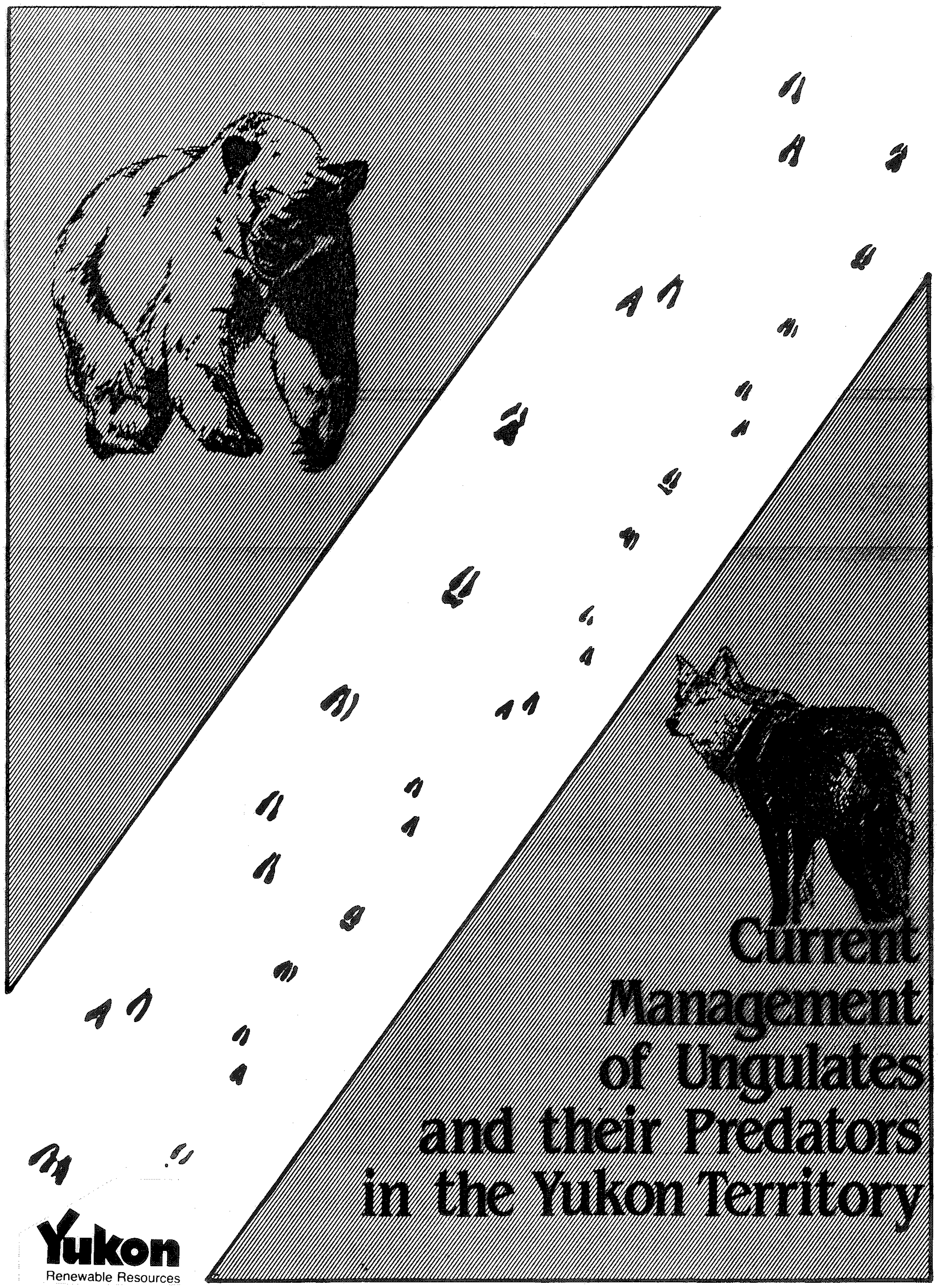


Current Management of Ungulates and their Predators in the Yukon Territory

Yukon
Renewable Resources

This report is not an exhaustive treatment or presentation of data, but is intended to give an overview of ongoing wildlife studies and management. As such, it contains many preliminary conclusions. Persons are free to use material in this report for educational or informational purposes, but tentative conclusions should be quoted as such. Persons intending to use this material in scientific publications should obtain prior permission from the Department of Renewable Resources. Due credit would be appreciated when material is used.

March 1984

Copies of this report may be obtained from:

Yukon Department of Renewable Resources
Wildlife Management Branch
P.O. Box 2703
Whitehorse, Yukon
Y1A 2C6

March 1984

Copies of this report may be obtained from:

Yukon Department of Renewable Resources
Wildlife Management Branch
P.O. Box 2703
Whitehorse, Yukon
Y1A 2C6

TABLE OF CONTENTS

Table of Contents (continued)

Page

SUMMARY

1. Recent studies have led to a new understanding of predator-ungulate relationships, particularly involving wolves and their prey. It appears that even in natural systems wolves and their prey fluctuate widely in numbers. When prey such as moose or caribou begin to decline, regardless of the season, the impact of predation increases rather than decreases. If the decline continues beyond a certain threshold, predation alone can continue the decline, primarily by preventing survival of young animals to adulthood. Recovery of the prey population occurs only after predators finally decline from lack of food.

2. Hunting by humans can play a role in these declines primarily by killing adults, thus lowering the ratio of prey to predators and increasing the impact of predation.

3. Reducing the number of predators to create a more favourable prey:predator ratio is an effective means of preventing or reversing a predator-maintained decline in a prey population.

4. Most southern Yukon moose populations are declining. The initial causes of the decline are not clear, but at present predation and hunting are keeping these populations depressed. In some populations predation alone is probably sufficient to cause continued declines. Bears and wolves are the primary predators involved. Bears are most significant as predators of very young calves, while wolves are killing calves and adults throughout the year.

5. An experimental program is underway to evaluate the response of moose populations to various combinations of wolf removal and bear removal. Moose hunting also is restricted to speed recovery of the populations.

6. The Finlayson Lake Caribou Herd has declined since at least 1977. Again the initial causes are not clear, but predation and hunting are suspected to be the present reasons. Wolves appear to be the primary predators. To halt the decline, half of the wolves in the herd's range were removed by trapping and aerial shooting in late winter 1982-83, sport hunting was restricted, and native hunters were requested to reduce their harvest. Calf survival has increased since wolves were reduced, and it appears that hunting pressure is lower.

7. The areas slated for predator removals comprise only a few percent of the entire Yukon and the number of wolves and bears to be removed are about 5% and 1%, respectively, of Territory-wide

populations. About 30% of all moose hunting effort and harvest by Yukon residents occurs in these areas. Therefore we feel that managing predators in this restricted area is justified to increase moose populations to a level that can at least sustain recent harvests.

INTRODUCTION

Predator control is seen in a new light by professional biologists today. Predator "management" is a term which more accurately reflects the high value which we now place on maintaining viable predator populations.

Nevertheless, "management" of predators when they compete with man for big game animals, such as moose and caribou, usually involves periodically killing some of the predators in a population.

This kind of reduction in numbers of predators continues to be the source of a tremendous biological and moral controversy, and there are factions on both sides which will use any information, misinformation or even myth, which supports their cause.

This report outlines the evolution of our new understanding about northern predator-ungulate relationships and how this has changed the wildlife manager's approach towards predators in trying to sustain huntable populations of wild ungulates.

Also presented are the biological facts which provide the basis for two predator control programs being undertaken by the Yukon Government.

Thanks are extended to the State of Alaska, Department of Fish and Game, for permission to exerpt portions of the section "Management Implications of Predator Prey Relationships" from their Wildlife Technical Bulletin No. 6, "Wolf-Prey Relationships in Interior Alaska" by W. Gassaway, R. Stephenson and J. Davis.

The Changing Image of the Predator

The maintenance of a healthy environment and its component wildlife resources is a concern that is shared and voiced by an increasing number of people. As part of this, there has been a great shift in public attitudes towards large predators. In North America, predators of ungulates were long considered undesirable competitors and vermin, largely based on the image of the wolf and other large carnivores as wanton killers with an insatiable appetite for domestic livestock.

Wolves, in particular, were the subject of widespread government sponsored reduction efforts during the 50's, 60's and even early 70's. Wolf control programs commonly employed bounties, poison-baiting, trapping, den raiding, aerial shooting, and generally unrestricted hunting methods and seasons. The effects of these programs on wolves and ungulate populations were largely unknown.

The emergence in the public eye of the predator, particularly the wolf, as a prudent culler of old, sick and unfit prey, as an intriguing social animal, and as a symbol of unspoiled wilderness, led to the cessation of indiscriminate killing, implementation of predator harvest restrictions, and even total protection in some areas.

Thus the pendulum of public and professional opinion swung from extreme antipredator feelings to intense protectionism as the "balance of nature" concept gained wide acceptance. Predation was seen as a simple but sensitive feedback system wherein predators selectively removed unfit individuals which were doomed to die in any case. Predators helped maintain stable numbers of prey by consuming more as prey populations increased and less as prey decreased. It was assumed that if prey did decline, predators would soon follow suit, or simply switch to other prey species.

Now the pendulum is swinging back to the middle. Recent long-term studies have shown that wolves are neither "all bad", as was thought prior to and during the 50's, nor "all good", as proposed in the 60's regarding their effects on prey. It is now clear that wide oscillations in both predator and prey numbers typically occur in many northern predator-prey systems, and that predators such as wolves are often not prudent during prey declines. Wolves are such effective predators that when prey decline for any reason, the rate at which wolves prey on them does not decline accordingly as was previously thought. The result is that the impact of wolves on prey actually increases.

If prey decline enough, the impact of predation can become so great that predation alone will cause continued declines until the wolves themselves finally decline from lack of food. Wolves and other predators tend to kill prey that are easiest to catch; this includes not only old, weak and sick prey, but also healthy young which would survive to adulthood in the absence of predation. Also, wolves will kill healthy adult ungulates if there aren't enough old, sick and very young to go around, or if all individuals are made vulnerable by winter snow conditions or some other circumstance.

Whenever man is one of several predators in such a system, he must accept (1) the likelihood of large natural fluctuations in both prey and other predators, and (2) that the establishment and maintenance of a relatively high but stable number of prey, with an annual surplus for his use, may be impossible without some control of these other predators.

MANAGEMENT IMPLICATIONS OF PREDATOR-PREY RELATIONSHIPS

The last decade has seen a substantial increase in our understanding of predator-prey relationships as a result of many excellent studies in North America. This insight will continue to influence the way the Yukon Department of Renewable Resources manages moose, caribou, wolves, and bears.

Predations Obscuring the Relationship Between Ungulates and Food

Calf production, calf survival, and age structure in the population were previously thought to be good indicators of the relationship between an ungulate population and its food resources. That is, an abundance of calves and young adults was viewed as a reliable indication of a population with plenty of food. Conversely, when few calves were present and a population included many old animals, it was thought that the population was facing food shortages. These relationships often hold when few predators are present but are unreliable when predators are abundant. We now recognize that predation on calves can obscure the true relationship beween ungulates and their food supply.

Misjudging the relationship beween ungulates and food in areas where wolves and/or bears are common has resulted in inappropriate management of ungulates and predators in some jurisdictions. In a number of situations, insufficient food and the lingering effects of severe winter weather were thought to be causing low production and survival when, in fact, the birth rate was near maximum and predation was lowering survival. To supposedly improve nutrition, game managers encouraged the reduction of ungulate densities. This action increased the effect of predation and further lowered survival. Much of the confusion caused by such situations has dissipated as a result of recent predator-prey studies.

Controls on Ungulate Population Size

It has become apparent that mortality of moose and caribou from predation, hunting, and severe winters is often largely additive. That is, the number of animals dying from one cause does not affect the number dying from other causes. This type of mortality contrasts with compensatory mortality, where an increase in the number of animals dying from one cause will reduce the number dying from other causes. An example of compensatory mortality is a starving moose being killed by wolves - if the moose would have died of starvation otherwise. A healthy moose calf being killed by wolves or a grizzly bear is not compensatory because the calf probably would have survived to adulthood. Likewise, a healthy 3 year old bull moose shot by a hunter would not be considered doomed to die for any other reason had the hunter not killed it. Additive mortality directly affects the rate of population increase or decline and, thus, controls population size. Predation sometimes results in a special form of control (called antiregulatory control) in which the effect of predation decreases as a prey population grows and increases when a prey population declines. This is very important because, if the effect of predation increases as a population declines, the prey population is headed toward a very low density and perhaps local extinction.

Predation by wolves has been shown to sustain declines in deer in Minnesota, moose on Isle Royale, and moose, caribou, and deer in Alaska. In each case, prey declines occurred as a result of a combination of factors (for example, deep snow, hunting, predation, and overuse of food by a high-density prey population). Wolf predation alone did not appear to limit growth of these populations prior to or during the initial phase of the declines. However, wolves increasingly controlled prey numbers because rapid declines in numbers or prey coincided with very slow declines or even increases in numbers of wolves. Prey reached relatively low densities because wolves exerted sufficient control to sustain the declines. In one area in Minnesota deer were temporarily eliminated by wolves. The conclusion is that declines in prey initiated by many causes may be maintained exclusively by wolf predation.

Response of Wolves to Declining Prey

Current information indicates no sensitive, fast-acting feedback process exists that regulates numbers of wolves relative to declining prey. Feedback is a process where a change in prey numbers or vulnerability affects the size of the wolf population or its rate of predation. For example, if a fast-acting feedback process existed, a decline in a moose population would result in a decline in the predation rate of wolves through lowered pup production or survival, thereby allowing the moose population to increase. The problem is that a notable lag-time exists before wolves begin to decline. The examples in which wolves have prolonged the declines of deer, caribou, or moose until prey reached low densitites, or were locally eliminated, demonstrate the ineffectiveness and slow-acting nature of the feedback system.

From the standpoint of the wildlife manager, only feedback mechanisms that rapidly reduce the impact of predation on declining ungulate populations are effective in maintaining harvestable numbers of prey. Since wolf populations do not always respond quickly, man's intervention through wolf control can be beneficial in maintaining moose or caribou populations adequate to sustain a desired level of harvest by humans.

The "balance of nature" concept is firmly established in the public's mind and also has underlain the thinking of many biologists. The balanced predator-prey system envisioned is one that generally remains near an equilibrium level through fast-acting feedback mechanisms. The result of the delayed feedback process is that predation can sometimes cause prey populations to fluctuate widely. Therefore, the "balance of nature" concept does not accurately describe some simple predator-prey systems. Instead, it is important to recognize that large fluctuations in predator and prey numbers occur naturally, and that reductions in harvest by man will not automatically allow prey to increase because of the dominant influence of predation.

Recovery of Moose Population from Control by Wolves

Ungulates have coexisted with predators for millenia, apparently with infrequent elimination over large areas and occasionally with rapid growth in the presence of naturally regulated predator populations. Therefore, natural mechanisms exist that allow moose, caribou, and deer populations, brought to low densitites by predation, to eventually escape control by predators. However, if under pristine conditions the escape and subsequent increase of prey is infrequent and short-lived (as suggested by prominant biologists such as A. Bergerud, D. Pimlott, and L. Keith), then wildlife managers, and users of wildlife are faced with a serious dilemma. In the Yukon few pristine ecosystems remain, but some areas have wolf, bear, and ungulate populations which are largely controlled by natural events. Both predator and prey populations are harvested to varying degrees by man in these areas; however, harvest of wild predators by man is usually insufficient to substantially reduce the impact of predation on the ungulate prey. Thus, it is virtually impossible to maintain moderate or high densities of ungulates for extended periods without some form of periodic predator reductions.

When predation is the primary factor controlling an ungulate population, a wildlife manager is left with two choices. He can either wait for a natural recovery of prey while reducing man's harvest or control the numbers of predators while reducing man's harvest. Given the apparent rarity of natural recoveries, artificial control of predators is most practical. Wolf control, for example, can involve an intensive effort to kill a certain number of wolves during a limited period, less intensive recreational and commercial trapping and hunting, or a combination of these methods. We view the second approach as preferable, if circumstances allow for it.

Improvements in Management of Predator-Prey Relationships

Wildlife biologists are becoming more skilled at accurately estimating the numbers of moose, caribou, wolves and bears. Knowing the numbers of each species and having estimates of the number killed has improved our ability to predict the status or health of moose and caribou populations.

Knowledge of the numerical relationship between predators and their prey provides a useful indication of the effects of predation. For example, 3 general types of moose-wolf relationships can be described based on studies where moose were the wolf's primary prey and wolf was the primary predator (Figure 1). First, at ratios of less than 20 moose:wolf, predation appears to cause a decline in moose numbers. Second, at a level of 20-30 moose: wolf, predation can be a primary force controlling numbers of moose; whether a moose population remains stable or declines is largely dependent on the combined effect of other factors influencing the moose population, including hunting, food supply, and winter severity. Third, at ratios greater than 30 moose:wolf, moose populations may remain stable or increase if food is adequate and if other sources of mortality are minor. These guidelines can assist wildlife managers in making initial assessments of moose-wolf relationships, when the results of long and expensive studies are not available.

If some ungulate other than moose is the primary prey in an ungulate-wolf system, or if there are a number of ungulate prey species available, the total prey biomass per wolf can be used as an index of the importance of predation to ungulate population dynamics. At less than 11,000 kg of prey per wolf, predation is likely the factor limiting ungulate population growth. The exact influence on each ungulate species would depend on the extent to which wolves prey on it relative to others.

Where 2 or more different kinds of predators prey heavily on moose, moose:wolf ratios will still indicate the potential importance of wolf predation on moose if other predators were absent, but not necessarily the existing amount of wolf predation. However, the total impact of predation on the moose population will be greater and the expected moose population trend will not conform to the above guidelines. For example, the management of wolves and the desirable ratio of moose:wolf will be altered when 1 or 2 species of bears are major competitors with wolves for moose. If total predation is high enough to maintain a moose population decline such that minimum population or harvest goals cannot be met, then it is necessary to reduce predation. Because wolves have a higher reproductive rate than bears and also repopulate habitat more rapidly, they are considered to be more manageable. As a result, the effects of predation are usually adjusted by altering wolf numbers. Where grizzly bears are abundant, the number of moose per wolf will probably have to be relatively high, perhaps between 50/1 and 100/1 because of the added effects of bear predation. In parts of the Yukon where bears are effective predators on moose calves, it is possible that wolf control alone might not cause the desired increase in moose numbers.

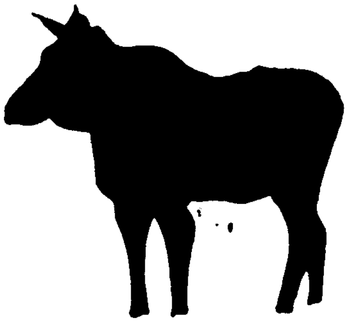
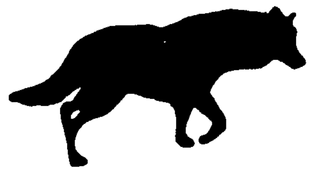
 Number of moose	 Number of wolves	Probable trend in moose population
Greater than 30	:1	Increase or Stable
20 ~ 30	:1	Stable or Decline
Less than 20	:1	Decline
In Whitehorse South; 8 ~ 12	:1	Decline

Figure 1. In combination with other evidence, moose:wolf ratios can be useful in deciding the impact of predation on a moose population.

Current Predator Management Programs in the Yukon

Our knowledge of Yukon wildlife populations has been increasing rapidly in recent years. In two cases, Southern Yukon moose and the Finlayson Lake Caribou herd, we are now aware of declines occurring in populations which have traditionally been important to hunters. Predator reductions have been chosen as part of the solution to reverse the declines in both cases. In this section we outline the background to both problems and our rationale in deciding the best course of action.

Southern Yukon Moose - In Decline

A. Status of Populations

In 1981, six priority moose management areas were identified in the Yukon. These were areas with heavily hunted moose populations, generally in the vicinity of major population centres. A moose inventory was initiated with highest priority given to those areas subject to the greatest hunting pressure. The objective of the program was to collect information on moose density, distribution and age and sex composition which could be used to assess the overall status of the populations and the impact of hunting.

Since 1981, aerial moose surveys have been carried out in two of these priority areas (Figure 2), using advanced block sampling techniques developed in Alaska. Surveys are conducted in the late fall after the hunting season, when bulls still carry antlers and most animals are in highly visible post rut aggregations.

The results of these surveys indicate that southern Yukon moose populations are not faring well (Figure 3). Declines have occurred since 1981 in 3 of 4 populations for which there are at least 2 years' estimates of population size. In the Haines Junction and Carcross areas there has been a 40% decline, and in the Kluane area west of Aishihik Lake, a 60% decline; only in Whitehorse South has the population been holding its own in the past three years.

What has caused the declines? If we visualize a moose population as comprised of only adults (i.e. animals at least two years old in November), then additions to the population are in the form of young moose which are born and survive to adulthood (this is called "recruitment"), and losses are adult moose dying. Since additions and losses occur every year, the population is bound to fluctuate unless these exactly balance. A decline results when more adults are dying than are being replaced by young animals entering the adult population. This can be due to either excessive numbers of adults dying, such that even if most young

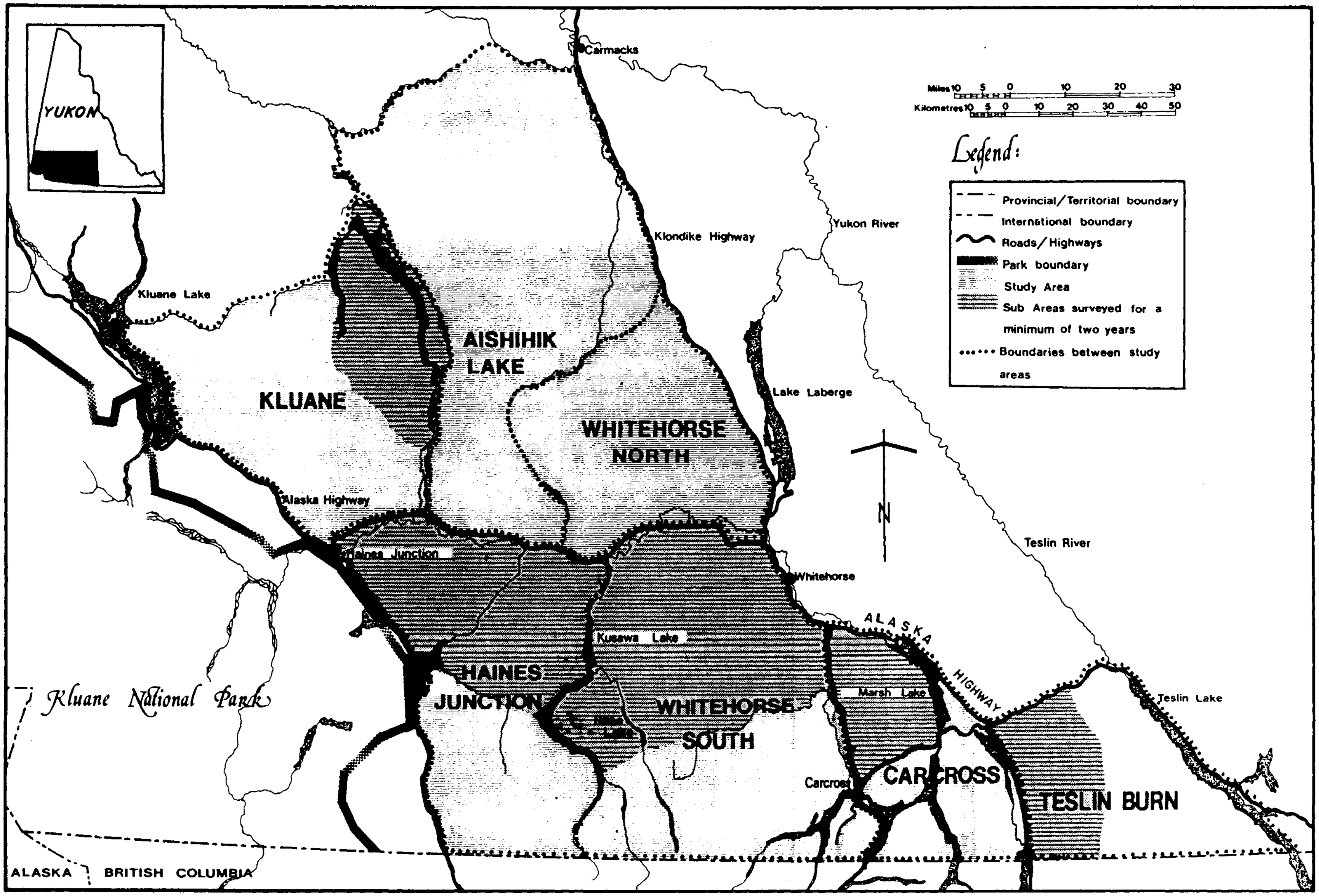


Figure 2. Southern Yukon study areas. Moose population statistics in Figure 3 refer to darkly shaded portions of each area.

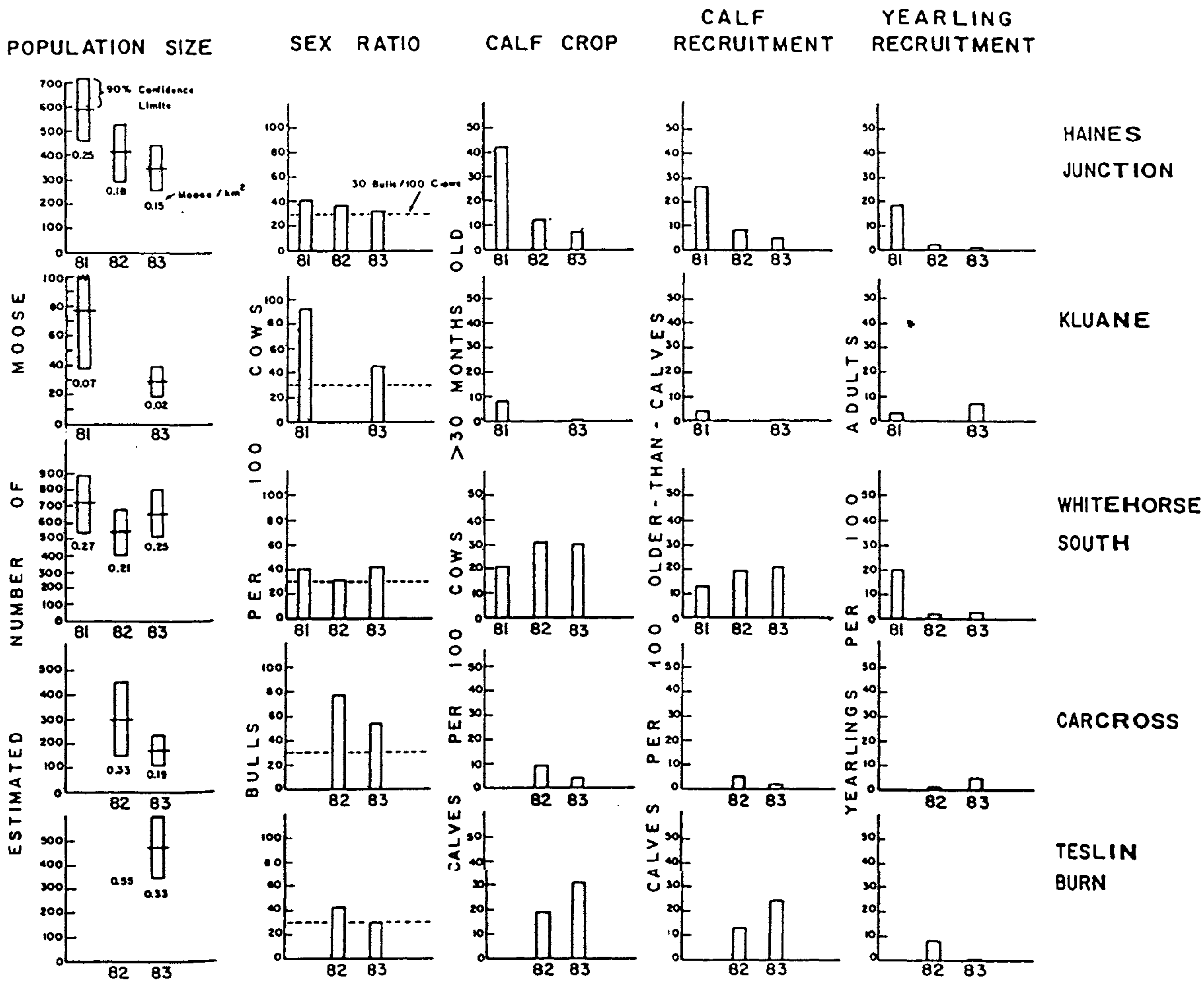


Figure 3. Characteristics of southern Yukon moose populations, 1981-1983, as determined by aerial surveys in November. All statistics apply to darkly shaded sub-areas indicated in Figure 2. Sex ratio statistics include yearlings.

survived to adulthood they could not compensate; or it can result from extremely poor production and/or survival of young animals, such that they cannot replace even a minimal number of dying adults. Of course, there can be combinations of the two as well. To decide which of these is the cause of the declines biologists examined all available information on recruitment of young animals and mortality of adults.

i. Recruitment

Very few calf or yearling moose were present in any of the populations during the November aerial surveys (Figure 3). Every 100 healthy adult cow moose should give birth to about 110 calves (some have twins) each spring, but southern Yukon populations have at most about 30 calves per 100 cows surviving in November. Either the calves aren't being born for some reason, or they are being born, but at least 70% are dying in the first six months of life. Proportions of yearlings indicate that less than one fifth of the calves surviving the first six months are able to survive until 18 months, the next November. The result is that fewer than 10 of these yearling moose are added each year for every 100 adults already present in the populations.

Age structure of the adult populations also indicates sustained low recruitment over at least the past six years (Figure 4). If the moose populations were stable or increasing, most of the adults alive now would have been born since 1977. In Whitehorse South, the female moose population is composed almost entirely of animals born between 1971 and 1977; since then few young have survived to adulthood. In the Teslin Burn most of the females now alive were born even earlier, prior to 1973. The reason for this difference is not clear, but in any case, neither population has had adequate recruitment since at least 1977, with the possible exception of young born in 1980 (see yearling recruitment in Figure 3).

Information from other moose populations, such as in parts of Alaska, led biologists to suspect that predation was the primary cause of this poor recruitment.

ii. Adult Mortality

(a) Natural Causes

Adult moose die from either a variety of natural causes or hunting. We are currently measuring natural mortality of radio-collared cow moose, but meanwhile we estimate, based on other studies in North America, that at least 10% of the adult moose die each year of natural causes, primarily predation.

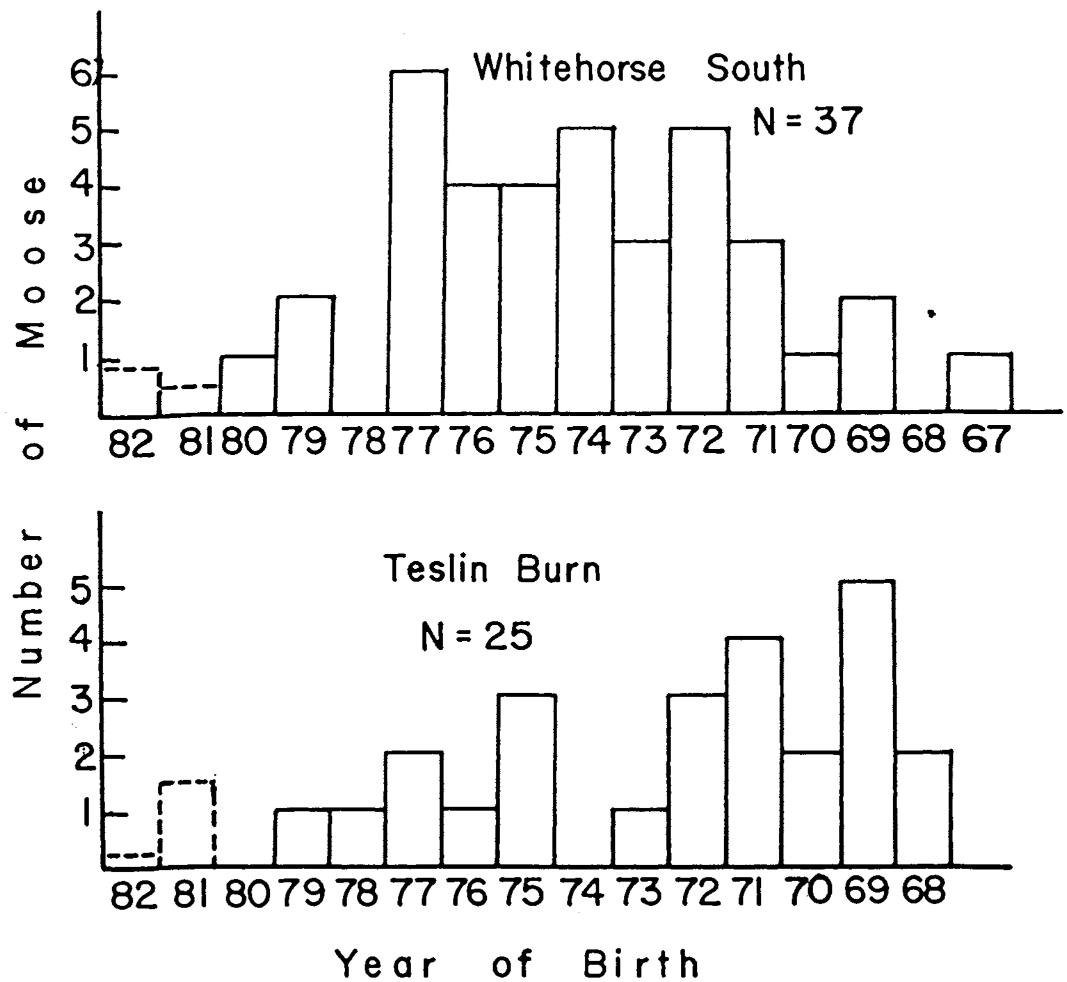


Figure 4. Age distribution of adult female moose captured during early spring 1983 in Whitehorse South and in the Teslin Burn. Relative size of 1981 and 1982 cohorts is calculated from aerial survey data.

(b) Hunting

Three types of hunting occur in this area. In Haines Junction, Whitehorse South, Carcross and the Teslin Burn, guided non-residents annually take about 30 bull moose; licensed resident hunters take about 250 moose, in 21,000 days of hunting effort (based on 1979-1980 figures). The moose in this area provide 20% of the Territory-wide non-resident moose harvest, and 30% of the Yukon total moose harvest and hunting effort by residents. Estimates of the 1981-1983 harvest are not yet available. Hunting of cow moose has been prohibited in the Haines Junction, Kluane, Aishihik Lake, and Whitehorse South areas since 1981, but was still allowed in 1983 in Carcross and the Teslin Burn.

Natives from six communities hunt moose in these areas. They are not subject to hunting regulations, and therefore may hunt any age or sex of moose in any season. We have no information on the size or composition of this harvest, but it may be substantial.

The decreasing male:female ratio in most southern Yukon populations (Figure 3) suggests that hunting of males is having a definite impact. At present we have a management goal of retaining a minimum of 30 bulls per 100 cows in these populations. We must either restrict hunting in some areas to satisfy this goal, or revise the desired ratio downward to accommodate further harvest. Although there are many hunted North American moose populations with fewer than 30 bulls per 100 cows, many of the cows are not successfully bred until later in the fall rut than they normally would be, and thus give birth correspondingly later in the spring. This appears to be happening to some extent in Whitehorse South. We would like to avoid delaying or extending the calving period since late-born calves and their mothers might be more susceptible to predation, or less able to prepare for the rigours of winter.

(c) **Weather and Range Conditions**

Studies have shown that declines in moose in other areas of North America are occasionally caused, at least in part, by severe winters. Deep snow makes it difficult for moose, particularly calves, to obtain adequate food and can make them vulnerable to predation by wolves. In extreme winters some moose may actually die of starvation, especially if the range is already heavily browsed.

The amount of snow on the ground seems to have been about average (based on 1959-83 data from Whitehorse) in the southern Yukon during the past 4 years, although we have little data on local variations. Recently, the winter of 1982-83 had exceptionally deep snow in the Haines Junction area and possibly the higher elevations of Whitehorse South, which undoubtedly led to increased overwinter wolf predation on the moose in those areas. The winter of 1978-79 had the deepest snow around Whitehorse since 1971, and may have contributed to the initial decline of moose in Whitehosre South.

We have no evidence that moose are suffering from a lack of food. All of the wolf-killed moose found during the winter of 1982-83 in Whitehorse South and the Teslin Burn were in good condition based on analyses of bone marrow fat, and blood tests of females captured and radio-collared in those two areas late that winter also indicated that they were healthy.

iii. Summary

At least 3, and probably 4 of 5 southern Yukon moose populations are declining. Observed recruitment of yearling moose into the adult population has been consistently less than 10%, except for Haines Junction and Whitehorse South in 1981. At least 10% of the adults are probably dying each year of natural causes, primarily predation. Thus, recruitment is not quite balancing natural mortality. Adult losses to sport hunting are presently being estimated for 1981 to 1983, but the harvest by native hunters has never been determined. The ratio of male:female moose is at or near the minimum of 30:100 which we wish to maintain in these populations.

B. Cow and Calf Mortality Studies

Although biologists felt that predation was the probable cause of the sustained low recruitment of young moose, it also was possible that the female moose were simply not giving birth to very many calves, or that the calves were dying for some reason other than predation. To determine the exact cause of the low recruitment, a study was initiated in 1983 in the Rose Lake area of Whitehorse South and in the Teslin Burn.

Sixty-six cow moose were darted with a tranquilizer gun in March prior to calving. Most (89%) were found to be pregnant, and all were in moderate to good physical condition. Sixty-three of these were radio-collared and closely monitored by aircraft as calving time approached. Four cows died of drug-related causes within a few weeks of being collared. The remaining 59 bore a total of 65 calves (average 1.1 calves/cow), and 23% of pregnant cows bore twins. These pregnancy and twinning rates are within the normal range for North American moose populations. Collared cows exhibited the same birth rates as uncollared cows, so the drugging operation and collars were not detrimental to the cows after the initial mortalities had occurred.

Since the cows were in normal health and exhibited normal pregnancy and birth rates, it was concluded that the availability and quality of food were adequate, and not limiting the population at present.

Most of the calves born to the collared cows were radio-collared, and the remainder left untouched. In addition, a sample of calves born to uncollared females were collared. Calves were collared as quickly and carefully as possible to prevent abandbnment by the cows. Only 1 calf was abandoned, and it was adopted by a nearby cow which had just given birth. All radio-collars were designed to transmit an altered signal if the collar remained motionless for more than a few hours (normally this indicates a dead animal). Whenever such a signal was detected, a helicopter was sent to investigate. In most cases the cause of death was evident from the condition of the carcass, clues in the immediate area, or observation of a predator on the kill.

i. Calf Mortality

In the Rose Lake study area, 60 calves were radio-collared. Calves were born between 17 May and 10 June. By 8 June, 30 (50%) of the 60 radioed calves were dead, and by 21 June, 41 (68%) were dead (Figure 5). Between birth and 21 June, grizzly bears accounted for at least 60% of the calf deaths. After 21 June calves died at a much lower rate, primarily due to greatly reduced predation by grizzly bears. By 1 March, about 9 months after birth, 53 (88%) of the 60 calves were dead. Of the 53 deaths, 50 (94%) were due to predators. Grizzy bears and wolves were by far the most important predators. Grizzly bears killed at least 25 calves prior to 21 June, but only 2 during the remainder of the summer and fall, for a total of 27. Wolves killed only 3 prior to 21 June, but 9 since then (a total of 12), and are expected to kill more during the remaining winter months. One calf death was due to black bears, and the other ten predator-related deaths were caused by various categories of undetermined predators: wolf/grizzy bear - 4, unknown bear - 4, unknown predator - 2.

In the Teslin Burn only 16 calves were radio-collared. These were collared beginning 1 June at an average age of 7 days, versus beginning 17 May and at an average age of 2.5 days in

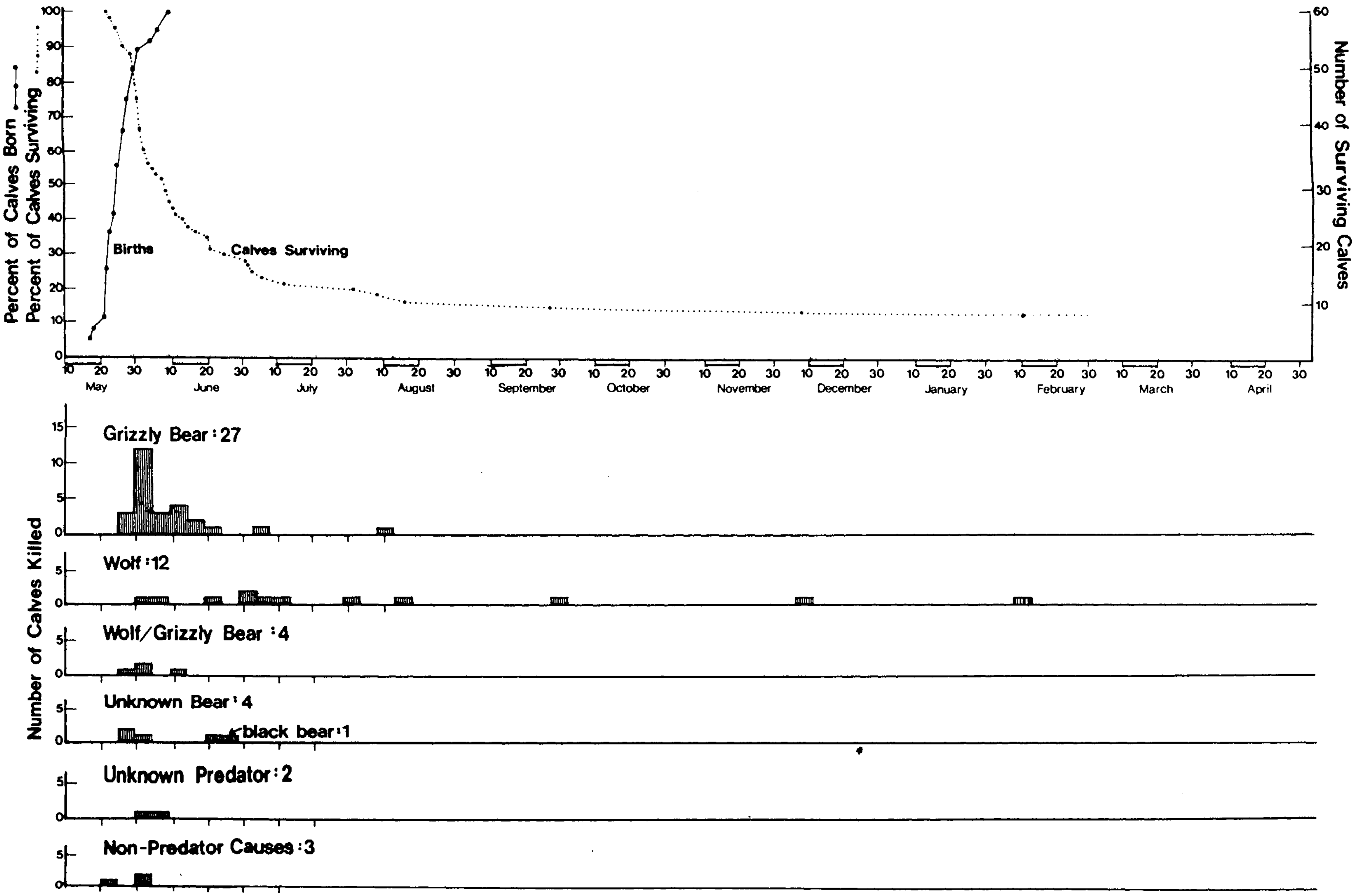


Figure 5. Timing of birth and death and cause of mortality of 60 moose calves radio-collared during May and June 1983 in Whitehorse South.

the Rose Lake study. In spite of this difference, mortality rates and causes seem to have been nearly identical in both areas.

Both collared and uncollared calves died at the same rate, and calves of collared females died at the same rate as those of uncollared females. This proved again that the animals were not adversely affected by the collars.

This calf mortality study suggested that 85% of the calves born in Whitehorse South would be dead by November. If 110 calves were born for every 100 cows in spring of 1983, this would mean that only 17 calves per 100 cows would remain in November. Our aerial surveys in November 1983 produced an estimate of 30 calves per 100 cows. We do not know which of these is closest to the truth; however, we believe that the study indicates the relative roles of the various predators in either case.

ii. Cow Mortality

Four (12.5%) of the 32 radioed cows in the Rose Lake area died of natural causes during the period March to mid-February. All 4 were killed by predators: 2 by wolves, 1 by grizzly bears, and 1 by either wolves or grizzly bears. Two (8%) of the 25 radioed cows died in the Teslin Burn, both killed by wolves.

ii. Summary

This study confirmed that plenty of calves were being born, and that the poor recruitment of young moose was due primarily to predators killing them. Additionally, predators caused all 6 of the cow deaths. Those 6 represent 11% of the total number of radio-collared cows - close to the 10% annual natural mortality rate biologists are presently assuming for adult moose. Considering that there is exceptionally little snow this winter, this 10% seems to be a conservative estimate.

C. Predator Populations

i. Wolves

Wolf populations surveys were initiated in Whitehorse South in mid-winter 1982-83 using a combination of radio -telemetry and aerial track counts. The population was estimated at 77 wolves for all of Whitehorse South, a density of 1 per 82 km^2, or 1 wolf per 8-12 moose. Later that winter in response to the low recruitment of yearling moose in the area, 24 wolves were killed by trapping and aerial shooting, a 31% reduction. Widespread research on wolf populations has shown that increased reproduction and pup survival allows wolves to recover completely from a harvest of up to 30% in a single breeding season. Wolves are being censused again this winter (1983-84) and it appears the population has recovered from last year's removals. In the northern part of Whitehorse South, which was the portion surveyed for moose in 1983, there are 55 wolves, 1 per 70 km^2.

At present, wolf population estimates for the other areas are derived from densities in Whitehorse South, but Haines Junction, Carcross and the Teslin Burn are being censused this winter.

ii. Bears

Black and grizzly bears are present throughout the area, black bears are primarily in lowland areas and grizzlies in a wide range of forested alpine, and subalpine habitat. Most of the remaining southern Yukon moose are primarily subalpine inhabitants, so grizzly bears are more significant to them than are black bears.

Our estimates of grizzly bear populations in this area come from studies in other dry interior mountain areas of Alaska, N.W.T. and elsewhere in the Yukon, 1 bear per 40-70 km^2. Based on these densities, grizzlies in the Haines Junction, Whitehorse South, and Teslin Burn areas have been harvested at the rate of about 2% per year, a rate which has probably maintained stable populations over the past 5 years. Bear removals mentioned in the management experiment are based on a more conservative estimate of 1 bear per 70 km^2. We have no data on black bear populations in these areas and do not feel that we can estimate densities from previous studies in other areas.

D. Development of the Management Program

i. The Roles of Predation and Hunting

Regardless of the reason for the moose declines, predation by bears and wolves is the primary factor preventing population growth at present.

Predators are killing adults and in most cases preventing enough young from surviving to replace them, let alone enough to replace additional losses to hunting. There are presently 10-14 moose per wolf in Whitehorse South, much less than the 20 moose per wolf at which wolf predation is capable of preventing moose population growth.

There are other ungulates present in some areas which may also be serving as prey for wolves, and thus possibly reducing the amount of predation on moose (Figure 6). In Whitehorse South in 1982, there were 2500 Dall sheep, 100 caribou, and 200 mountain goats in addition to 815 moose. This represented a total biomass of about 564,000 kg, or 7,330 kg for each of the approximately 77 wolves. This is less than the threshold limit of 11,000 kg per wolf at which predation alone is probably limiting population growth. Thus at present wolves could be limiting all these ungulate species in Whitehorse South. Moose, however, appear to be the major prey. The most abundant species, Dall sheep, may be relatively immune to wolf predation because of the terrain they inhabit.

Predation can be very complex in multiple prey systems. One interaction which has been observed elsewhere is that wolf populations can exist largely on some alternate prey even when their primary prey (in this case moose) becomes scarce. However, they may continue to prey on moose whenever possible and drive them to even lower levels than would occur in a single prey system. In this situation, the presence of other prey species would be detrimental to moose when moose become very scarce.

Grizzy bear predation on moose calves is substantial in Whitehorse South (as shown by the Rose Lake study) and probably also in other parts of the southern Yukon where grizzlies are numerous relative to moose. Unfortunately, the interrelationships of bear and wolf predation on moose are poorly understood. Possibly, existing numbers of bears alone are capable of preventing moose population growth in some areas at present.

Hunting of male moose is not directly preventing moose population growth other than by reducing the total number of moose in the population and thus, slightly reducing the prey:predator ratio. Hunting or predation of female moose directly reduces the reproductive ability of the population, and predators additionally interfere with recruitment by killing most of the calves born every year.

We are not in a position to address the harvest of moose by natives, but we can put hunting of male moose by licensed hunters into persepctive relative to predation. Consider the present moose population in Whitehorse South, which we estimate was composed of 153 males, 8 yearling males, 371 adult cows, 8 yearling cows, and 111 calves in November 1983. If licensed hunting and predation remain unchecked, we expect the following to occur prior to November 1984: licensed hunters will kill 15-60 adult males; predators will kill 37

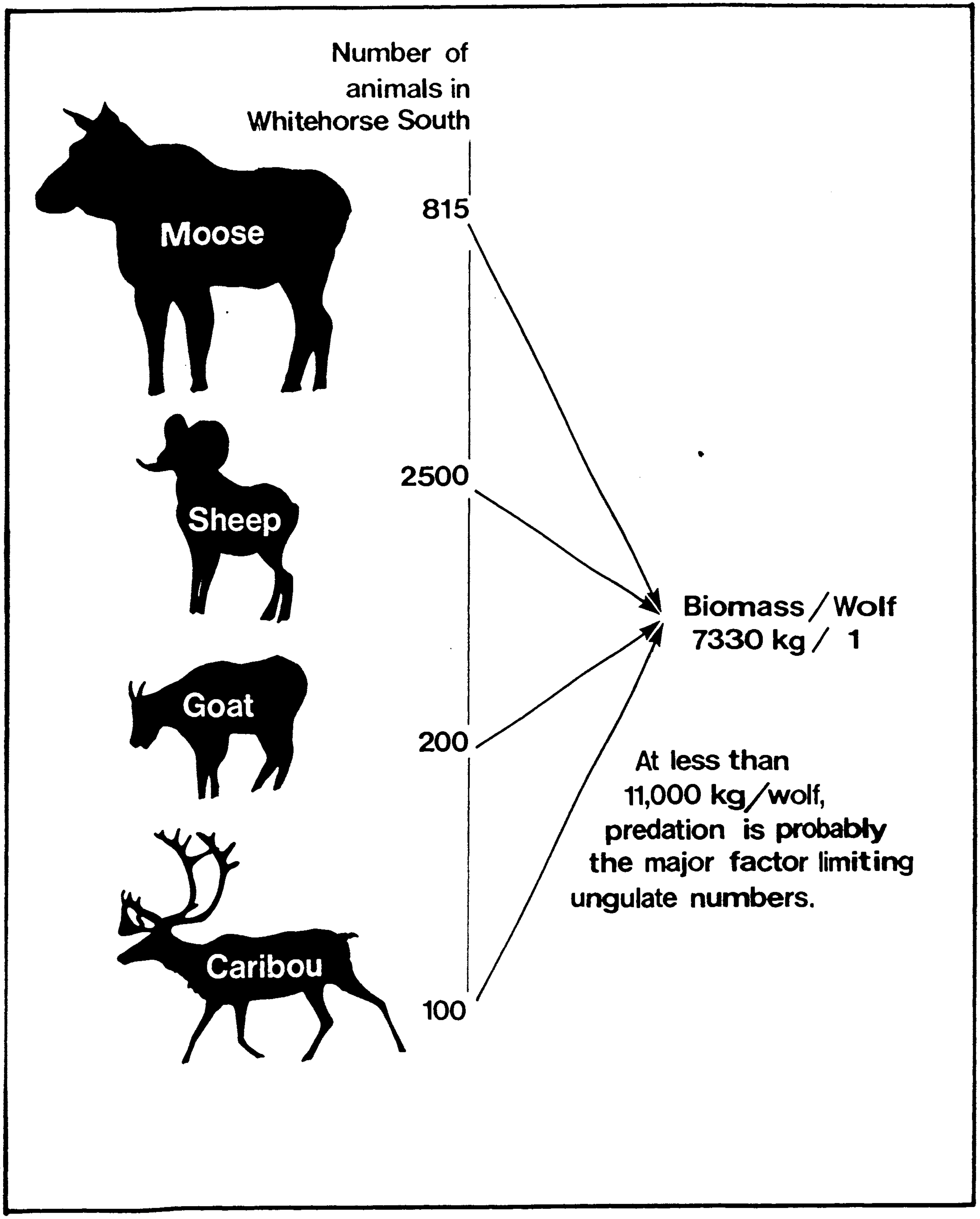


Figure 6. Even though moose are the main food of wolves in Whitehorse South, there are enough wolves to potentially limit numbers of all ungulate species present.

adult and yearling females, 15 adult and yearling males, 56 of the remaining calves born in 1983, and 270-330 calves born in the spring of 1984. Licensed hunting thus represents 3-15% of the total 408-468 moose which will die in the coming year, and predators will account for the other 85-97% (remember that hunting by natives is not being considered here).

In order to enable southern Yukon moose populations to grow, more young moose must survive to adulthood. In addition, we cannot afford to lose very many more adults from most populations since there is already a big "gap" in the age structure where 1-6 year old moose should be. We need to preserve all cows to ensure maximum production of calves, and enough bulls to ensure that all cows are bred in a timely fashion each fall.

ii. The Management Experiment

Hunting restrictions and predator reductions will both be employed to rehabilitate the southern Yukon moose populations. At the same time, biologists will take an experimental approach in an attempt to learn as much as possible about the dynamics of bear and wolf predation on moose under different management strategies.

Trappers and hunters are being encouraged to take wolves in these areas to help reduce predation, although experience has shown that this will have a negligible effect on the wolf populations. In the Haines Junction area wolves will be reduced by aerial shooting to meet a goal of 40 moose/wolf, during winter 1983-84. Grizzly bear populations will be maintained at current levels. Wolves will also be reduced to meet a 40 moose/wolf ratio in Whitehorse North during winter 1983-84. In Whitehorse South and Whitehorse North, grizzly bears will be reduced by 30% through hunting as well as transplants or exports of live-captured bears where feasible. This is to be accomplished by June 1985. Wolves there will be reduced to 40 moose/wolf, but not until late winter 1983-84, after the Rose Lake moose mortality study has nearly completed a full year. The Carcross area and part of the Kluane area will have no predator reductions and will act as a "control" (reductions will take place in "experimental" areas). In the Teslin Burn the grizzly bear population will be reduced by 50% by mid 1985, again through hunting and transplants. Some wolves there will be radio-collared for further study, but none will be removed in 1984. In wolf reduction areas, removals will be continued for 3 years, as necessary to maintain a 40 moose/wolf ratio.

Moose hunting by licensed hunters will be restricted to antlered moose in all areas, and the season will be substantially curtailed in the most accessible parts of the Haines Junction area, north of Carcross, and east of Bennett Lake in Whitehorse South. These seasons only remain in areas where grizzly bears are to be reduced in the hope that moose hunters will participate in grizzly bear hunting at the same time.

Once grizzly reductions have been accomplished, all moose seasons wil be on a harvestable surplus basis. If there is no harvestable surplus, as determined by the amount by which recruitment exceeds adult natural mortality from all causes, there will be little or no harvest. Some of the harvestable surplus will be retained to allow growth of the populations.

Moose populations will be surveyed again in fall 1984 and radio-collared cows will be monitored this summer (1984) to determine rate and timing of calf mortality. Cows will be collared in Haines Junction, Kluane, and an additional few will be collared to replace losses this year in Whitehorse South and the Teslin Burn. In this way, the response of cow and calf survival to different predator removal strategies can be evaluated. Future management programs will remain flexible to accommodate findings during the first year.

The Finlayson Lake Caribou Herd

The Finlayson Lake Caribou Herd (FCH) occupies an area of about 18,400 km^2 (7300 mi^2) in the east-central Yukon, generally east of the town of Ross River, bordered on the north by the Canol Road and in the south by the St. Cyr Range (Figure 7).

Since 1981, Y.T.G. Department of Renewable Resources biologists have been studying this herd, initially in response to potential threats posed by mining and hydroelectric developments in the area, and also because of reportedly high caribou harvests by local residents.

A. Distribution

Movements of radio-collared animals during 1982 and 1983 and the distribution of animals observed during aerial surveys have revealed the major winter, calving, and summer ranges of this herd (Figure 7). The majority of animals winter in forested areas adjacent to the upper Pelly River, particularly from the Slate Rapids area south to the Robert Campbell Highway. Smaller numbers winter along the upper Ross River. Most calving takes place in the alpine highlands in a broad arc north, east, and south of the winter range, stretching from Sheldon and Otter Lakes through Pelly Lakes, Tillei Lake, and the northern slopes of the St. Cyr

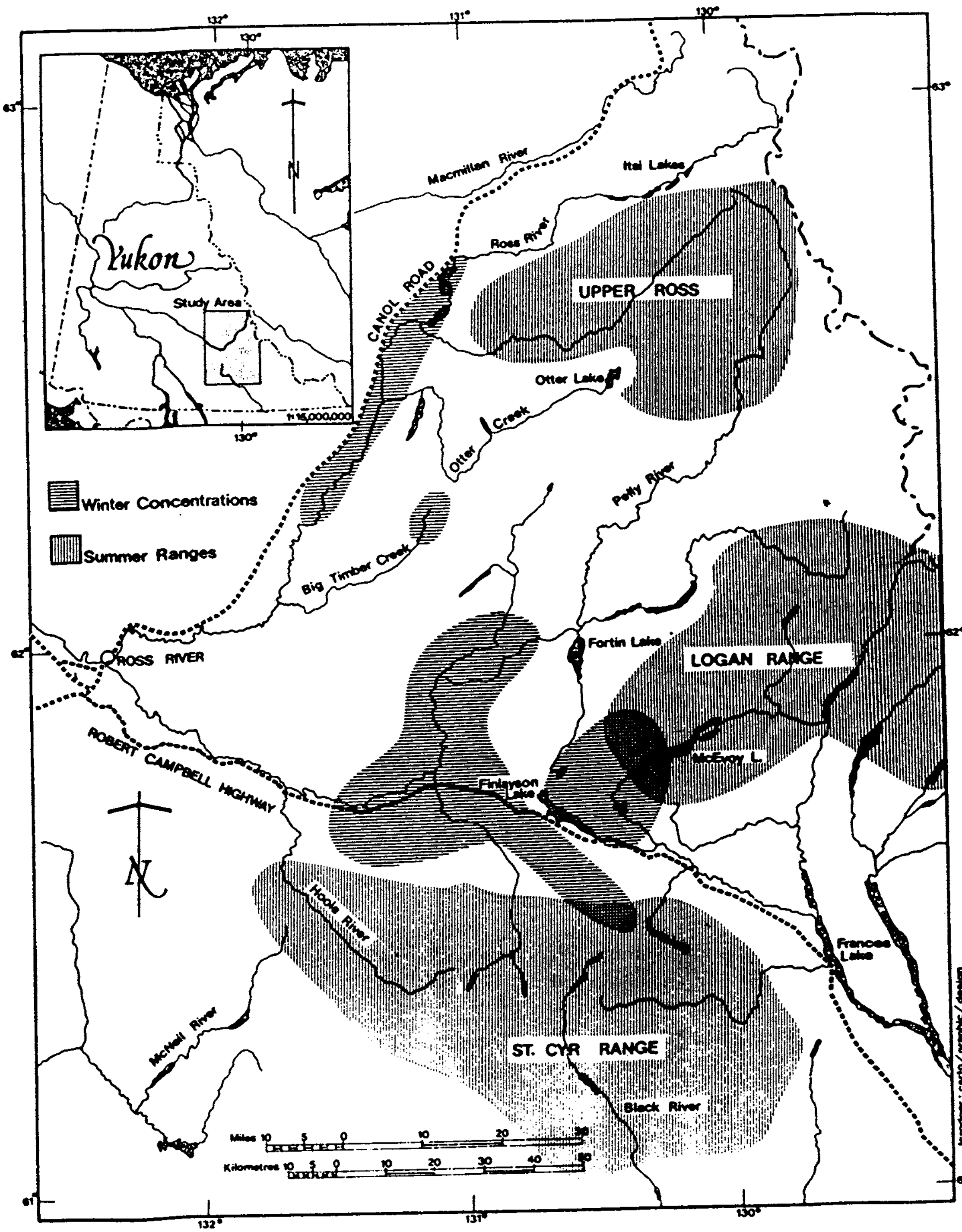


Figure 7. Winter and summer ranges of the Finlayson Lake Caribou Herd in 1982 and 1983.

Range. There are 3 fairly discreet summer ranges which have been named St. Cyr Range, Logan Range, and Upper Ross (Figure 7).

B. Population Status

The only quantitative historical information on the Finlayson herd comes from a helicopter survey of sheep during July 1977 in the St. Cyr Range (Figure 8). Despite the fact that woodland caribou are in small bands and difficult to see during midsummer, 1412 caribou were counted.

In fall 1982 an intensive aerial survey of most of the range resulted in an estimate of 2000-2500 animals. Weather conditions prevented a similar survey in 1983. Of the 1244 caribou actually counted in the fall '82 survey, 999 were in the area covered by the 1977 midsummer count. Considering that woodland caribou are much easier to see and count in the fall than midsummer, and that observers in 1977 were primarily looking for sheep, this indicates a very significant decline. Every native hunter in Ross River who was interviewed in 1982 concurred that the numbers of caribou were indeed declining.

i. Recruitment

The ratio of calves to older animals in the July 1977 survey was very high, 37.5:100, but has declined drastically since then (17.8:100 in July 1983). Other recruitment statistics in 1982 indicated that, as with the moose, calves were present in reasonable numbers early in the summer (at least 43 calves per 100 cows), but were not surviving well until October (16.5 calves per 100 cows). There were only 5.3 yearlings per 100 adults (7.6 yearlings per 100 cows) in October, suggesting very poor survival of calves during the previous winter. Additionally, the ratio of immature:mature bulls was almost 1:1 rather than the 3:1 expected in a population with sustained recruitment.

C. Mortality

Hunting harvest of the herd in 1982 was estimated at 200-250 animals, about 8-13% of the adult population. Between 30 and 60 of these were taken by licensed sport hunters and the rest by native residents of Ross River, Pelly Crossing, Watson Lake, Faro, Carmacks, and Mayo. Most of this harvest takes place during the winter adjacent to the Robert Campbell Highway, which bisects the major winter range.

The only information on natural mortality rates comes from a relatively small number of radio-collared cows. Five (27.8%) of 18 radio-collared caribou died between March 1982 and March 1983, all killed by wolves. This is an extremely high natural mortality

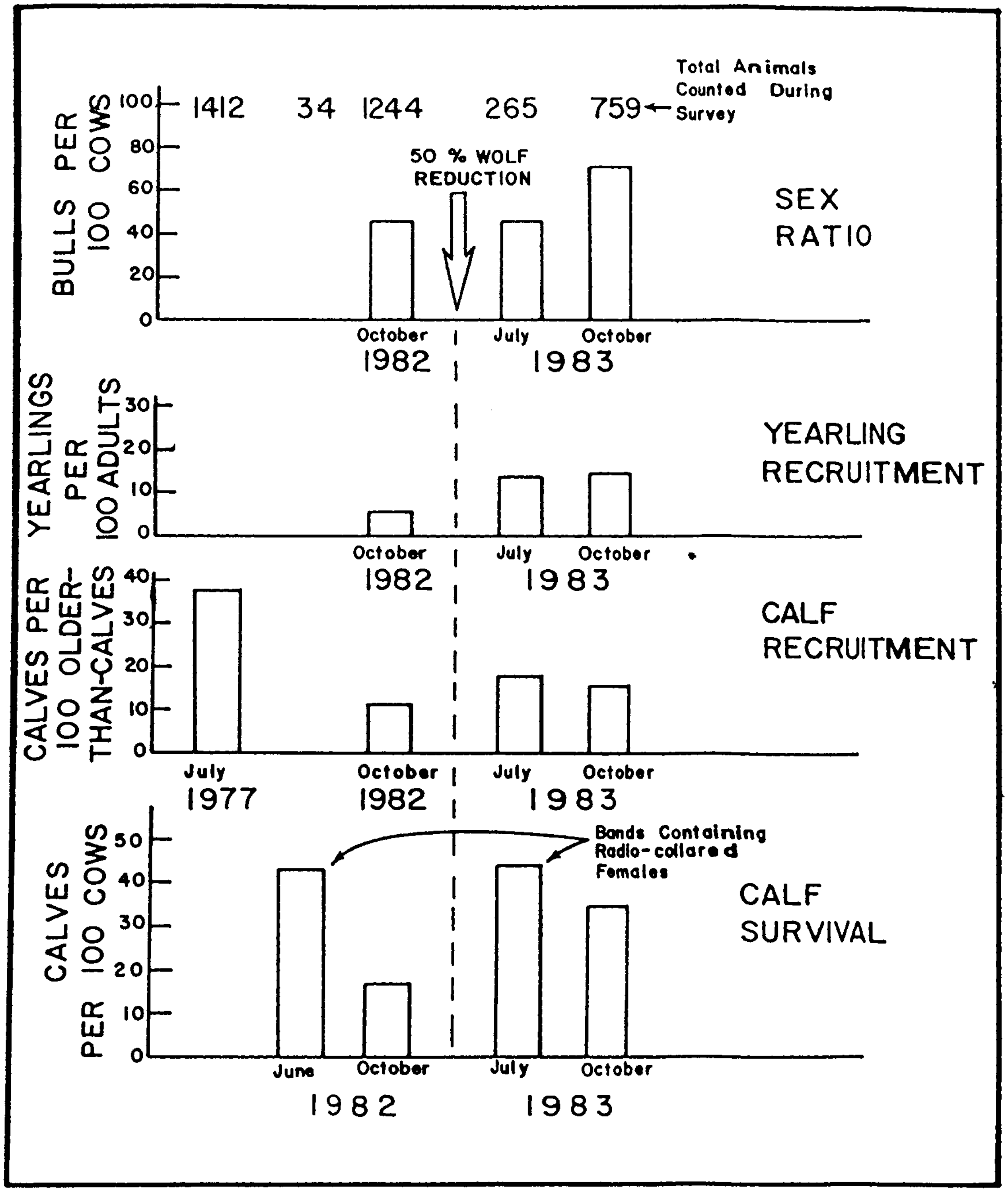


Figure 8. Population characteristics of the Finlayson Lake Caribou Herd 1977, 1982-83.

rate, and we are reluctant to believe it is representative of the entire adult segment of the herd. Adult natural mortality of about 10-15% annually would be expected based on the dynamics of previously studied caribou herds.

D. **Predator Populations**

Wolves were thought to be the major reason for both the high natural mortality of adult caribou and the low recruitment of young. Aerial surveys during the winter of 1982-83 indicated a population of about 200 wolves, a density of 1 per 92 km^2. Again local residents were virtually unanimous in feeling that wolves were more abundant than in past years.

E. **Recovery Efforts**

The herd appeared to be suffering a drastic decline. With adult mortality totalling 18-28% and yearling recruitment of only 5.3% the adult population declined 13-22% in 1982 alone. If natural mortality of adults actually was 28% as indicated by the radio-collared mortalities, things were very serious indeed.

Biologists decided to take immediate action to reverse this decline by reducing both the number of wolves and the harvest by hunters. All reasonable efforts have been made to reduce the harvest: Sport hunting was restricted to bulls only for the 1983 season, and it is believed the harvest was only about 10 animals. Local native residents have been requested to reduce their harvest and they seem willing to cooperate. However, there has been considerable difficulty in estimating this harvest, and there are no legal means by which it can be regulated. Due to this uncertainty, and thus the possibility of relatively unrestrained harvests in the future, wolf reduction was considered vital to ensure the rehabilitation of the herd and allow it to grow to a size that can sustain the harvest levels of the past few years. Wolves were removed beginning in late winter 1982-83, with an intitial goal of reducing the population by at least 30%. Y.T.G. personnel removed 77 wolves by aerial shooting and trappers and hunters accounted for another 28, for a total of 105; a reduction of about 50%.

F. **Response to Recovery Efforts**

Although several years data would be desirable to properly gauge the effects of wolf removal on the caribou, initial results are encouraging. Late winter, summer, and fall surveys of the FCH were conducted again in 1983. Recruitment has improved markedly over 1982. July calf crops were similar to those observed in 1982, and these calves appear to have survived well as of October, in contrast to the previous year. There is no conclusive evidence yet that this is because of the wolf reduction. Calf/cow ratios in July were highest (36-47/100) in the Logan Mountains and Upper Ross area where wolves were most reduced, and lowest (17/100) in the St. Cyr summer range where fewer wolves were removed. This would normally be evidence that wolves were the cause of low calf survival. Strangely, in October, calf/cow ratios appeared to be highest in the St. Cyr Range and lowest in the Upper Ross area, the reverse of the situation in July. Possibly some large-scale movement of animals occurred in the interim, or one of the counts was not an accurate reflection of the sex and age of caribou actually present in each area. Until this discrepancy can be explained, or we have more data, we cannot definitely attribute increased survival of calves to wolf removal.

Based on our very limited radio-telemetry data, natural mortality of adults shows little sign of improvement since wolf reduction, but wolves may have become less important contributors to the total predation. All 5 deaths of radio-collared cows between March 1982 and March 1983 were attributed to wolves, but since March 1983, 3 (18.8%) of 16 radio-collared animals have died; 2 killed by bears and 1 by undetermined predators. In the event that no more deaths occur prior to March 1984, the indicated adult natural mortality rate will be 18.8%, but one more death will bring it to 25%, similar to that in 1982.

Studies will be continuing during 1984, with the following objectives:

1. Obtain an accurate estimate of the native and sport harvest.

2. Survey wolves within the FCH range and remove at least 50% of them during late winter.

3. Determine age, sex, and condition of wolves removed, in order to assess impact of reduction on the wolf population.

4. Determine age, sex, and condition of any wolf-killed moose or caribou found.

5. Radio-collar 10 more adult female caribou to provide further information on movements, productivity, and natural mortality.

6. Monitor late winter, post-calving, and October composition to evaluate the status of the herd and the need for future action.

The Predator Management Programs in a Yukon-Wide Perspective

The areas in which predators are being reduced to benefit moose and caribou represent a small fraction of the entire Yukon, and the predators slated for removal also are only a small part of Territory-wide populations.

Wolf reductions are being undertaken over 14,750 km^2 in the moose study area of the southern Yukon, and 18,400 km^2 in the Finlayson Caribou Herd range, a total of 33,150 km^2, or 6.7% of the entire Yukon. The number of wolves to be killed in both these programs is less than 150 this year (1984), or 4-6% of the Yukon population, which we very tentatively estimate at 2500-3500 animals.

Grizzly bears are to be reduced in an area of 12,960 km^2, or 2.6% of the Yukon. The 64 bears we propose to remove represent only 0.5-1.1% of the Yukon population of 5700-14000.

In contrast, the ungulates in these areas play an extremely important role in the Territory-wide picture. Haines Junction, Whitehorse South, Carcross, and the Teslin Burn together provide 30% of the total moose hunting effort and harvest by licensed residents, and 20% of the harvest by non-residents. Licensed resident hunters harvest about 6 moose for every 1 taken by non-residents in the entire Yukon, and the ratio is 7:1 in the 4 areas just mentioned. These areas are also extremely important to native hunters, as many Yukon Indian people live in or adjacent to this part of the southern Yukon.

Grizzly bears and wolves are totally protected in Kluane National Park, the Kluane Game Sanctuary, and the MacArthur Game Sanctuary, an area of 30,370 km^2, or 6% of the Yukon. With the exception of the predator control programs, the remainder of the Territory is managed to at least sustain current populations of both wolves and grizzly bears.

CONCLUSION

The two predator-ungulate systems described here appear to conform to those found in other recent studies. There is no longer a question of whether large, stable ungulate populations can be maintained indefinitely in largely pristine areas without periodic control of predators. In most cases, the answer is no. Now we have to decide whether we want to live with or without predator control in the future. If we wish to live without it we have to continually modify our hunting demands to accommodate fluctuating ungulate populations and the needs of their other predators. If we want to live with predator reductions, what balance of predators and prey is acceptable? These are matters of public opinion.

At present the Yukon Department of Renewable Resources feels that moose and caribou hunting are important enough in these two small parts of the Yukon to justify the implementation of predator control to increase the ungulate populations. It is not, and has never been our intention to exterminate either wolves or grizzly bears in those areas, or in any part of the Yukon.