[a]
1986	A26-031	58	316, 318, 326, 328, 412-422, 426-436, 438-439, 441, 444, 446 446	S1-015	39	316, 318, 412-422, 426-439, 441, 444,	$20	$250
	A26-031	67	440, 442, 445	S1-015	45	same		
	S2-031	52	302, 306, 308, 400-406, 408	residents only				
1987	A26-031	58	316, 318, 326, 328, 412-422, 426-436, 438-439, 441, 444, 446	S1-015	38	316, 318, 412-422 426-436, 438, 439 441, 444, 446	$40	$275
	A26-031	67	440, 442, 445	S1-015	45	same		
	S8-031	47	302, 306, 308, 400-406, 408	residents only				
1988	A26-029	56	326, 328, 412-422, 426-436, 438-439, 441, 444, 446	S1-015	38	412-422, 426, 436, 438, 439, 441, 444, 446		
	A26-029	65	440, 442, 445	S1-015	45	same		
	S6-029	46	302, 306, 308, 400-406, 408	residents only				

Appendix I (concluded)

Year	Hunting seasons: Residents[a] Season dates	Days Open	Areas open	Non-residents[a] Season dates	Days open	Areas open	Licence Fees[b] Resident	N.R./ N.R.A.[a]
1989	A26-028	55	326, 328, 412-434, 436-439, 441, 444, 446	S1-014	38	same	$40	$275
	A26-028	64	440, 442, 445	S1-014	44	same		
	S5-028	47	404, 406, 408	residents only				

[a]A "resident" is a person who makes his home and is ordinarily present in Alberta and is either a Canadian citizen or has resided in Canada for the previous 12 months.
A "non-resident" is a person who does not live in Alberta, but is and has been living in Canada for the previous 12 months (acronym is N.R.).
A "non-resident alien" is a person who is neither a resident nor a non-resident (acronymn is N.R.A.).

[b]From 1964 to 1969 a Non-Resident Big Game Licence permitted a non-resident to harvest one trophy sheep, one antlered animal and one black bear. Separate trophy sheep licences were issued from 1970 on.

[c]Same indicates there is no difference between resident and non-resident for season dates, days open to hunting or areas open to hunting.

[d]The 1965 and 1966 extended hunting seasons were available to both residents and non-residents. In 1967 and 1968, extended seasons were for residents only.

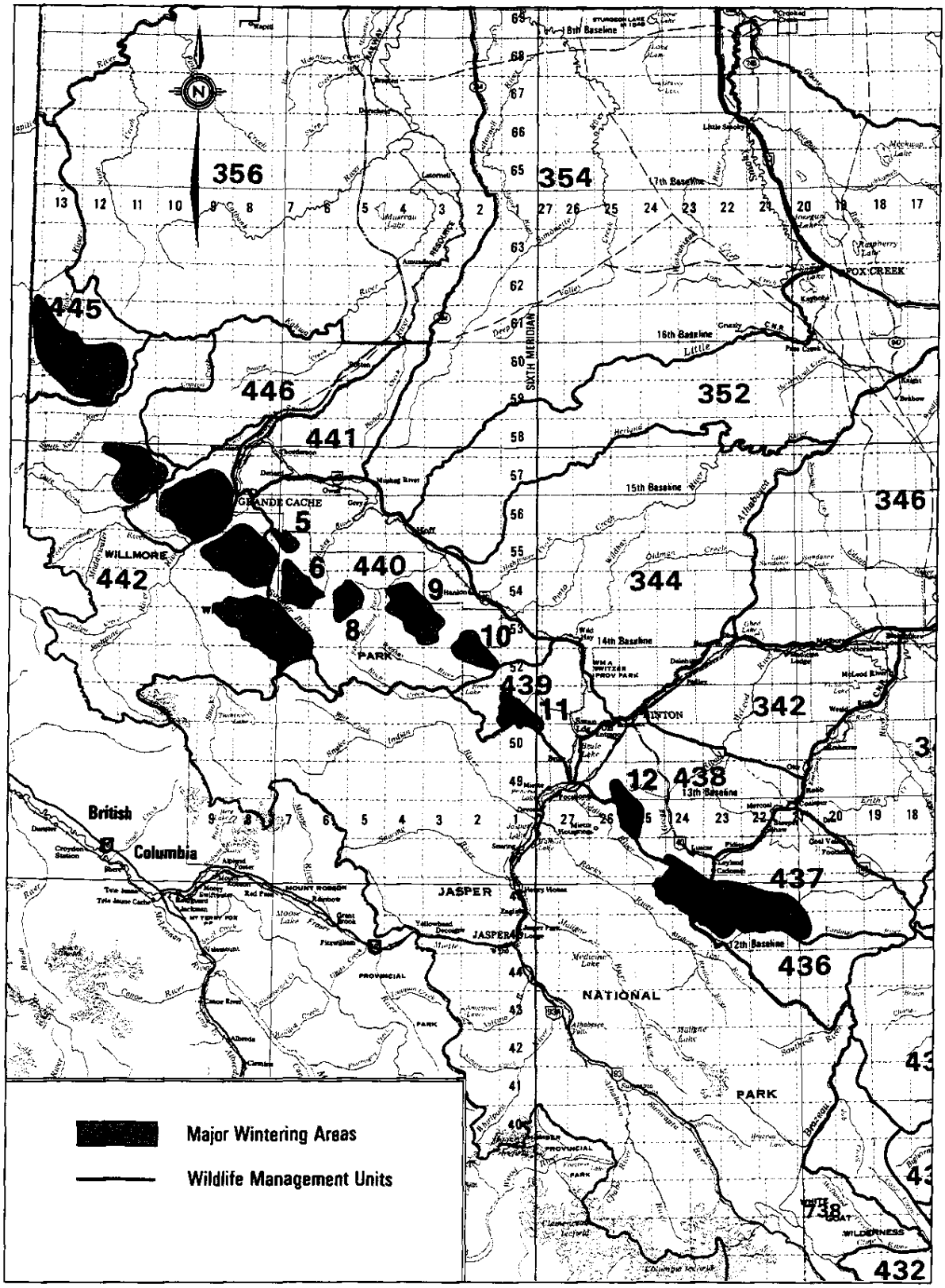
[e]Sunday hunting introduced.

[f]Non-resident hunting restricted to a draw system.

Appendix II. Major wintering areas for bighorns in the regions of Edson, Rocky Mountain House, Calgary and Lethbridge.

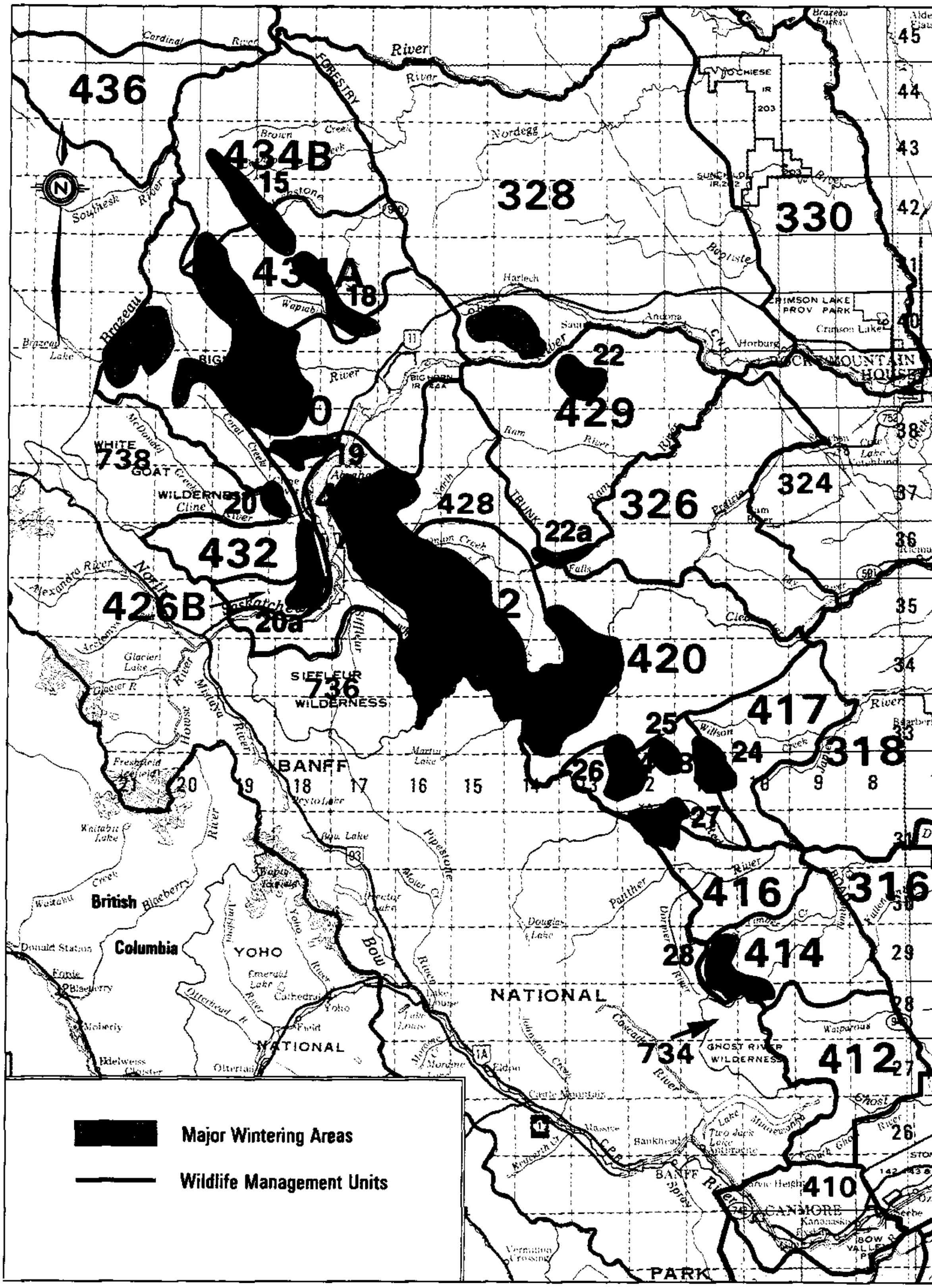
Appendix II-A. Major wintering areas for bighorns in the Edson region of Alberta, 1984.

1. Mount Torrens
2. Swift and Horn creeks
3. Mount Stearn
4. The Triangle (local name)
5. Hayden Ridge
6. Rocky Pass
7. Monoghan
8. North Berland
9. Moon and Plant creeks
10. Mumm and Collie creeks
11. Solomon Creek
12. Folding Mountain
13. Whitehorse Creek
14. Redcap Complex


356
354
445
446
352
441
346
5
6
440
9
442
344
8
10
439
11
342
12
438
437
436
JASPER
NATIONAL
PARK
FOX CREEK
GRANDE CACHE
WILLMORE
SIXTH MERIDIAN
British
Columbia
Major Wintering Areas
Wildlife Management Units

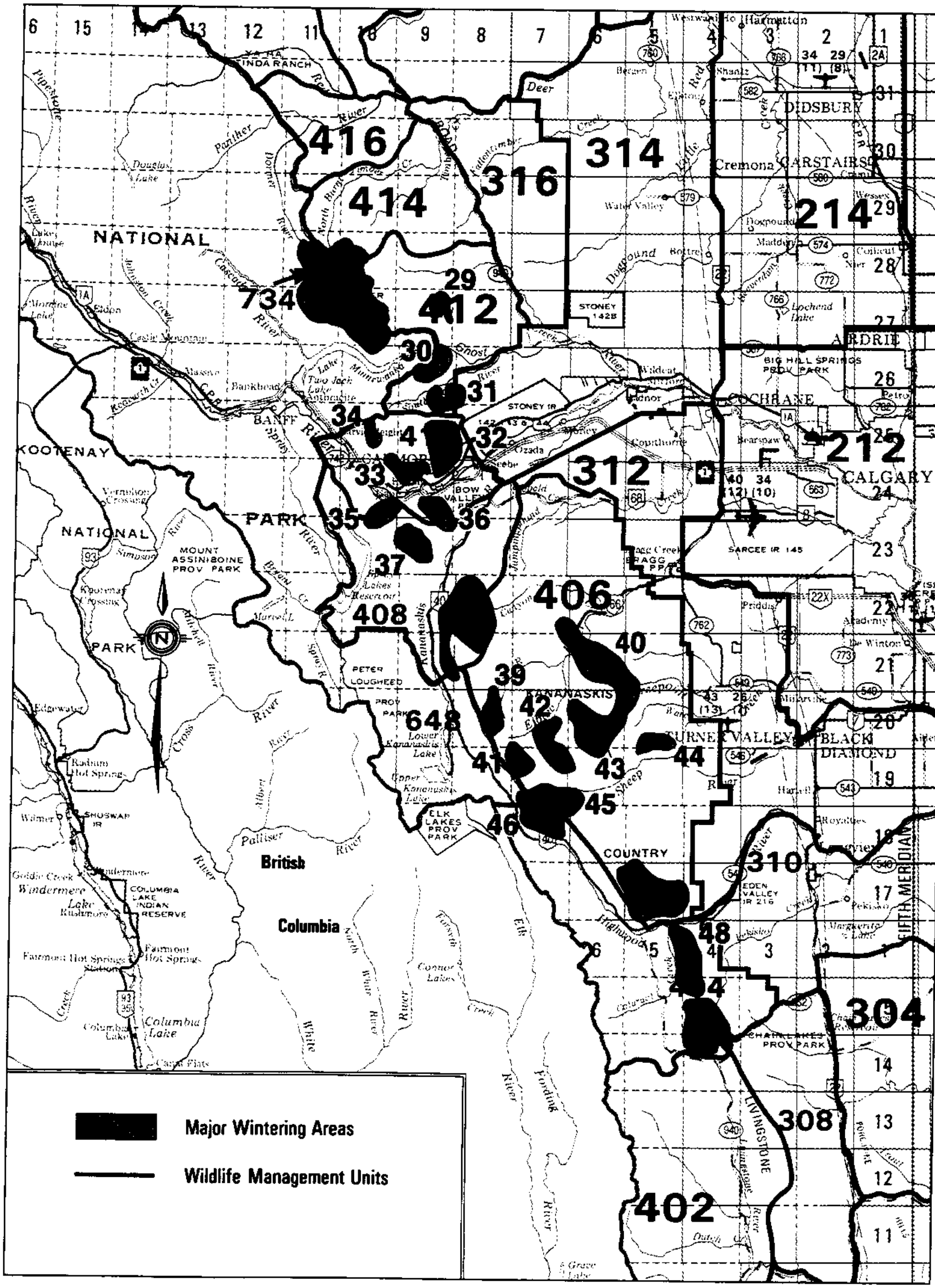
Appendix II-B. Major wintering areas for bighorns in the Rocky Mountain House region of Alberta, 1984.

15. Chungo-Blackstone
16. Front Range, Bighorn
17. Coral and Job creeks
18. Wapiabi (south tip)
19. Windy Point
20. Cline Point
20a. Whirlpool Point
21. Shunda Mountain
22. Ram Mountain
22a. Ram Falls
23. Whiterabbit-Ram-Clearwater
24. Eagle-Bighorn
25. Scalp Creek (East)
26. Scalp Creek (West)
27. Barrier Mountain
28. Burnt Timber


Major Wintering Areas
Wildlife Management Units
436
434B
434A
328
330
429
428
326
324
432
426B
420
417
318
416
316
414
412
410
738
736
734
22
22a
15
18
19
20
20a
24
25
26
27
28
WHITE GOAT WILDERNESS
SIFFLEUR WILDERNESS
GHOST RIVER WILDERNESS
BANFF
NATIONAL
PARK
YOHO
British
Columbia
CANMORE
Nordegg
Harlech
Horburg
CRIMSON LAKE PROV PARK
Brazeau Lake
Southesk River
River
Cline River
Alexandra River
Glacier Lake
Mistaya River
Bow River
Pipestone
Panther
Ghost River
Lake Minnewanka
Cascade River
Lake Louise
Moraine Lake
Emerald Lake
Hector Lake
Douglas Lake
Castle Mountain
Bankhead
Eldon
Field
Cathedral
Otterhead R.
Donald Station
Golden
Moberly
Blaeberry
Vermilion Crossing

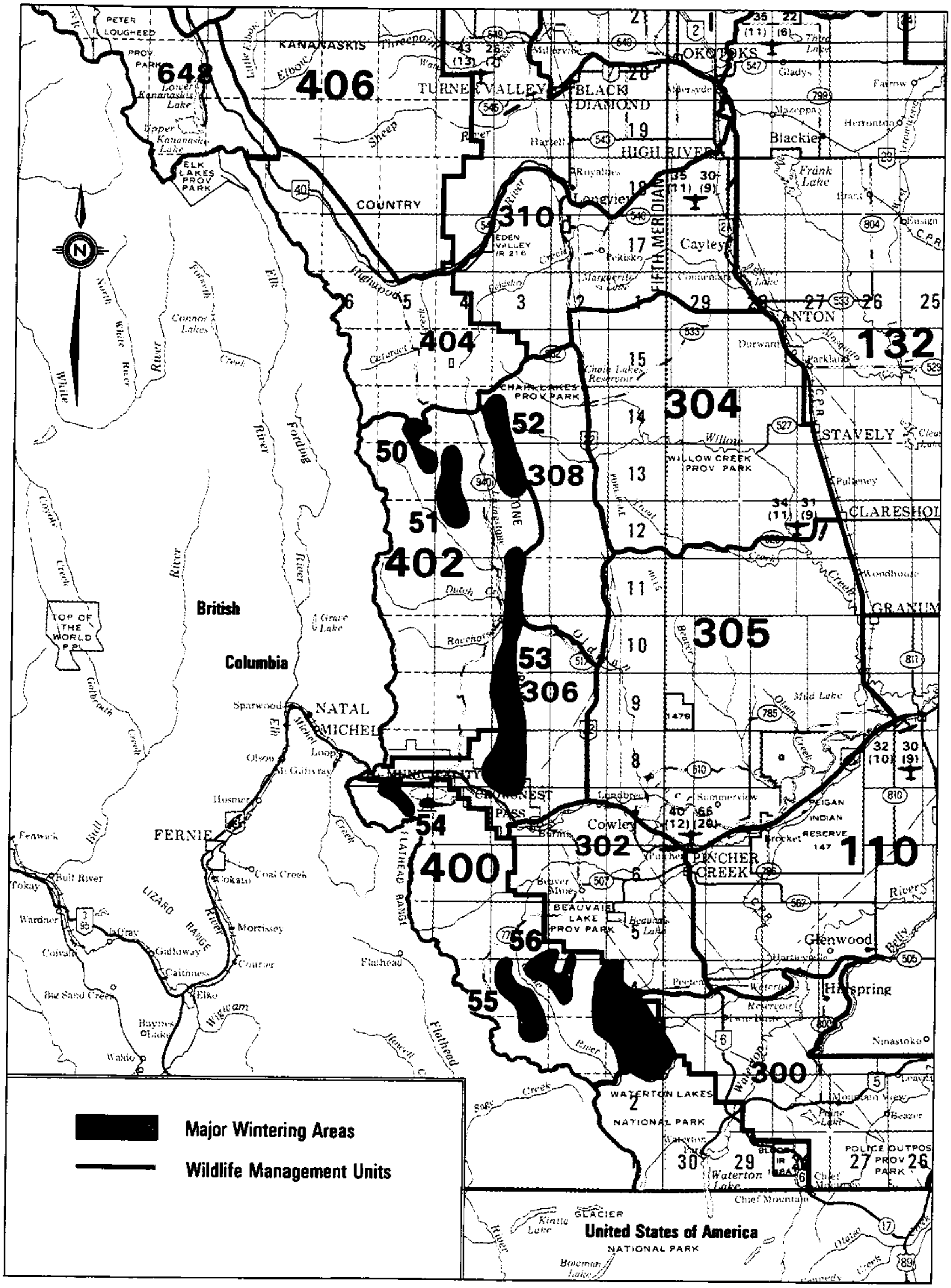
Appendix II-C. Major wintering areas for bighorns in the Calgary region of Alberta, 1989.

29. Black Rock Mountain
29a. Ghost River Wilderness
30. Orient Pt.
31. End Mountain
32. Mt. Laurie
33. Grotto Mountain
34. Mt. Charles Stewart
35. Three Sisters-Wind Ridge
36. Pigeon Mountain-McGillivray
37. Ribbon Creek-Mt. Allan
38. Evans-Thomas Creek
39. Little Elbow River
40. Forgetmenot Mountain
41. Mt. Rae
42. Mt. Burns
43. Mt. Ware-Mt. Rose
44. Sheep River
45. Gilbraltar Mountain
46. Mist Mountain
47. Mt. Head
48. Cataract Creek
49. Plateau Mountain


Major Wintering Areas
Wildlife Management Units
416
414
316
314
214
412
312
212
406
408
648
310
304
308
402
734
NATIONAL
PARK
KOOTENAY
British
Columbia
CALGARY
COCHRANE
AIRDRIE
DIDSBURY
CARSTAIRS
BLACK DIAMOND
TURNER VALLEY
KANANASKIS
COUNTRY
FIFTH MERIDIAN

Appendix II - D. Major wintering areas for bighorns in the Lethbridge region of Alberta, 1989.

50. Pasque Mountain
51. Cabin Ridge
52. North Livingstone
53. South Livingstone
54. Crowsnest Pass
55. Barnaby Ridge
56. Table Mountain-Castle Mtn.
57. Prairie Bluff-Yarrow Ck.


Major Wintering Areas
Wildlife Management Units
British Columbia
United States of America
648
406
310
404
402
304
305
308
306
302
300
400
110
132
50
51
52
53
54
55
56
KANANASKIS
COUNTRY
TURNER VALLEY
BLACK DIAMOND
HIGH RIVER
OKOTOKS
STAVELY
CLARESHOLM
PINCHER CREEK
Cowley
Glenwood
FERNIE
NATAL
MICHEL
WATERTON LAKES NATIONAL PARK
GLACIER NATIONAL PARK
FIFTH MERIDIAN
ELK LAKES PROV PARK
CHAIN LAKES PROV PARK
WILLOW CREEK PROV PARK
BEAUVAIS LAKE PROV PARK
PEIGAN INDIAN RESERVE 147
TOP OF THE WORLD P.P.