Wolf Population Research and Management Studies in the Yukon Territory

1983 Progress Report

Yukon

Renewable Resources

David Porter - Minister

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The study area lies in the Coast Mountains ecoregion (Oswald and Senyk 1977). The physiography is mainly rugged sedimentary and intrusive mountains, decreasing in elevation northward. Much of the southern part of the study area is glaciated, with several ice-covered peaks higher than 2,400 m above sea level (a.s.l.). The northern portion is composed of remnant glacial formations and extensive mountain blocks, surrounded by high rolling plateaus. Five river systems drain the area: the Ibex, Takhini, Primrose, Watson, and Wheaton Rivers. Proglacial lakes are found throughout the elevated terrain in the central and northern study area.

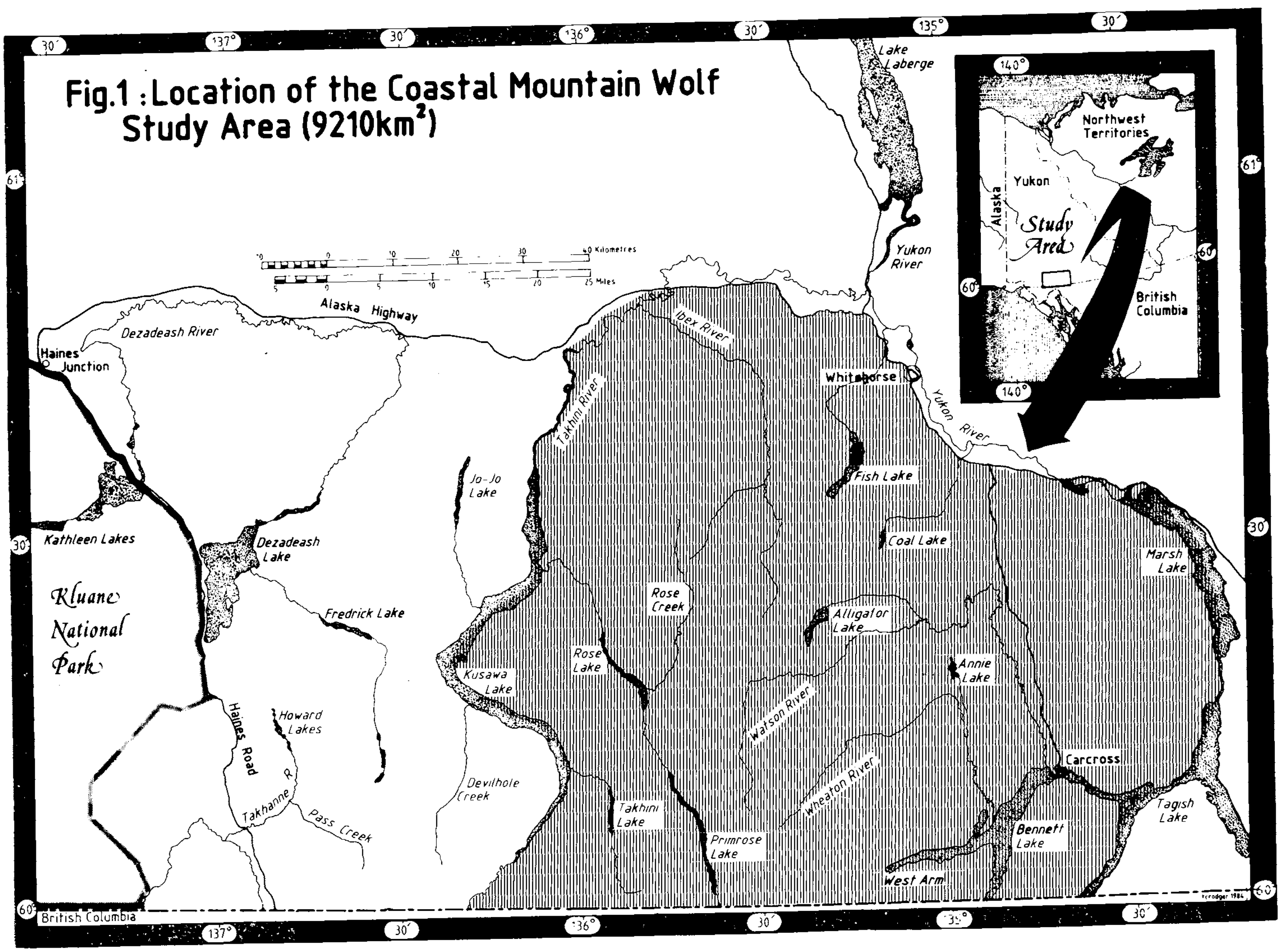

Fig.1 :Location of the Coastal Mountain Wolf Study Area (9210km²)

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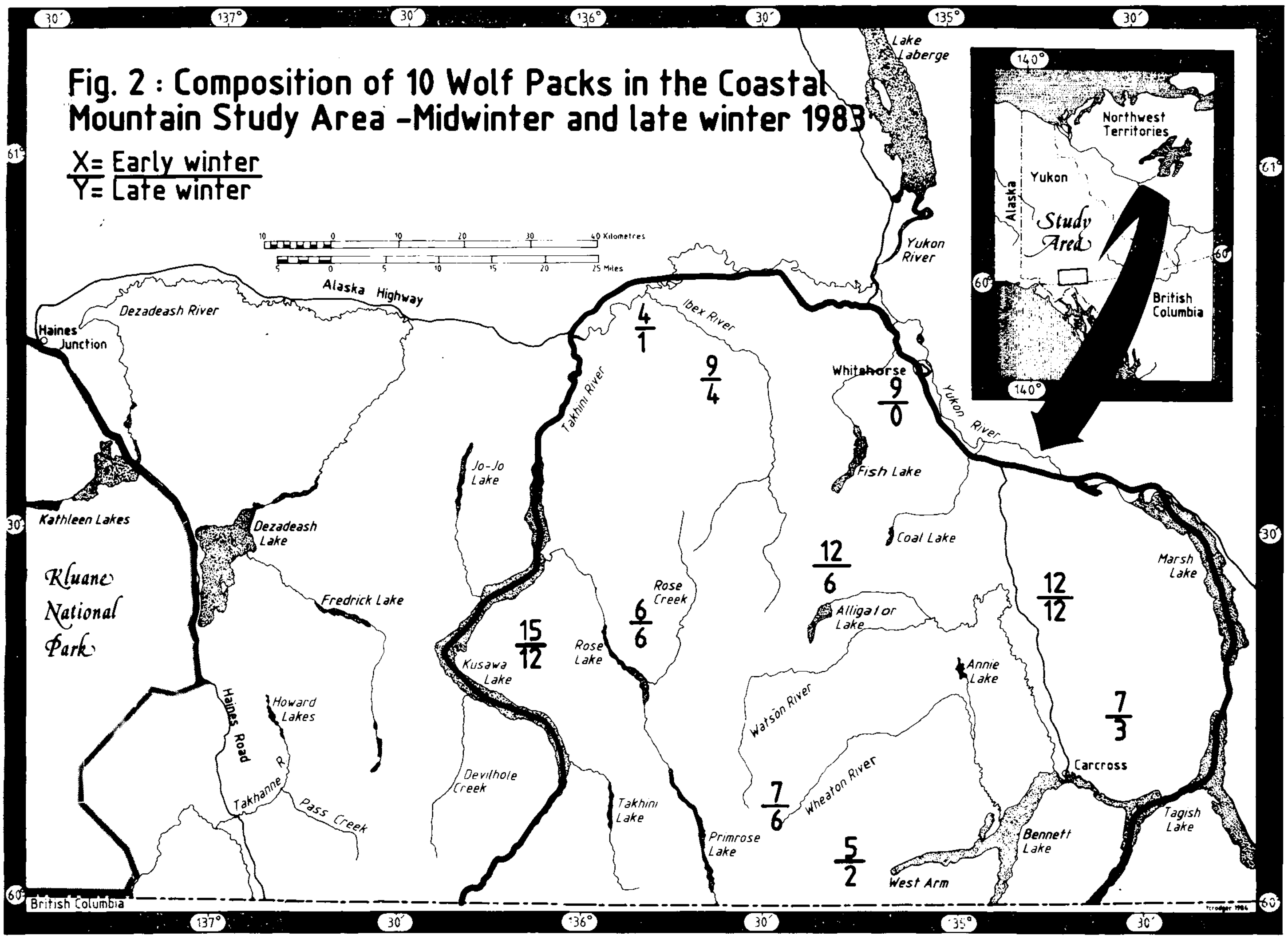
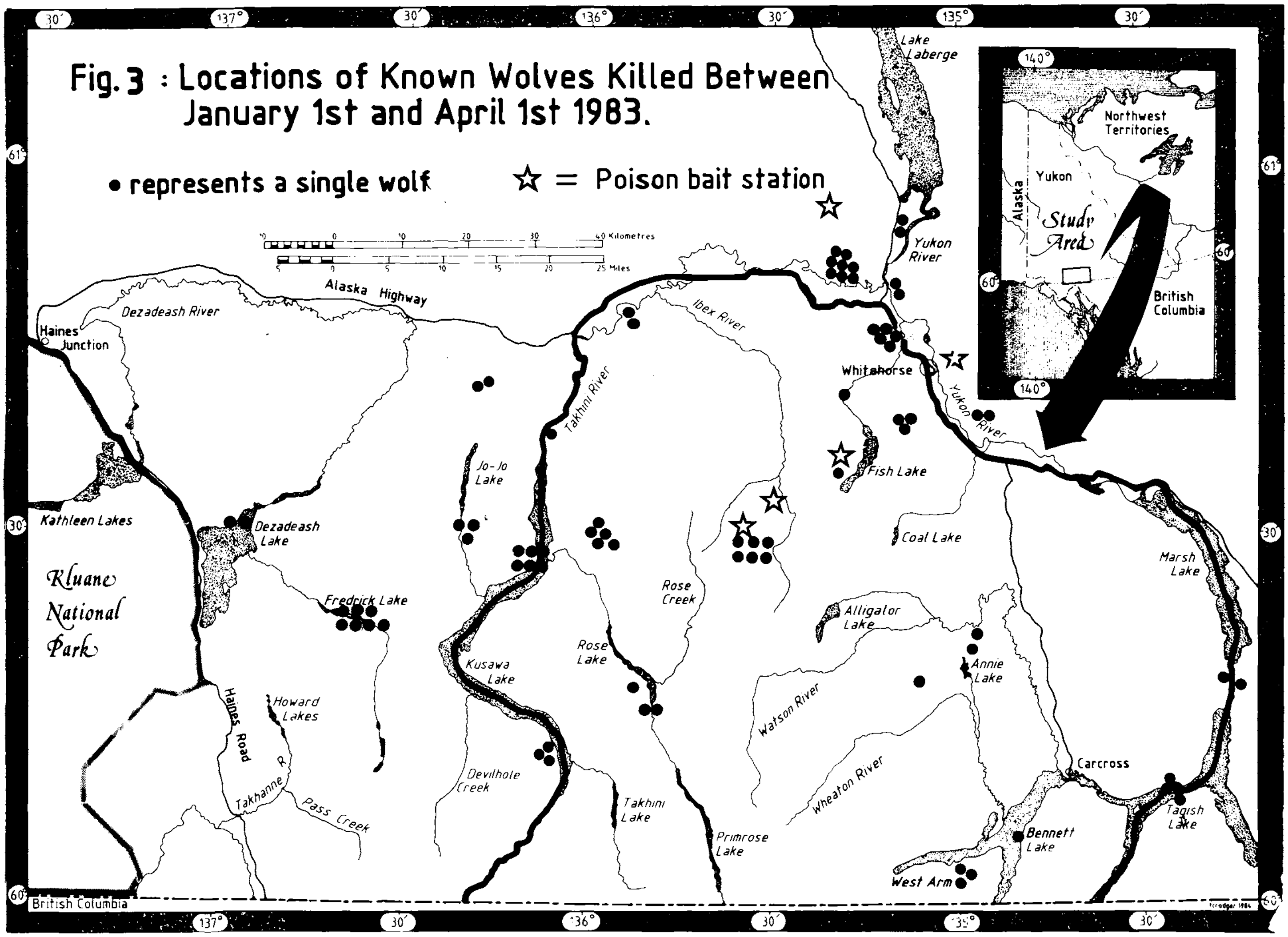


Fig. 2 : Composition of 10 Wolf Packs in the Coastal Mountain Study Area -Midwinter and late winter 1983



Aerial hunters were licenced to hunt a 24,400 sq.km. area (figure 4) including the study area, during the period December 15-February 15. Aerial hunters were required to report all shot wolves and present retrieved carcasses to the Department of Renewable Resources. Only five study area wolves were killed by private aerial hunters.

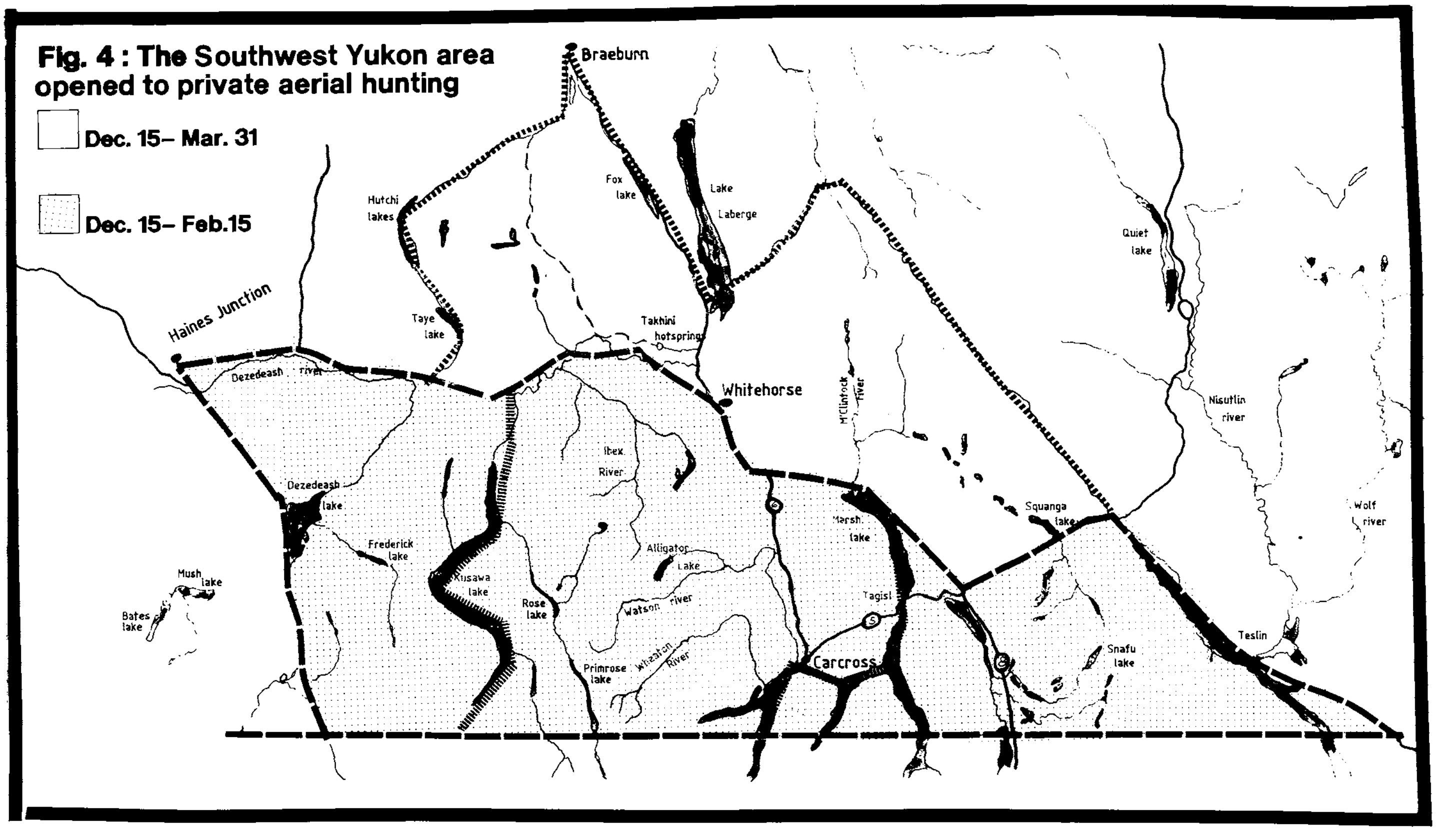


Fig. 4 : The Southwest Yukon area opened to private aerial hunting

Table 2. Wolf reduction methods and mortalities in the southwestern Yukon, 1982-83.

KILL METHOD	WOLVES KILLED IN STUDY AREA	BORDER
Strychnine (government)	1	2
Government trapping	4	2
Government aerial hunting	3	7
Public trapping/hunting	31	22
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SUBTOTAL	42	35
TOTAL	77	

Government wolf control was concentrated in approximately a 30 sq.km. radius of Whitehorse where five strychnine bait stations were monitored between December 15 and January 28 (figure 3). Only three wolves were known to have died as a result of the poison. Departmental aerial hunters shot 10 wolves in response to livestock and pet-related wolf complaints and Wildlife officers trapped or snared five others. In total, 24 wolves were killed within 30 km of Whitehorse. Most wolves were killed singly or in in pairs making it difficult, if not impossible, to determine the pack affilsq.km. (table 6). The largest territory was occupied by the 12-member Alligator pack. From the radio-instrumented wolf population we calculated a density of 79 sq.km. per wolf, close to the density of 84 sq.km. derived from wolf surveys.

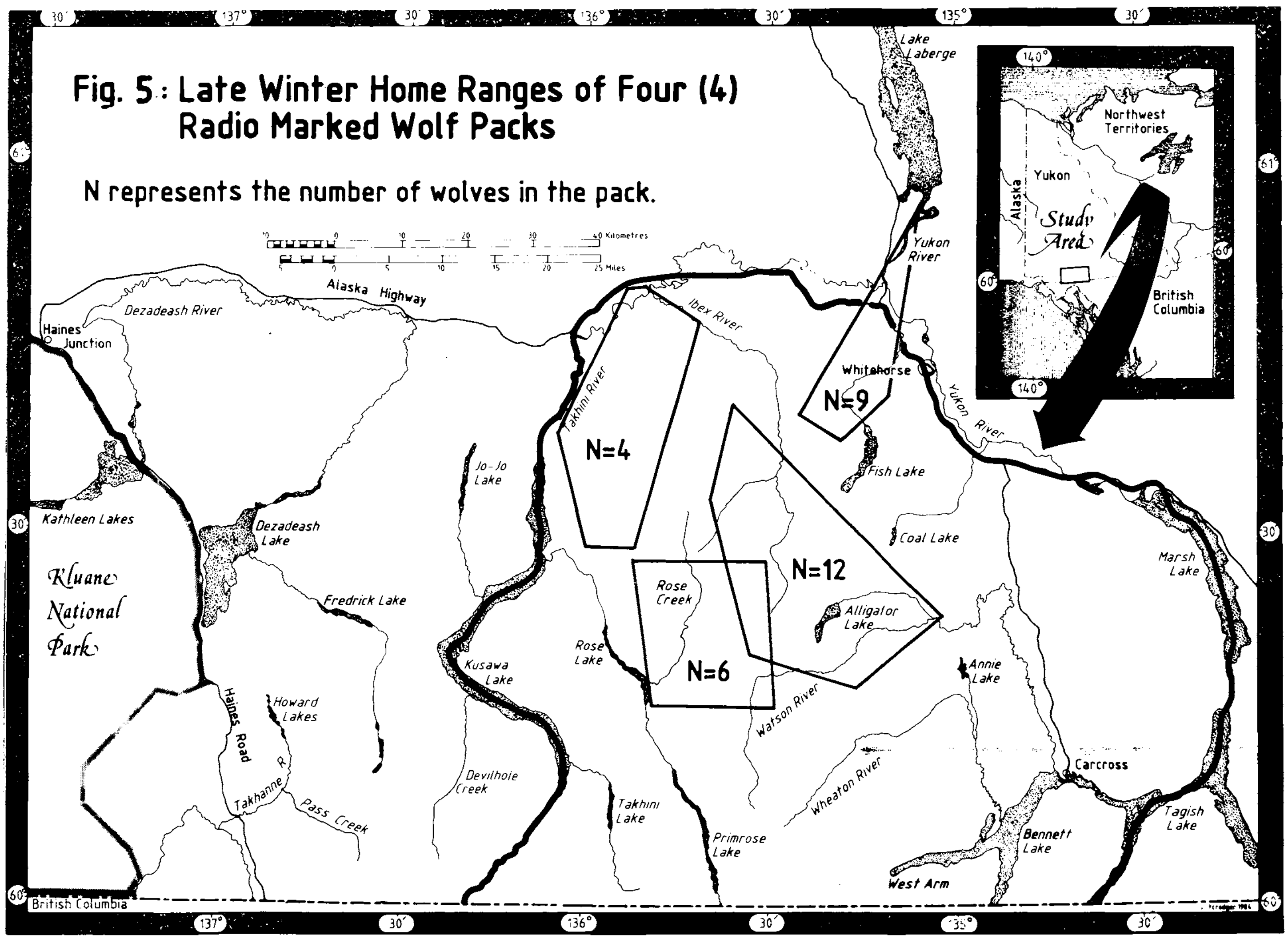

Fig. 5: Late Winter Home Ranges of Four (4) Radio Marked Wolf Packs

N represents the number of wolves in the pack.

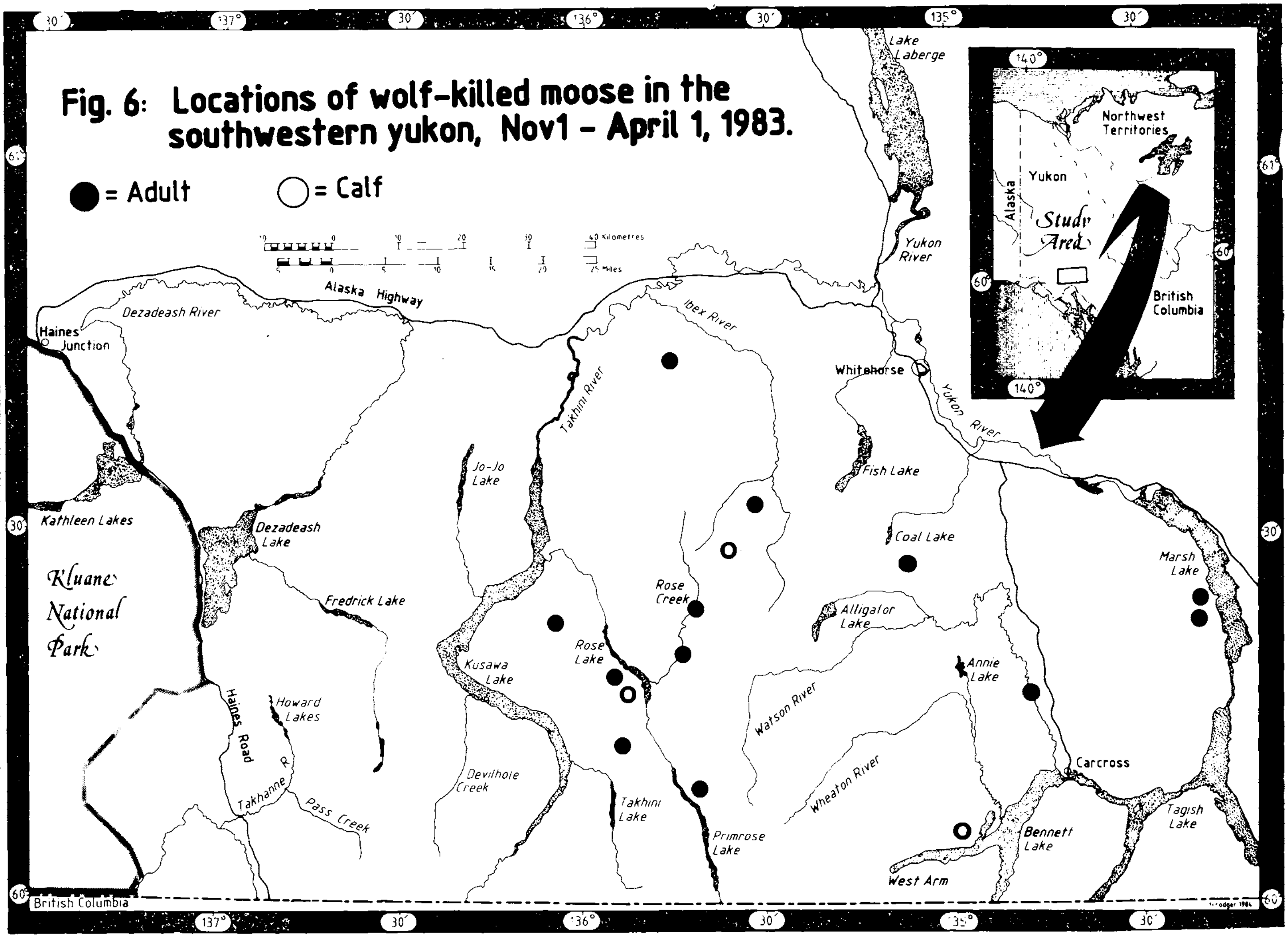

Fig. 6: Locations of wolf-killed moose in the southwestern yukon, Nov1 - April 1, 1983.

Bone marrow fat analyses showed the calves ranged between 39-60%: adults ranged between 75-99% fat. Peterson et al. (1984) noted that winter moose calves generally have less fat reserves than adults due to the calves growth requirements. Adults averaged 89% (n=6 ,SE=3.64) and calves averaged 46.6% (n=3, SE=6.69). Stephenson and Sexton (1972) and Peterson et al. (1984) noted that adult Alaskan moose suffering from severe malnutrition characteristically had marrow fat levels of less than 20% and calves less than 10%. Our marrow fat data indicated that malnourished moose were not present in the prey sample.

The local habitat of each mortality site was documented. Moose kills were most frequently observed on lake or creek ice (52%). Five kills (26%) were found in subalpine shrub or

WOLF MANAGEMENT ANNUAL REPORT

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Date: Oct 31, 1985

The wildlife projects reported here are continuing and conclusions are tentative. Persons are free to use this material for education or informational purposes. Persons intending to use the information in scientific publications should receive prior permission from the Fish and Wildlife Branch, Government of Yukon, identifying in quotation the tentative nature of conclusions.

WOLF POPULATION RESEARCH AND MANAGEMENT STUDIES IN THE YUKON
1983 ANNUAL REPORT

1. Southwestern Yukon

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Yukon Fish and Wildlife Branch Annual Report
Department of Renewable Resources
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ACKNOWLEDGEMENTS

The authors especially thank D. Grangaard, D. Kellyhouse and R.O. Stephenson of the Alaska Department of Fish and Game for their advice on study design, and wolf census, telemetry and necropsy procedures. R.O. Stephenson was especially helpful for his insights on wolf biology and management. Our thanks is also extended to D. Holleman of the Institute of Arctic Biology, Alaska for Cesium 137 analyses.

Cessna 185 pilots H. Kitchen and B. Watson of Alkan Air, Midwest Helicopter pilot J. Flesher, and various Trans North Air helicopter pilots flew safely and efficiently during surveys and darting flights.

We thank H. Jessup, D. Larsen, R. Markel and B. Smith for field assistance, and J. McDonald for her help with wolf necropsies. H. Hoefs, D.V.M., analyzed female reproductive tracts. Conservation Officers D. Drummond and R. Wotton provided information on wolf reduction efforts in the Whitehorse area.

T. Rogers designed and drafted all figures and drew the cover illustration.

INTRODUCTION

Until recently, the gray wolf (*Canis lupus*) was assigned a low management priority in the Yukon (Smith 1983). In January 1983, the Yukon Department of Renewable Resources initiated wolf ecology studies in the southwestern Yukon in response to a regional moose (*Alces alces*) population decline (Johnston and McLeod 1983) and low moose calf survival rates since 1981 (Larsen 1982, Johnston and McLeod 1983, Markel and Larsen 1983).

Similar to the situation in Fairbanks, Alaska in 1974-75 (Gasaway *et al.* 1983), the number of wolf /livestock and pet conflicts increased greatly in autumn 1982 in the Whitehorse area. Wolf-related complaints increased from one in 1980, seven in 1981, to 39 in 1982. Largely fueled by sensationalized media reporting, a public paranoia of wolves developed in the Yukon which undoubtedly accelerated public reporting of wolf encounters. Misidentification of coyotes (*Canis latrans*) for wolves occured and these smaller canids were responsible for various complaints. Nevertheless, wolf-related livestock losses did occur, especially in the Takhini River basin (figure 1) west of the city. In response, a government wolf- snaring and trapping program was initiated in October. The fall program was localized and generally ineffective. Only two wolves were trapped near the Takhini livestock area. Livestock and pet loss increased through early winter and media reports continued to fashion stories of a city beseiged by wolves. The regional moose population decline (Johnston and MacLeod 1983) and low calf survivorship trend (Markel and Larsen 1983) in the southwestern Yukon provided strong public and governmental pressure to extend wolf control in the region. Although there was no empirical data to support the thesis that wolves were responsible for the moose population trends, a 24,000 sq. km wolf control area was opened to public aerial hunting on December 15, 1982.

While local response to wolf control was varied, national and international reponse was dramatic and largely negative. Most critical reports centred on the bio-political conflict between the Yukon government and high-profile preservation groups. Media coverage of wolf events continued throughout the winter and reporting continued to be inaccurate and sensationalized.

In an attempt to establish responsible management of wolf populations in the Yukon, a management program was initiated in December 1982. In addition to being a predator or ungulates and livestock, the wolf is also a valuable furbearer and symbolizes the Yukon wilderness to many residents and visitors. The goal of Yukon wolf management is to establish wolf population data and develop management criteria that recognizes the various ecological and economic components of the wolf resource in the Yukon.

In an attempt to increase regional wolf harvest by trappers, various workshops on wolf-trapping and snaring techniques were conducted by the Department of Renewable Resources. Additionally, a wolf-pelt subsidy was established to increase wolf trapping harvest throughout the Yukon (Jessup 1983).

The wolf research and management program was established to develop wolf population and ecology studies in the southwestern Yukon. This paper presents and discusses interim results of the first year of studies.

GOALS AND OBJECTIVES

The broad goals of wolf studies are;

1) to describe wolf ecology in a moose-Dall's sheep (*Ovis dalli*) -woodland caribou (*Rangifer tarandus caribou*) prey system; and
2) to measure the impacts of wolf predation on these game populations in the southwestern Yukon.

The objectives of wolf studies in 1983 were;

1) to census the wolf population in Game Management Subzones (GMS) 7-13 to 7-35 and 9-01 to 9-05;
2) to document spatial relationships of resident wolf packs and their general food habits in late winter;
3) to determine wolf density and wolf/moose ratio;
4) to monitor the wolf harvest in the southwestern Yukon.

STUDY AREA

PHYSIOGRAPHY, VEGETATION AND CLIMATE

The 7,950 sq.km. study area is located in the southwestern Yukon (60-61 N and 135-136 W), bordered by the Alaska Highway to the north, Marsh, Tagish and Bennett Lakes to the east, the Yukon-British Columbia border to the south and Kusawa Lake to the west (figure 1). The Game Management Subzones included in the study area were GMS 7-01 to 7-35 and 9-01 to 9-05. The city of Whitehorse (population 14,000) is the largest community in Yukon and forms the northeastern boundary of the study area. Carcross (population 300) and

Tagish (population 200) are located in the southeastern corner (figure 1). Significant road access into the study area is limited to a 38 km mining road in the Wheaton River valley.

The study area lies in the Coast Mountains ecoregion (Oswald and Senyk 1977). The physiography is mainly rugged sedimentary and intrusive mountains, decreasing in elevation northward. Much of the southern part of the study area is glaciated, with several ice-covered peaks higher than 2,400 m above sea level (a.s.l.). The northern portion is composed of remnant glacial formations and extensive mountain blocks, surrounded by high rolling plateaus. Five river systems drain the area: the Ibex, Takhini, Primrose, Watson, and Wheaton Rivers. Proglacial lakes are found throughout the elevated terrain in the central and northern study area.

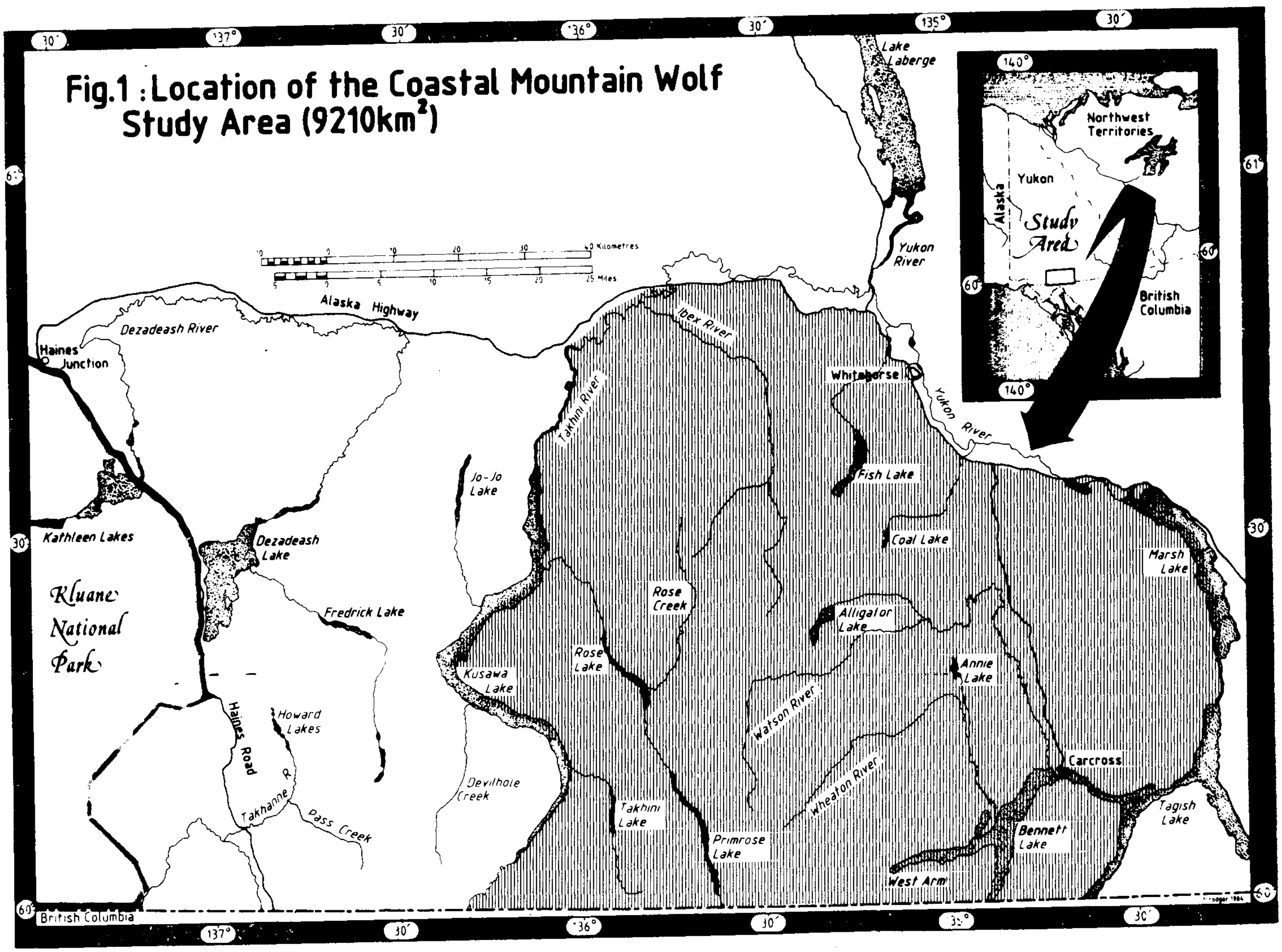

Fig.1 : Location of the Coastal Mountain Wolf Study Area (9210km²)

Most of the area lies above treeline (1050-1200 m a.s.l.) (Oswald and Senyk 1977). The subalpine shrub community is mainly composed of dwarf birch (Betula spp.) and willow (Salix spp.). The headwater valleys of the Wheaton, Watson and Ibex Rivers are dominated by extensive, sparsely-treed subalpine shrub meadows. Lower elevations are characteristically mesic, supporting white spruce (Picea glauca), lodgepole pine (Pinus contorta) and trembling aspen (Populus tremuloides). Soapberry (Sheperdia canadensis) and willow dominate the shrub understory. In the northern area, aspen are common in the seral community, following a major forest fire in 1958.

The study area lies in the St. Elias and Coast Mountains rainshadow and receives between 250-300 mm of precipitation annually. Snow accumulation varies by latitude and elevation, with the deepest snows at high elevations in the south, diminishing northward. By mid-winter, snow above treeline is well-consolidated by wind action and temperature fluctuation, and alpine ridges are usually snow-free. Late-winter snow depths on the valley floors range between 30-60 cm. The average annual temperature is -1 C (Whitehorse station). Between January 1 and April 1 1983, the average temperature was -11.8 C similar to the 10-year Whitehorse station average (-11.3 C). The average wind velocity in Whitehorse was 12.4 km/hr in 1983 with high winds especially prevalent in the Coastal Mountains in late winter.

PREY POPULATIONS

The Yukon's first stratified moose census was conducted in the fall of 1981 by Larsen (1982) in a 19,000 sq.km. area of southwestern Yukon including the wolf study area. Larsen estimated a moose density of 0.17 moose/sq.km. and documented a ratio of 22 calves/100 adult females. Larsen predicted this ratio was too low and could be causing moose numbers to decline in the area. Johnston and McLeod (1983) resurveyed GMZ 7 in October 1982 estimating 20% fewer moose in a 5000 sq.km. area west of Kusawa Lake. They documented continued low calf/cow ratios ranging between 6/100 to 31/100 in various areas. Combined fall surveys by Johnston and McLeod (1983) in GMZ 7, and Markel and Larsen (1983) in GMZ 9 estimated about 1,200 moose in the study area in 1982.

Barichello (pers. comm.) estimated between 2200-2400 Dall's sheep and 100-200 mountain goats (Oreamnos americanus) in the study area. Sheep are distributed throughout the entire alpine zone of GMZ 7 but are absent in the mountains east of the Carcross Road. Goat distribution is limited to the moister southern fringe of the study area along the B.C. border.

Two herds totalling 180-200 woodland caribou range throughout the eastern portion of the study area (Larsen and Nette 1980, Farnell 1982). The Ibex caribou herd, numbering 80-100 animals, occupies alpine and subalpine plateaus from the upper Ibex River and Coal Lake (figure 1) to Bennett Lake. Another 100 caribou summer in the alpine zone on Lorne and Caribou Mountain, east of the Carcross road. In early winter, the herd descends into the spruce-lodgepole pine forest to a complex of low lakes and bogs on the west shore of Marsh Lake (Larsen and Nette 1980).

Mule deer (Odocoileus hemionus hemionus) are uncommon in the southern Yukon and probably do not represent an important prey species for wolves.

The Coastal Mountains provide only marginal habitat for beaver (Castor canadensis) due to the limited availability of forested areas (Slough pers. comm.). Snowshoe hare (Lepus americanus) were rarely observed during the study period, following a major population decline in the winter of 1981-82 (Slough pers. comm.). Marmot (Marmota caligata), arctic ground squirrel (Spermophilus parryii) and porcupine (Erethizon dorsatum) were present but their relative abundance was unknown.

HISTORICAL AND RECENT WOLF EXPLOITATION

Unlike Alaska where localized wolf reduction programs were carried out through the 1970's (Stephenson 1978, Gasaway et al. 1983, Harbo and Dean 1983, Skoog 1983), Yukon wolf populations have received only minor harvesting in the past 10 years. The most recent systematic wolf reduction was a poisoning program carried out in the late 1960's (Smith 1983). Unfortunately, bait stations were not monitored and the program's effects on the wolf population were unknown. The intensive poison coverage in the southwestern Yukon likely resulted in a significant regional wolf decline, especially in our study area where bait stations were concentrated (Yukon Game Branch files).

Since a ban was placed on poison use in 1972, the average annual Yukon wolf harvest has been about 200 wolves (Smith 1983), taken primarily by trappers and resident hunters. Smith estimated that these harvests represented about 5% of the annual Yukon population based on wolf densities observed in comparable Alaskan areas. Keith (1983) speculated that an annual wolf harvest of less than 30% can be sustained by wolf populations in the presence of adequate food through regulatory mechanisms, including compensatory increases in reproduction and pup survival. The low harvest levels in the Yukon since the early 1970's indicate that the wolf population was essentially unexploited and we conclude that wolves in the study area were naturally-regulated for a ten year period between 1972-1982.

PROCEDURES

WOLF POPULATION CENSUS

A wolf census was conducted from February 1 to March 31 1983, using techniques described by Stephenson (1978a). The technique requires fresh snowfall and suitable light conditions to successfully follow wolf trails and locate packs. In this study, suitable fresh snowfall occurred in the southern portion of the study area where the method was used twice over 3,900 sq.km. using Cessna 185 aircraft. The more xeric northern sections received only light snowfall during February and March, inadequate for systematic track surveys. However, this area was flown intensively through the late winter while following instrumented packs or searching for new wolves to collar.

All surveys were conducted by the first and second authors. Prior to surveys, both observers received practical instructions on survey techniques from experienced Alaska Department of Fish and Game (ADF and G) biologists in Tok, Alaska. About 200 aircraft hours were flown during the study period including radio-telemetry and census flights.

A questionnaire was sent to all trapline holders in, or bordering, the study area. The questionnaire requested information on wolf pack sizes and travel areas, fur loss to wolves and wolf harvest. The questionnaire was designed to increase knowledge of pack movements between trapping concessions.

RADIO-TELEMETRY

Wolf packs were initially located by observers in Cessna 185 aircraft and pack members were subsequently pursued by a helicopter (Bell 206B or Hughes 500D) darting crew. Wolves were administered an intramuscular injection of Ketamine Hydrochloride (Parke-Davis) and Xylazine (Rompun, Cutter Laboratories) from a Capchur (Palmer Chemical and Equipment Co.) darting system. Capture attempts were made in most vegetation types. Wolves that entered dense forest cover unsuitable for darting were hazed uphill to subalpine areas where immobilization was completed. A $300.00 live-capture fee was offered to trappers in the study area. Captured wolves were physically-examined and those judged to be uninjured were immobilized, radio-collared and released.

Whenever possible, immobilized wolves were weighed and measured. Each wolf was aged as juvenile (<12 months old), yearling (<24 months old) or adult (>24 months old), based on tooth wear and canine eruption (Ballard et al. 1981, Stephenson pers. comm). Wolves were fitted with an adjustable, fibreglass-reinforced radio collar (Telonics, Mesa ,Arizona) and released following precautions in Ballard et al. (1981). In most cases, personnel attended wolves until initial recovery was observed. Instrumented wolves were subsequently relocated from aircraft equipped with a programmable scanning receiver (Telonics, Mesa, Arizona) and the wolf locations and activities were recorded (Mech 1974). Whenever a wolf pack was located in the same vicinity for two or more consecutive days, an aerial search was made to locate possible ungulate kills.

All wolf-kill sites were examined from the air and, in most cases, moose kills were also examined on the ground. Whenever possible, sex was determined, a lower incisor bar was collected to determine age by tooth cementum annuli (Sargent and Pimlott 1959) and femur or metatarsal marrow fat content (Neiland 1970) was measured to identify severely malnourished animals.

Territory area was calculated by using Mohr's (1947) minimum polygon method for radio locations on 1:250,000 and 1:50,000 topographical maps. Elevation changes were not incorporated into area calculations.

NECROPSY

Wolves retrieved by departmental and private aerial hunters and carcasses voluntarily submitted by trappers were necropsied following procedures described by Stephenson (pers. comm.) and Nielsen (1977). Collected biological data are outlined below.

Carcasses were often delivered in a skinned and frozen state. These were allowed to thaw for a few days before being weighed and measured. For skinned wolves, we estimated unskinned weights by multiplying weights by a factor of 1.1 to account for hide and fur weight (Stephenson pers. comm). Contour length (extending from the nose tip to the base of the tail), chest and neck circumferences were measured. The length of the longest canine was measured between the alveolus to canine tip. The width of the same tooth was measured between the anterior and posterior edges of the canine at the alveolus.

Subcutaneous fat deposits were measured to the nearest mm at the sternum, flank and rump. Xiphoid fat was extracted from the xiphisternum and abdomen, then weighed. Omental fat was rated as absent, low, moderate or high in abundance.

Female reproductive tracts including the bipartite uteri, oviducts and ovaries were removed. The uteri were stored in tap water and frozen. The ovaries were placed in formalin for at least a week to allow sufficient tissue hardening for sectioning. Uteri were opened longitudinally and placental scars (new and old) were recorded. Ovaries were sectioned at 1 mm intervals and the number of corpora lutea and corpora albacantia were noted.

The stomach was opened, contents were identified or collected and the weight was estimated. Helminth parasites were collected from the stomach and gastrointestinal mesentery tissue. The sternum was split to access the thoracic cavity and the interior surface of each rib was examined for healed fractures. Legs and skulls were examined for breaks and any tooth damage was recorded. Skulls of all wolves were collected and those estimated to be older than yearlings were delivered to S. Pederson (ADF and G) for taxonomic identification. Each specimen was aged by canine eruption, premolar and carnassial toothwear and breakage. The presence of epiphyseal cartilage on the distal edge of the radius and ulna was checked to verify juvenile wolves (Rausch 1968). A single premolar was extracted and the root cementum examined to accurately determine age. Premolars were used because they displayed good cementum deposition and were easiest to extract without boiling the skull or destroying the mandible. Cementum analysis procedures were as follows:

The tooth was placed in a tissue capsule and decalcified in a buffered formic acid bath (Fogl and Mosby 1978, Archibald and Jessup 1984). The 45% formic acid bath was mixed with an equal volume of 200 g sodium citrate in a litre of distilled water. After 36 hours, the crown was removed with a scalpel, the tooth was rinsed in running tap water for 12 hours then re-rinsed in distilled water. Root sectioning was performed on a Cryostat Microtome (American Optics). Forty-eight 10 micron thick sections were cut longitudinally from the root to the alveolar interface. Sections were floated in distilled water then mounted on albuminated slides. For each tooth, two slides with 6-8 of the best sections were studied.

After drying at room temperature, the sections were stained in a solution of 80 mg Toluidine Blue O (Fisher Scientific) in 250 ml of distilled water (Thomas 1977). One drop of stain from an eye dropper in 250 ml of stain gave a pH of 8.5. It was found that a neutral , or slightly acidic stain resulted in a minimal annuli definition. After staining for 10-15 minutes, the slides were cleared in a 20% alcohol bath then rinsed in distilled water. After air-drying samples for at least four hours, cover slips were applied with Permount (Fisher Scientific). The interpretation of cementum layers was performed following techniques described by Klevezal and Kleinberg (1969), and Stephenson and Sexton (1974).

One kilogram of wolf skeletal muscle tissue was removed from the upper hindleg and radioassayed for Cesium 137 on a nuclear data spectrometer by D. Holleman (Institute of Arctic Biology , Fairbanks, Alaska), following procedures described in Holleman et al. (1979) and Holleman and Stephenson (1981). The radiocesium technique evalutes wolf food habits by measuring the bioaccumulation of radiocesium in potential prey species and wolves (Holleman and Stephenson 1981). Wolf cesium levels are proportionally related to levels in prey species. Caribou, which feed extensively on lichen and mosses in late winter, have high Cesium 137 (Cs-137) concentrations between 5,000-13,000 pCi/kg wet muscle tissue, while deciduous feeding species, including moose and Dall's sheep exhibit significantly lower Cs-137 concentrations (80-390 pCi/kg) (Holleman pers. comm). To calibrate existing regional prey levels, a moose and caribou were sampled in the study area in late winter.

RESULTS AND DISCUSSION

WOLF INVENTORY AND POPULATION REDUCTION

Five of 10 wolf packs in the study area were radio-marked and memberships were counted on various occassions. The size of four additional packs were estimated from aerial interpretion of wolf trails and verified by trapper observations. Another pack partially removed by an aerial hunter was subsequently estimated by trail counts on two occassions. Based on findings of other studies (Mech 1970, Stephenson 1978a) we added 10% of the pack population to estimate a proportion of lone wolves in the area.

Packs on the study area borders may have occassionally travelled into the study area. Conversely, resident packs were known to range beyond the study area boundaries. For the purpose of inventory, we considered the study area packs as the only residents, although there were probably other wolves that used the area occassionally.

The census estimated a mid-winter population of 94 wolves. Table 1 and figure 2 show the mid and late-winter memberships of 10 packs and their general locations. The minimum mid-winter density was 84 sq.km./wolf, comparable to interior Alaskan densities in the Tanana flats (85 sq.km./wolf) (Gasaway et al. 1983) and Denali Park (80 sq.km./wolf) (Haber 1977). Pack membership averaged 8.6 wolves (SE=1.7, range=4-15), which falls within the range of

6-10 wolves/pack found in unexploited wolf populations studied elsewhere in North America (Mech 1970, Stephenson 1978, Fuller and Keith 1980, Gasaway et al. 1983, Peterson et al. 1984).

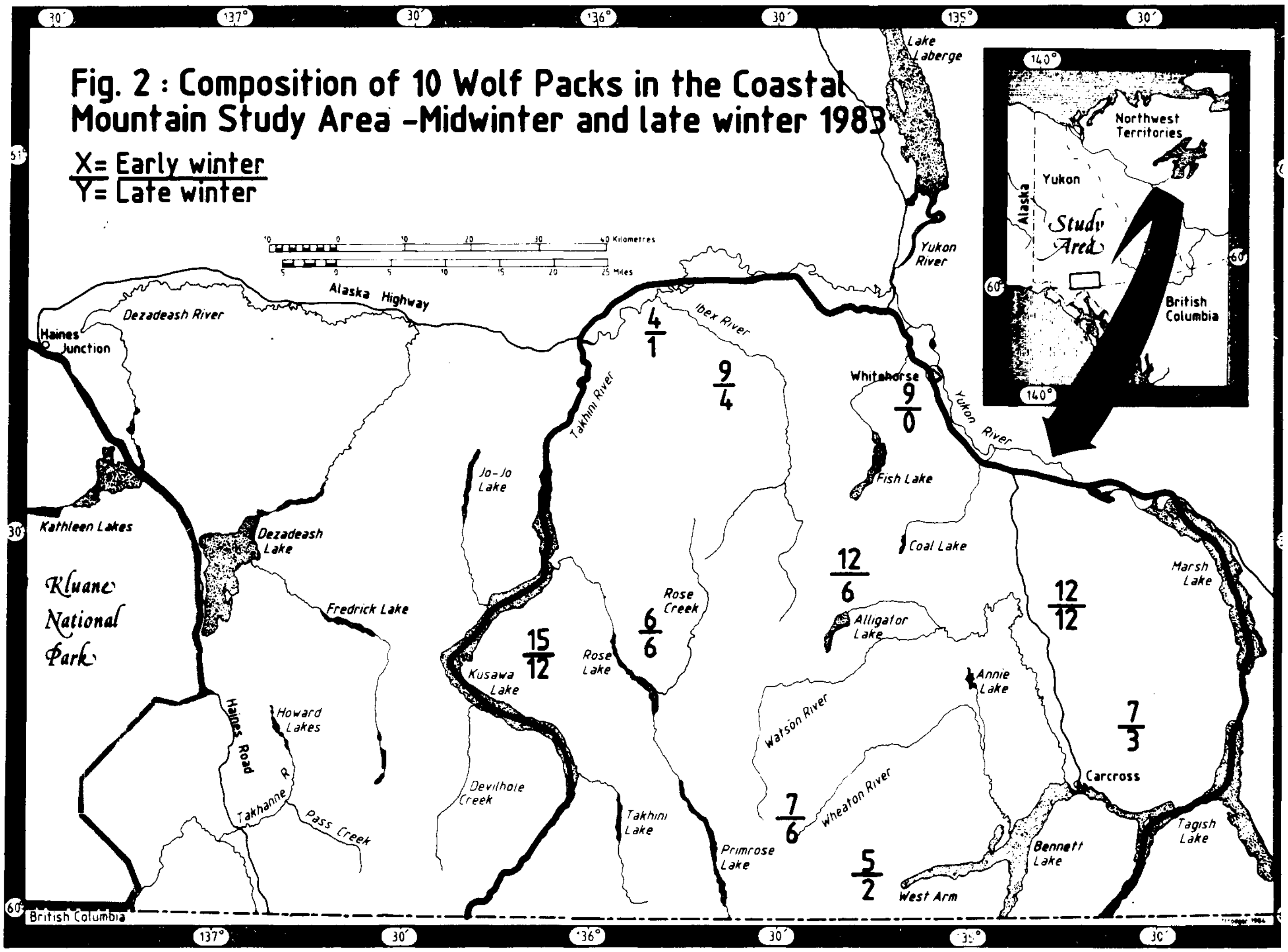

Fig. 2 : Composition of 10 Wolf Packs in the Coastal Mountain Study Area -Midwinter and late winter 1983

TABLE 1. The composition of 10 wolf packs in the study area, mid and late-winter, 1982-83.

Pack Name	Numbers of wolves		
	mid-winter	removed	remaining
Takhini	4*	3	1*
Arkell	9	5	4
Whitehorse	9*	9	0
Sandpiper Creek	15*	3	12*
Primrose	6*	0	6*
Alligator	12*	6	6*
Wheaton River	7	1	6
West Arm	5	3	2
Lorne Mountain	12	0	12
Caribou Mountain	7	4	3
PACK SUBTOTAL	86		
LONE WOLVES	8	0	8
UNKNOWN WOLVES		8	
TOTAL	94	42	52

* represents radio-marked pack

Between October 1, 1982 and April 1, 1983, 77 wolves were killed in the southwestern Yukon, including 42 in the study area and 35 taken near the study area boundaries (figure 3). The number of wolves taken by various techniques are listed in table 2. Fifty-three wolves were killed by resident hunters and trappers, representing 68% of the total southwestern Yukon kill. Within the study area, no complete pack removals were reported by the public and the largest pack proportions removed were 5 of 9 members (55%) of the of Arkell pack, 4 of 7 (57%) of the Caribou Mountain pack, and 6 of 12 wolves (50%) of the radio-marked Alligator pack (figure 2). Outside the study area, seven wolves killed at Frederick Lake and six shot on the north end of Kusawa Lake were the largest groups shot. Both packs had unknown memberships.

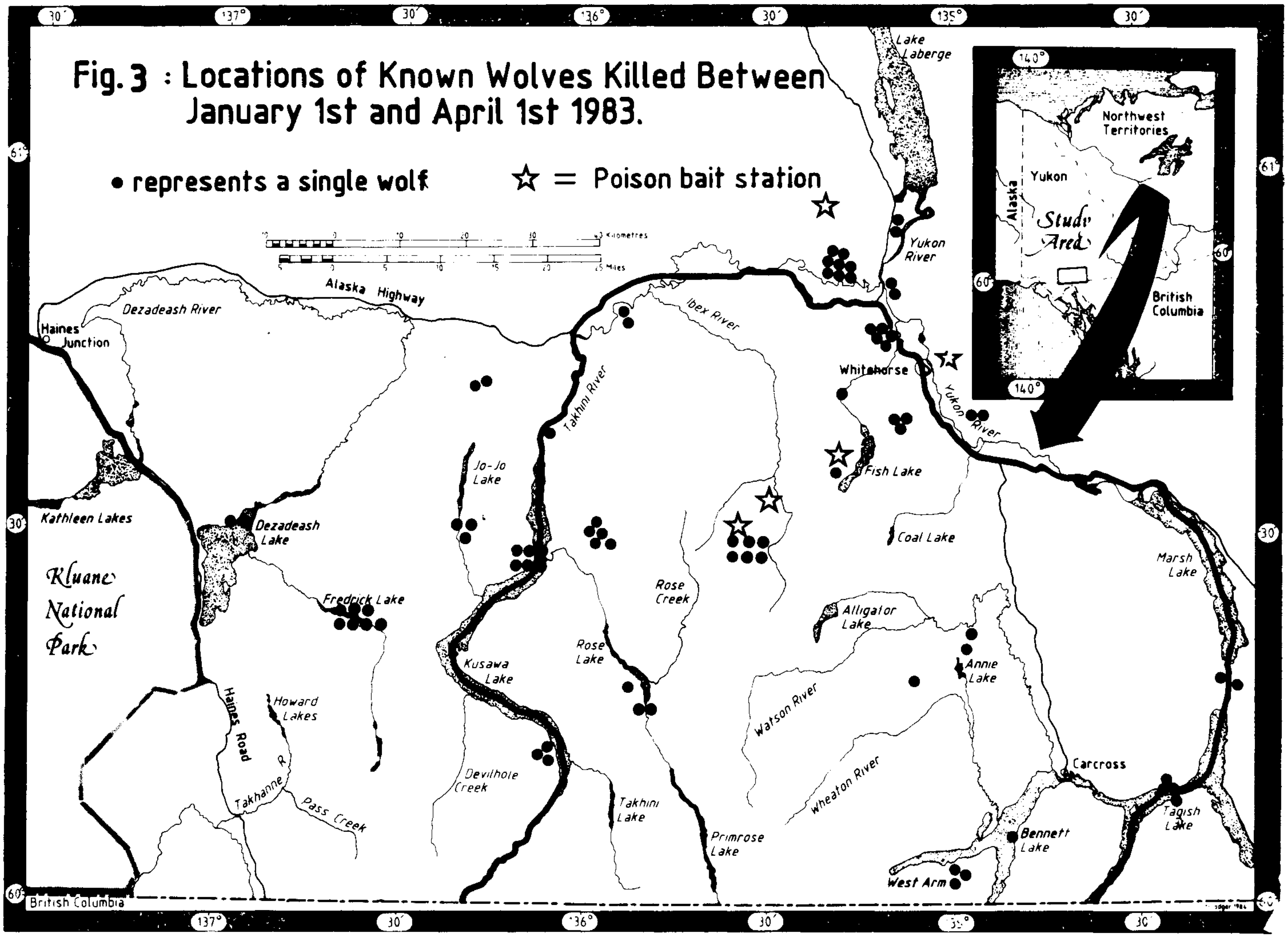

Fig. 3 : Locations of Known Wolves Killed Between January 1st and April 1st 1983.

Aerial hunters were licenced to hunt a 24,400 sq.km. area (figure 4) including the study area, during the period December 15-February 15. Aerial hunters were required to report all shot wolves and present retrieved carcasses to the Department of Renewable Resources. Only five study area wolves were killed by private aerial hunters.

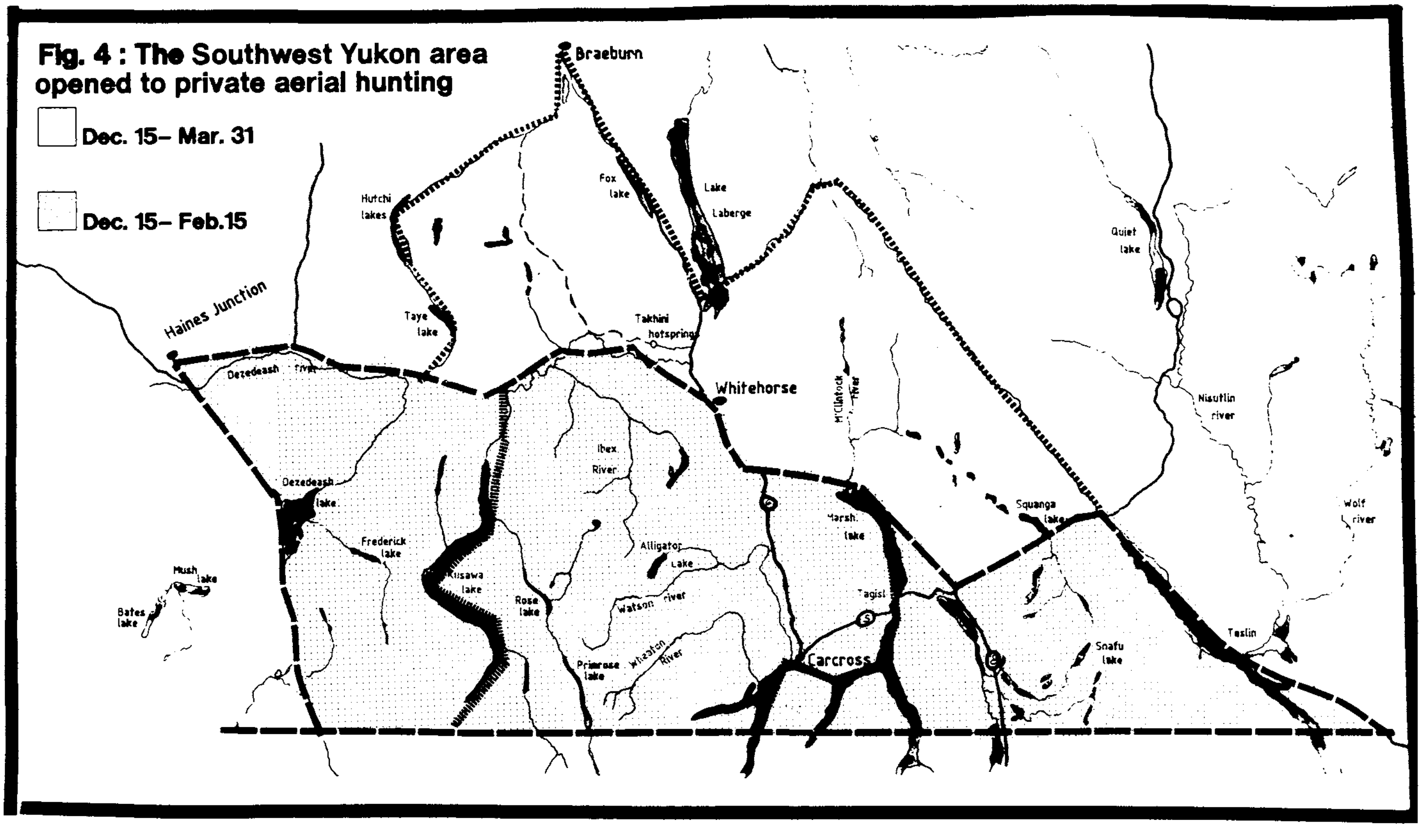

Fig. 4 : The Southwest Yukon area opened to private aerial hunting

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Government wolf control was concentrated in approximately a 30 sq.km. radius of Whitehorse where five strychnine bait stations were monitored between December 15 and January 28 (figure 3). Only three wolves were known to have died as a result of the poison. Departmental aerial hunters shot 10 wolves in response to livestock and pet-related wolf complaints and Wildlife officers trapped or snared five others. In total, 24 wolves were killed within 30 km of Whitehorse. Most wolves were killed singly or in in pairs making it difficult, if not impossible, to determine the pack affiliations of most Whitehorse area wolves. However, three historically reproductive females were shot suggesting that three discrete packs travelled through the city area.

Only 2 of 10 packs (20%) in the study area were unhunted, showing the extensive area of wolf harvest in 1982-83. By late winter, the estimated wolf population had fallen to 52 wolves, a 44 % decline from the mid-winter population: wolf density fell to 152 sq.km. per wolf and average pack size declined to 5.9 wolves per pack.

A total of 38 wolf carcasses, representing 50% of the known harvest, were collected and necropsied including 24 females (63%) and 14 males (37%). Twenty-seven of the carcasses were collected from the study area. Table 3 shows a breakdown of the age structure of the kill. Twenty-four wolves, or 63% of the sample were subadults (juveniles and yearlings). Juveniles were the largest group, representing 34 % of the sample, yearlings comprised 28% and two-year old wolves were 24% of the sample. The oldest adult was a four year old female.

Table 3. The age classes of 38 wolves killed in the south-western Yukon.

AGE	FREQUENCY	PERCENT	CUM. PERCENT
juvenile	13	34	34
yearling	11	28	62
2 years	9	24	86
3 years	4	11	97
4 years	1	3	100
TOTAL	38	100	100

The average weights and external measurements of adults (>24 months) are listed in table 4. Adult males averaged 38.2 kg (n=5,SE=3.21) while females averaged 30.8 kg (n=8,SE=2.12) Contour length, chest and neck circumferences were also greater for males.

Table 4. Average weights and measurements of adult male and female wolves.

VARIABLE	N	AVERAGE	SD	MINIMUM	MAXIMUM
Females					
whole weight(kg)	8	30.8	6.0	24	42
contour length(mm)	7	1217	44.5	1150	1290
chest circum(mm)	8	686	32.6	625	728
neck circum(mm)	8	379	20.2	360	425
Males					
whole weight(kg)	5	38.2	7.2	30	47
contour length(mm)	5	1228	50.7	1170	1280
chest circum(mm)	5	706	62.6	628	780
neck circum(mm)	5	404	40.8	363	460

Recent placental scars were present in 4 of 23 (17%) reproductive tracts. Based on placental scar counts, the average litter size was 3.7 pups (SD=1.2). Two previously-bred females were 3 years old, one was 4 years old and another was 2 years old. Two additional females in the Arkell pack, both 34 months old (two- year old), showed recent corpora lutea indicating they ovulated in the 1983 breeding season.

RADIO-TELEMETRY

Between February 11 and March 5, 11 members from five discrete wolf packs and an additional lone wolf were radio-equipped. Table 5 summarizes biological and radio-frequency data for each wolf and drugging-related data are listed in Appendix 1 table. In total, six females were collared including four adults, one yearling and one juvenile. The age distribution of six collared males was the same as for females. Attempts were made to collar the largest and most elusive pack members, assuming these were the breeding members. To the best of our knowledge, we collared the breeding pairs of the Whitehorse and Takhini packs, the breeding male of the Primrose pack and the breeding female of the Alligator pack. Judgement of breeding or alpha status was made by the following criteria; relatively large size, age greater than 3 years, dominant behaviour or breeding displays. Ten wolves were immobilized and collared from helicopters and two others were collared after being captured by trappers. No capture related mortalities were experienced using Ketamine dosages as high as 15mg/kg. A 31mm needle length was usually sufficient to deliver injections. Annotated histories of the 12 radio-instrumented wolves follow Table 5.

Table 5. Biological and radio-frequency information for radio-equipped wolves in the study area.

PACK NAME	NO.	STATUS**	SEX	AGE*	WT.(kg)	DATE	FREQUENCY
Primrose	6	alpha	M	A	45	Feb 11	150.192
		subord	F	J	34	Feb 11	150.170
		subord	M	J	--	Mar 5	151.100
Alligator	12	subord	M	Y	51	Feb 21	151.040
		subord	F	Y	43	Feb 21	151.000
		alpha	F	5	46	Mar 5	151.151
Takhini	3	alpha	F	A	39	Feb 20	151.020
		alpha	M	A	49	Mar 3	151.090
Whitehorse	3	alpha	M	3	44	Feb 19	151.160
		alpha	F	4	30	Mar 5	151.080
Sandpiper		subord	M	A	45	Mar 3	151.070
Lone wolf		?	F	A	25	Mar 2	151.050

** alpha represents dominant status, subord is subordinate.
* J represents juvenile, Y is yearling and A is adult .

PRIMROSE PACK.

The six-member Primrose pack was first located February 11 at 1500 m near Rose Lake on sheep winter range. Two wolves were captured and collared; an adult, grey-tan alpha male (0192) and a juvenile grey-tan female (0170). Their activities were monitored beginning February 18. On March 5, a juvenile male (1100) was collared while the pack was hunting a band of Dall's sheep rams 2 km south of Mud Lake. During March, the pack was relocated on 10 occasions with most observations occuring in the Rose Creek drainage. Throughout February and March, the pack was observed in the alpine zone on eight of 17 pack days.In most instances the pack was located near wintering sheep and at least two sheep kills were suspected but not confirmed. During the study period, two confirmed ungulate kills were made by the pack; a cow moose killed February 23 and a Dall's sheep of unknown age and sex taken on February 26.

ALLIGATOR PACK

This pack was first instrumented on February 21 when 12 wolves were located on the lower Watson River. Two wolves were collared, a yearling grey-tan male (1040) and a yearling grey-tan female (1000). On March 3, a dead moose was found at Two Horse Creek apparently killed by the pack. The pack killed a calf moose on March 5 near Mud Lake. The bordering Primrose pack was about 2.0 kilometers from this pack on the same day. A large, adult grey-tan female collared near the kill (1151) was verified in May as the breeding female member of the pack. By March 15, the pack had split into 3 groups: wolf 1000 spent about a week alone near the Two Horse Creek kill, 1040 and six others moved north to Mount Ingram near the lower Ibex River and 1151 remained in the upper Ibex drainage accompanied by a large cream-coloured wolf later identified as the alpha male. On March 22, the three collared wolves were seen together and the pack remained in the Ibex mountain area until March 31 although no more than six wolves were ever seen. It is likely that six grey-tan wolves shot at Mud Lake in mid-March were members of the original 12.

TAKHINI PAIR

Contact with this pack was established on February 20 when an adult black-grey female (1020) was trapped by W. Huebeschwerlen and subsequently collared near the Takhini River. Wolf 1020 was relocated February 25 and March 3 with a grey-tan wolf. This yearling male (1090) was immobilized and instrumented on March 3 while feeding on a fresh horse kill. Wolf 1020 remained near the kill and 1090 moved south into the Ibex River with a previously unknown black-grey wolf. On March 22, both collared wolves were located 50 km south of their capture locations. On March 26, 1020 was shot by a private citizen near Kusawa Lake. The horse kill made by this pair was the only known kill.

WHITEHORSE PACK

Initial contact was made on February 19 when a lone, black-grey adult male (1160) was darted and collared at Upper Laberge, 30 km north of Whitehorse. Between the capture date and March 5, three non-visual locations were made within Whitehorse city limits. On March 5, 1160 was observed with two other wolves 15 km west of Whitehorse and a second pack member, a grey-tan coloured adult female (1080), was collared. The pack was hunting a band of three Dall's sheep rams at the time. On March 7, the pack was located in Whitehorse and the three wolves were killed after a dog was reported killed on the same day. All three wolves were adults. Wolf 1080 was previously-bred and aged as 4 years old.

SANDPIPER WOLF

Wolf 1070 was an adult black-grey male collared on March 3 at High Rose Lake. At the time, the wolf was associated with 14 wolves, one of which was shot by trapper L. Metropolit the same day. Between the capture date and March 15, the wolf was relocated on five occasions, moving south from Rose Lake to the Kusawa River headwaters in British Columbia. On each occasion, 1070 was on or near a heavy, fresh wolf trail. After March 15, we were unable to find the wolf in the study area. We suspect this wolf was probably ostracized from the large pack, remaining loosely associated but alone.

LONE WOLF

An adult grey-tan female (1050) was captured in a leg-hold trap at John's Lake by trapper D. Young. In an attempt to improve her emaciated condition, we periodically provided her with horse meat at the capture site. Between March 2-15, 1050 was located 6 times, all of which were within a few kilometers of the capture site. By March 22, she moved northeast to Rose Lake where she remained until April. During the study period, 1050 was not observed at or near any ungulate kills.

WOLF PACK TERRITORIES

In this study, territoriality is defined (Etkins 1964) as " any behaviour on the part of an animal which tends to confine its movements to a particular locality". A radio-instrumented pack territory is described by the minimum polygon area defined by all radio transmitter locations.

The territorial nature of most North American wolf populations has been well-documented in areas where large mammal prey exhibit local seasonal movements (Mech 1970, Peterson 1977, Stephenson 1978, Fuller and Keith 1980, Peterson et al. 1984). Preliminary results from our studies suggest southwestern Yukon wolves occupy discrete territories in late winter. Figure 5 shows the territories of four radio-instrumented wolf packs studied at various intervals (table 6) between February 11 and April 1. Only 2 bordering packs were studied. The Primrose and Alligator packs overlapped activity in a 53 sq.km. area. The overlap was produced when the Alligator pack made a brief movement through the Primrose pack's eastern territory.

The rate of radio-telemetry relocations varied between packs (table 6). The Alligator pack was most intensively monitored at 1.7 days between relocation followed by the Primrose pack at 2.8 days. Pack study periods varied between 39 to 49 days. Wolf sightings were made on 85% of locations showing the generally good visibility of most wolf activity areas. While the short study periods were considered inadequate to delineate complete pack territories, we felt the data were adequate to describe late winter territories of all packs except the Whitehorse pack which was infrequently located. The late winter territories varied between 413-636 sq.km. (table 6). The largest territory was occupied by the 12-member Alligator pack. From the radio-instrumented wolf population we calculated a density of 79 sq.km. per wolf, close to the density of 84 sq.km. derived from wolf surveys.

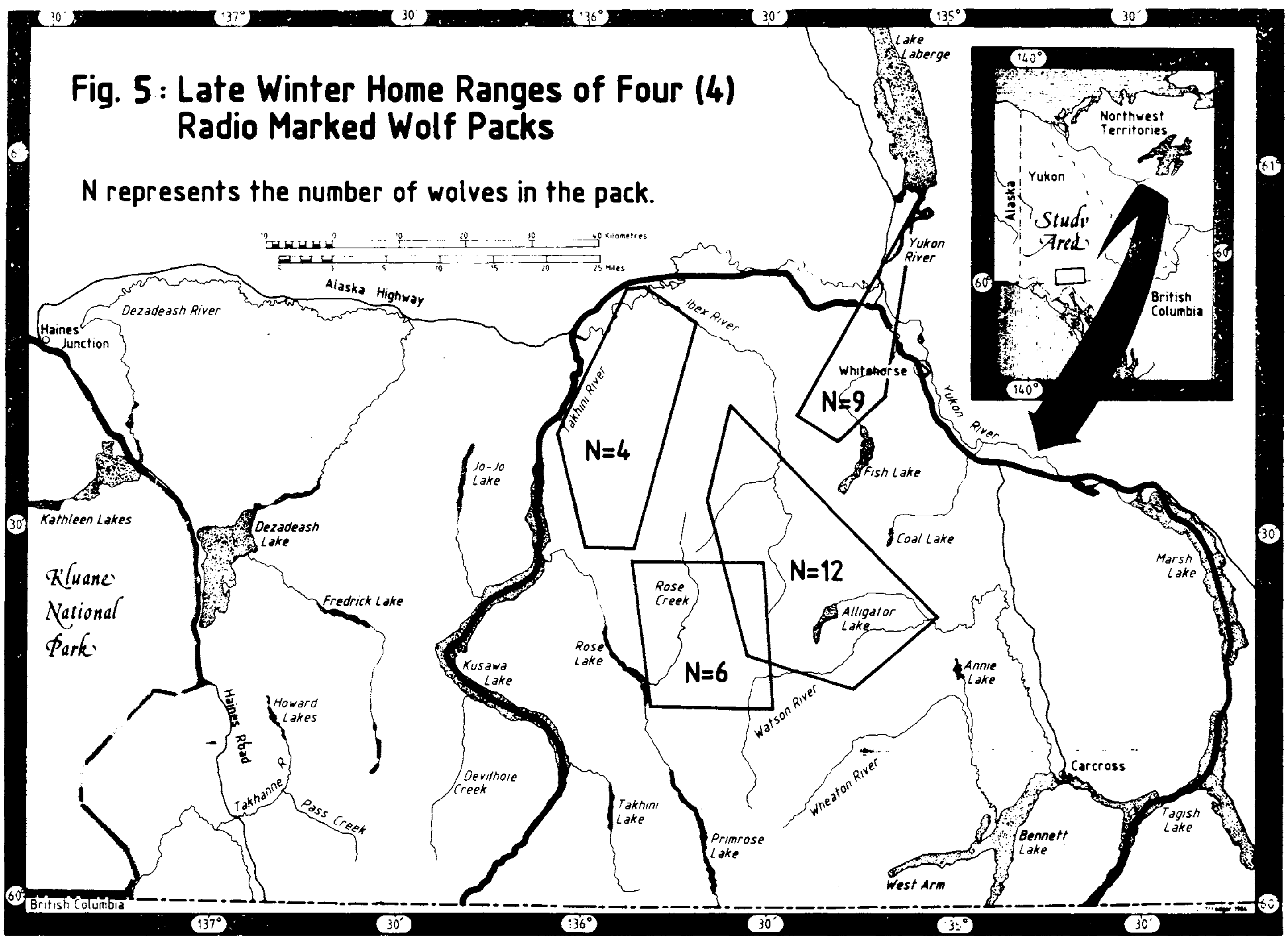

Table 6. Radio-telemetry data from 4 wolf packs studied in late winter.

Pack Name	collars/ pack	Study period (days)	days monitored	x days between locations	sq.km home range	sq.km per wolf
Primrose	3	49	17	2.8	413	69
Alligator	3	39	23	1.7	636	53
Takhini	2	40	13	3.0	550	275
Whitehorse	2	41	7	5.8	215	72

Instrumented wolves were not regularly monitored to document predation on ungulates. A total of four ungulate kills were observed during relocation flights, including three moose, one Dall's sheep and one horse. Factors limiting our ability to observe kills were observer inexperience and aircraft type. The Cessna 185 aircraft had limited low-level and speed capabilities which restricted our ability to detect kills in forested areas and alpine canyons. In addition to observed kills we suspected study packs killed three other moose and two sheep during the study period, based on their prolonged presence in certain areas. Future predation studies will require a low-speed aircraft (Supercub type) to effectively monitor wolf activities.

CHARACTERISTICS AND CONDITION OF WOLF-KILLED UNGULATES

Between Nov 1 and April 1, 19 ungulate carcasses were observed in the southwestern Yukon (figure 6). All were suspected to be wolf kills based on the presence of wolves or their sign near the carcass. Evaluation of carcass condition suggested that the animals likely did not die of other causes (see below). The total prey composition was as follows; 17 moose, one Dall's sheep and one horse. We landed at eight moose mortality sites, collecting incisor bars for ageing. The sample included three calves and five adults ranging between 3 and 10 years old. The average age of adults was 6.4 (SD=2.5) years. We considered the sample too small to compare calf/adult ratios of kills with the same ratio in fall survey populations.

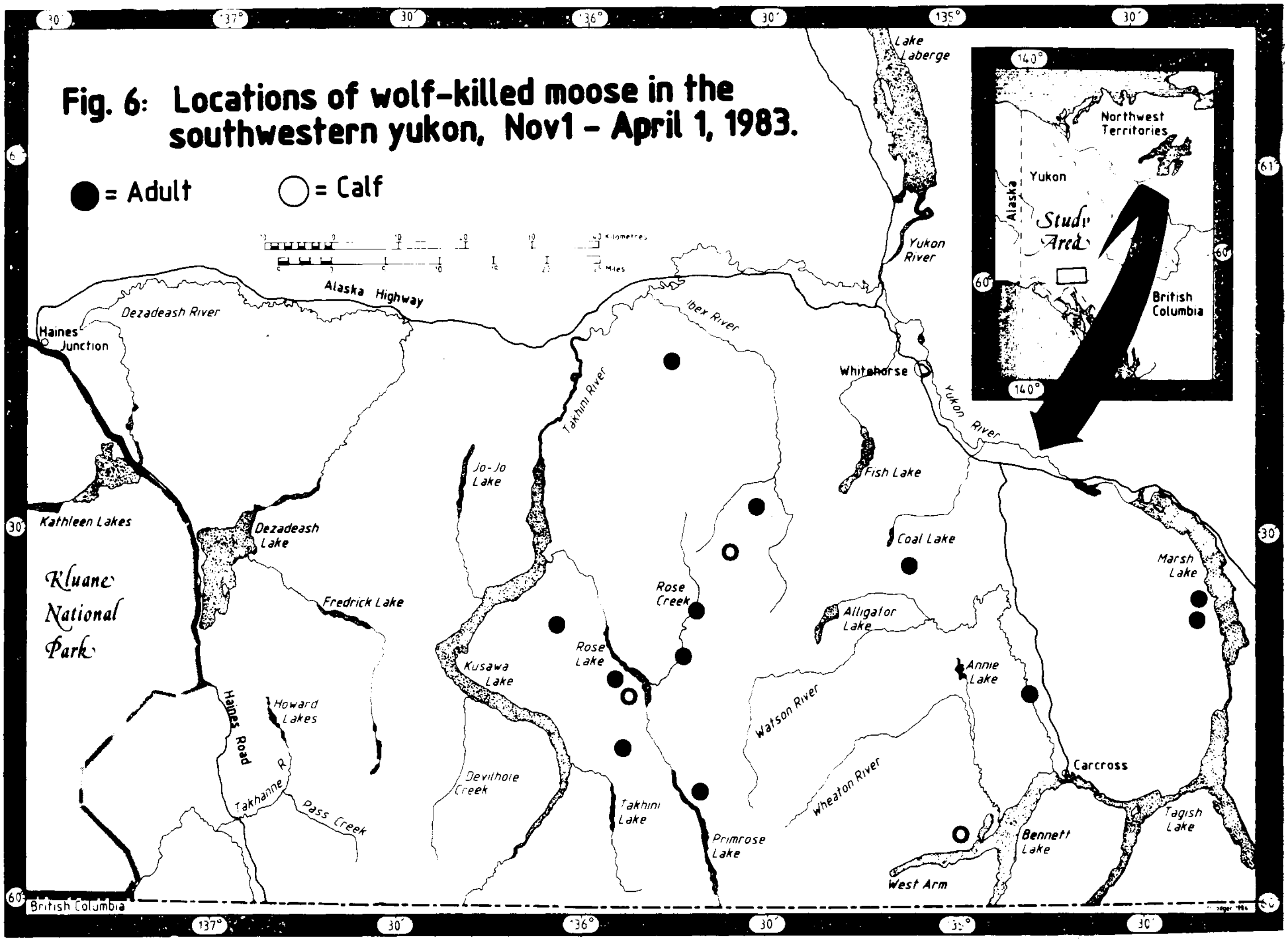

Fig. 6: Locations of wolf-killed moose in the southwestern yukon, Nov1 - April 1, 1983.

Bone marrow fat analyses showed the calves ranged between 39-60%: adults ranged between 75-99% fat. Peterson et al. (1984) noted that winter moose calves generally have less fat reserves than adults due to the calves growth requirements. Adults averaged 89% (n=6 ,SE=3.64) and calves averaged 46.6% (n=3, SE=6.69). Stephenson and Sexton (1972) and Peterson et al. (1984) noted that adult Alaskan moose suffering from severe malnutrition characteristically had marrow fat levels of less than 20% and calves less than 10%. Our marrow fat data indicated that malnourished moose were not present in the prey sample.

The local habitat of each mortality site was documented. Moose kills were most frequently observed on lake or creek ice (52%). Five kills (26%) were found in subalpine shrub or shrub-conifer communities at treeline. We recognize that biases operate to favour kill observations in these open habitat types rather than under forest canopy cover. Intensive monitoring of radio-instrumented packs is neccessary to establish comparisons between habitat and successful hunting by wolves in the area.

Table 7. Characteristics of winter moose mortalities.

PLACE	AGE	SEX	MARROWFAT	DATE KILLED
Lewes Creek	-	f	-	Nov 2 82
Little River	-	-	-	Nov 17 82
Ibex Mountain	-	-	-	Dec 1 82
Primrose River	-	m	-	Dec 25 82
Rose Creek	-	-	-	Jan 1 83
John's Lake	-	m	-	Jan 15 83
Watson Siding	3	f	95	Jan 15 83
West Arm	ca*	-	60	Jan 20 83
Arkell Creek	-	-	-	Unknown
Sandpiper Ck.	10	f	93	Unknown
Rose Lake	-	f	75	Feb 9 83
Rose Lake	ca	-	41	Feb 9 83
Two Horse Ck.	-	-	-	Feb 23 83
Monkey Creek	6	f	99	Mar 1 83
Monkey Creek	7	m	90	Mar 1 83
Mud Lake	ca	-	39	Mar 5 83
Rose Creek	6	m	82	Mar 17 83

* ca represents calf of the year.

RADIO-CESIUM

Analyses of nine study area wolves that were sampled for Cs-137 showed generally low levels (table 8). The average cesium level was 634 pCi/kg(SE=220) indicating that predation on caribou was low. Two wolves contained levels between 1200-1400 pCi/kg. Holleman (pers. comm.) suggested that levels between 1000-3000 pCi/kg showed light caribou predation. Both wolves were collected from the winter range of the Ibex caribou herd in the east-central study area (pers. obs.). No samples indicated significant use of caribou, nor were any caribou kills found during the study period. The low density of caribou in the area and their localized winter distribution likely limits their selection by wolves. An objective of cesium analyses will be to derive an index to differentiate between moose and sheep cesium levels.

Table 8. Cesium (Cs-137) concentrations from 9 wolves collected from the study area in late winter.

ID	AREA	AVERAGE pCi/kg	STANDARD DEVIATION
0113	Whitehorse	1346*	48
0114	Champagne	355	35
0116	Jo Jo Creek	517	37
0122	Wheaton River	815	44
0127	Tagish Creek	742	47
0130	Arkell Mountain	183	39
0135	West Arm of Bennett L.	1287*	50
0100	Sandpiper Creek	164	30
0111	Jo Jo Lake	386	33

* indicates light caribou use (Holleman pers. comm).

WOLF/MOOSE RATIOS

Based on a long term population study in interior Alaska, Gasaway et al. (1983) provided a wolf/moose ratio index to predict the effects of wolf predation on moose population dynamics. In summary, they concluded that when there are less than 20 moose/wolf and moose are the primary prey species, wolf predation would usually be sufficient to cause a decline in moose numbers and lower the survival rates of calf and adult cohorts: at 20-30 moose/wolf , predation alone could limit the moose population and a static or declining population would be largely dependent on combined effects of other factors: At ratios less than 30 moose/wolf, wolf predation could be significant but not neccessarily limit growth. Gasaway et al. (1983) noted that ratios were only predictive in naturally-regulated moose populations. Excessive additive mortality from hunting, severe winters and natural predation could cause a decline regardless of the ratio size. We calculated a ratio of 8-12 moose/wolf in a 6400 sq.km. portion of the study area where Larsen and Markel (1983) conducted moose inventories. The ratio suggests that wolf predation is likely causing a decline in moose numbers in the area. Between 1981-1982, moose numbers in the study area were stable at about 800 animals (Larsen and Markel 1983). The census technique produced a variance range between 10 to 30% in various regions, therefore declines or increases of less than these values between years would remain undetected.

CONCLUSIONS

Prior to wolf reduction, the population status of southwestern Yukon wolves was apparently healthy in 1982-83. A general assessment of physical condition indicated that most wolves were in good to excellent physical condition based on adipose tissue ratings. A number of wolves collected from the Whitehorse area were in relatively poor condition and their presence near the city was likely due to reduced natural prey densities around Whitehorse. Moose density was lower in accessible areas of the southwestern Yukon (Larsen pers. comm.) suggesting that human harvest was largely responsible for the lower density near Whitehorse. The concentration of wolves in livestock areas was likely related to a low availability of natural prey in 1982. It is also notable that the incursion of wolves into Whitehorse coincided with a major die-off of snowshoe hare in February 1982. The loss of this prey base, in conjunction with depressed wild ungulate numbers around Whitehorse, was probably responsible for the increased density of wolves in Whitehorse in autumn, 1982.

The wolf density of 84 sq.km. in the study area is within the range of densities observed in other unexploited populations in Alaska (Haber 1977, Gasaway *et al.* 1983, Peterson *et al.* 1984).It is difficult to determine if the resident wolf population was increasing, decreasing or stable without *a priori* wolf census data.

Wolf population reduction in the study area was about 44% or perhaps higher, given the significant number of wolves killed on the edges of the study area - especially at Whitehorse and Kusawa Lake. With government aerial hunting restricted to the northeast corner of the area, ground shooting and trapping were the most important harvest methods and together were responsible for nearly 70% of the regional harvest and 50% of the study area harvest.

Assuming that the necropsied wolf sample (49% of total) reflects the biological status of the total known harvest, then the wolf age classes were mainly represented by juvenile, yearling and two-year old wolves (86%). Since no complete pack removals were recorded, it is difficult to assess the pre-reduction population status using age class proportions (Keith 1983). Incomplete pack reductions likely selects for younger-aged wolves and against older, more experienced wolves that would be more likely to escape. The low proportion of adults in the sample (14%) is probably related to this inherent bias. As a result, it is not possible to empirically define the population status of the wolf population based on the present sample by following Keith's

(1983) age index. If the sample was representative, the 34% juvenile proportion would predict a stable or declining population.

Our present radio-telemetry data is inadequate to describe territorial relationships between packs or their spatial requirements. The late winter activities and distribution of two bordering packs suggest wolves establish unique territories and concentrate activities in certain portions of their home ranges. Radio-telemetry predation data is inadequate to assess selection of ungulates, but in combination with incidental observation of ungulate kills in the study area, it appears that moose are the primary prey species. The sample of 19 moose kills showed mainly adults were taken and assessment of moose condition showed no individuals that were within the range for starving moose in Alaska. Our study sample was considered too small to test differences in age or sex of moose kills.

Wolf/moose ratio predicts that the pre-reduction wolf population should cause a decline in moose numbers in the area regardless of other additive mortality agents. Grizzly bear predation on neo-natal moose calves (Larsen, in prep.) appears to be limiting recruitment into the population and wolf predation, human harvest and natural mortality are probably causing excessive mortality in adult cohorts.

From this initial year of study, we identify a number of important wolf ecology questions that need to be addressed. Firstly, the prey base utilized by study area wolves remains largely unknown. While moose were the most commonly found prey carcass, we also recognize that, by its large size and contrasting colour on snow, this species would be more likely observed than sheep. Presently, there are about twice as many Dall's sheep in the study area compared to moose. Moose appear to be declining in certain areas of the southwestern Yukon and the adaptive nature of wolves will likely allow for a predation shift to sheep, if wolves were not previously selecting sheep as a primary prey. To document predation rates of wolves on the resident ungulate populations, we propose to study the activities of two or three radio-instrumented wolf packs in late winter 1983-84. Secondly, we have limited wolf predation data on moose cohorts. Using the above mentioned study, we will collect intensive wolf predation data on moose age classes, in addition to continued incidental collection of winter moose mortality data over the entire study area.

APPENDIX 1

Drugging-related Data

A Ketamine/Rompun mixture of 6:1 was administered to all wolves. Initially, the Ketamine concentration was prepared at 9 mg/kg based on a maximum wolf weight of 60 kg. Actual mean weights in the following table indicate we administered most males with a mean concetration of 11 mg/kg and 15 mg/kg for female wolves. Induction* and anaesthesia** periods varied between individual wolves. The average induction time for all wolves was 5.6 (SD=3.9) minutes ranging between 1-14 minutes. Anaesthesia time was more variable averaging 13 (SD=11.5) minutes and ranging from 3-40 minutes.

In 9 of 13 cases (70%) additional drug was required to fully immobilize wolves after the initial 3 cc injection was administered. In most of these cases, wolves had reasonable control of the head, including general movement and eye-blinking responses. Some wolves periodically stood up, lunged and fell forward while under 3 cc dosages. The mean dosage to fully immobilize all wolves was 5.3 (SD=2.3) cc's. The range was 3-12 cc's.

While no significant sex related differences (t.025) were observed for induction and anaesthesia time, both ranges were greatest for males suggesting the mean male dosage (11 mg/kg) was too low. An increase in the male dosage to 15-20 mg/kg could cause the induction period to decline but recovery period wil probably be extended.

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* Induction time was the period elapsed between first drug contact and signs of first immobilization effects, usually the loss of rear leg coordination.

** Anaesthesia time was the period from first hit to unconciousness.

Table. Drugging information for immobilized wolves.

No.	Sex	Wt.(kg)	No. of Minutes: Induction	Anaesthesia	Recovery	CC's
1020	F	---	4	13	43	6
1090	4	49	7	30	--	5*
1170	F	---	2	5	118	6
0192	M	---	5	6	138	6*
1100	M	46	8	22	--	4*
1850	M	---	2	6	--	3
1121	M	---	11	15	--	6
1000	F	43	3	9	61	6*
1040	M	52	3	40	150	12
1150	F	46	3	8	64	3
1160	M	44	1	3	70	3
1080	F	30	2	4	--	3
1070	M	45	14	17	--	6
	mean		5.6	13	62	5.3
	standard dev.		3.9	11	36	2.3
	range		1-14	3-40	43-130	3-12

* indicates additional drug was administered by hand following a dart injection.

LITERATURE CITED

Archibald, W.R., and R.H. Jessup, 1984. Population dynamics of the pine marten (Martes americana) in the Yukon Territory. Pages 81-97 In Olsen, R., F. Geddes, R. Hastings (Eds.). Northern ecology and resource management, 1984. University of Alberta Press, Edmonton, Alberta.

Ballard, W.B., R.O Stephenson, and T.H. Spraker, 1981. Nelchina basin wolf studies. Alaska Dept. Fish and Game, Fed. Aid. Wildl. Rest. Final Rep. Proj. W-17-8 through W-17-11. 201 pp.

Etkin, W., 1964. Cooperation and competition in social behaviour. pages 1-36 In Etkin, W. (Ed.). 1964. Social behaviour and organization among vertebrates. Univ. Chicago Press, Chicago, Illinois.

Fuller, T.K., and L.B. Keith, 1980. Wolf population dynamics and prey relationships in northeastern Alberta. J. Wildl. Manage. 44(3):583-602.

Farnell, R., 1982. Incidental observations and relocations of the Ibex caribou herd. Yukon Fish and Wildl. Br. annual report.

Fogl, J.G. and H.S. Mosby, 1978. Aging gray squirrels by cementum annuli in razor-sectioned teeth. J. Wildl. Manage. 42:444-448.

Gasaway, W.C., R.O. Stephenson, J.L. Davis, P.E.K. Sheperd, and E.O. Burris, 1983.Interrelationships of wolves, prey, and man in interior Alaska. Wildl. Monogr. 84. 50pp.

Haber, G.C., 1977. Socio-ecological dynamics of wolves and prey in a subarctic ecosystem. University of British Columbia. Ph.D. thesis. 586 pp.

Harbo, S.J., and F.C. Dean, 1983. Historical and current perspectives on wolf management in Alaska. Pages 51-64 in L.N. Carbyn (ed.) Wolves in Canada and Alaska, their status , biology and management. Can. Wildl. Serv. Rep. Ser. 45. Ottawa.

Holleman,D.F., R.G. White, J.R. Luick, and R.O Stephenson, 1980. Energy flow through the lichen-caribou-wolf food chain during winter in northern Alaska. Pages 202-206 in Reimers,E., and S. Skjenneberg (eds.) Proc. 2nd Int. Reindeer/Caribou Symp., Roros, Norway.

Holleman, D.F., and R.O. Stephenson, 1981. Prey selection and consumption by Alaskan wolves in winter. J. Wildl. Manage.45(3):620-628.

Johnson, W.G., and H.A McLeod, 1983. Population dynamics and early winter habitat utilization by moose (Alces alces) in the southwest Yukon Territory. Unpubl. Rep. Yukon Fish and Wildl. Br., 53 pp.

Jessup, H., 1983. The Yukon wolf incentive program. Yukon Fish and Wildl. Br. annual rep.

Keith, L.B., 1983. Population dynamics of wolves. pages 66-77 in L.N. Carbyn (ed.) Wolves in Canada and Alaska, their status , biology and management. Can. Wildl. Serv. Rep. Ser. 45. Ottawa.

Klevezal, G.A., and S.E. Kleinenberg, 1969. Age determination of mammals by layered structure in teeth and bone. Fish. Res. Bd. Can. Transl. Ser. No. 1024. 141 pp.

Larsen, D.G., and T. Nette, 1980. Moose census in the Lorne-Caribou mountain area. Unpubl. rep., Yukon Fish and Wildl. Br.

Larsen, D.G., 1982. Moose inventory in the southwest Yukon. Alces 18, pages 142-167.

Markel, R., and D.G. Larsen, 1983. 1982 Moose surveys: study areas 5 and 7. Unpubl. Rep. Yukon Fish and Wildl. Br. 37 pp.

Mech, L.D., 1970. The wolf: the ecology and behaviour of an endangered species. Natural History Press, New York, N.Y. 384 pp.

Mech, L.D., 1974. Current techniques in the study of elusive wilderness carnivores. Trans. Int. Congr. Game Biol. 11:315-322.

Mohr, C.O., 1947. Table of equivalent populations of North American small mammals. Am. Midl. Nat. 37(1):223-249.

Nielsen, C.A., 1977. Wolf necropsy report: preliminary pathological observations. Alaska Fed. Aid Wildl. Rest. Prog. Rep. Proj. W-17-8 and W-17-9. 129 pp.

Neiland, K.A., 1970. Weight of dried marrow as indicator of fat in caribou femurs. J. Wildl. Manage. 34(4):904-907.

Oswald, E.T. and J.P. Senyk, 1977. Ecoregions of the Yukon Territory. Fisheries and Environment Canada, Victoria. 115 pp.

Peterson, R.O., 1977. Wolf ecology and prey relationships on Isle Royale. U.S. Natl. Park Serv. Sci. Monogr. Ser. 11. 210 pp.

Peterson, R.O., J.D. Woolington, and T.N. Bailey, 1984. Wolves of the Kenai peninsula. Wildl. Monogr. 88. 52 pp.

Pimlott, D.H., J.A. Shannon and G.B.K Kolenosky, 1969. The ecology of the timber wolf in Algonquin Park. Ontario Department of Lands and Forests Research, Rep. no 87. 92 pp.

Rausch, R.A., 1968. Wolf studies. Alaska Fed. Aid Wildl. Rest. Prog. Rep. Proj. W-15-R-2 and 3. 51 pp.

Sergeant, D.E., and D.H. Pimlott. 1959. Age determination in moose from sectioned incisor teeth. J. Wildl. Manage. 23(3):315-321.

Skoog, R.O., 1983. Results of Alaska's attempts to increase prey by controlling wolves. Acta Zool. Fennica 174:245-247.

Smith, B.L., 1983. Status and management of wolves in the Yukon Territory. pages 48-50 in L.N. Carbyn (ed.) Wolves in Canada and Alaska, their status , biology and management. Can. Wildl. Serv. Rep. Ser. 45. Ottawa.

Stephenson, R.O., and J.J Sexton , 1974. Wolf report. Alaska Fed. Aid Wildl. Rest. Prog. Rep. Proj. W-17-5 and 6. 28pp.

Stephenson, R.O., 1978. Unit 13 wolf studies. Alaska Fed. Aid Wildl. Rest. Prog. Rep. Proj. W-17-8. 75pp.

Stephenson, R.O., 1978a. Characteristics of exploited wolf populations. Alaska Fed. Aid Wildl. Rest. Prog. Rep. Proj. W-17-3 through W-17-8. 21 pp.

Thomas, D.C. 1977. Metachromatic staining of dental cementum for mammalian age determination. J. Wildl. Manage. 41:207-210.

WOLF POPULATION RESEARCH AND MANAGEMENT STUDIES IN THE YUKON TERRITORY, PROGRESS REPORT 1983

2. The Finlayson caribou management area.

R. Hayes Wildlife Biologist II
R. Farnell Wildlife Biologist II

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Yukon Fish and Wildlife Branch Annual Report.

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INTRODUCTION

During fall composition counts in 1981 and 1982 , Farnell (1982) documented low recruitment rates in the Finlayson Lake woodland caribou herd in the east-central Yukon. Calf/cow ratios, an index of herd recruitment potential, was only 16.5 calves / 100 cows in fall 1982. This fall recruitment rate was considered too small to sustain the herd given the present mortality factors operating on the herd. Subsistence and sport harvest removed about 11 percent of the herd in 1982 (Farnell 1982) and the calf/cow ratio was low prior to the winter period when wolves (*Canis lupus*) traditionally exert the greatest predation pressure on ungulate populations. Most residents of Ross River who traditionally hunted the woodland caribou (*Rangifer tarandus caribou*) felt the herd was declining in recent years.

While empirical harvest and natural mortality data were limited, Farnell (1982) suggested that excessive subsistence and sport harvest on adults, and wolf predation on young age classes were the major factors limiting the herd. In fall 1982, a management experiment was introduced to initiate a population recovery in the herd. A bulls-only sport hunting season was implemented ; an education program was initiated in a effort to reduce native harvest levels ; and a three year, 50-70 percent wolf reduction was recommended in the FCH range.

This report describes the wolf population status in the area and presents the results of the initial year of wolf reduction, based on the necropsy studies of 88 wolf carcasses. Detailed caribou population data are discussed in Farnell (1982) and should be consulted for a comprehensive overview of the problem.

OBJECTIVES

The objectives of 1982-83 wolf studies were;

1. To make a preliminary assessment of wolf numbers and density in the study area.
2. To incidentally document wolf predation on caribou and moose (*Alces alces*) during the winter.
3. To describe wolf winter distribution and wolf population variables, including age, sex , physical condition and prey selection based on necropsied wolf specimens.

STUDY AREA

1. Physiography, Vegetation and Climate

The 23,000 sq. km study area is located in east-central Yukon (figure 1), roughly bordered by the North Canol Road to the west, the Nahanni Range Road to the east, the St. Cyr Range of the Pelly Mountains to the south and the MacKenzie Mountains to

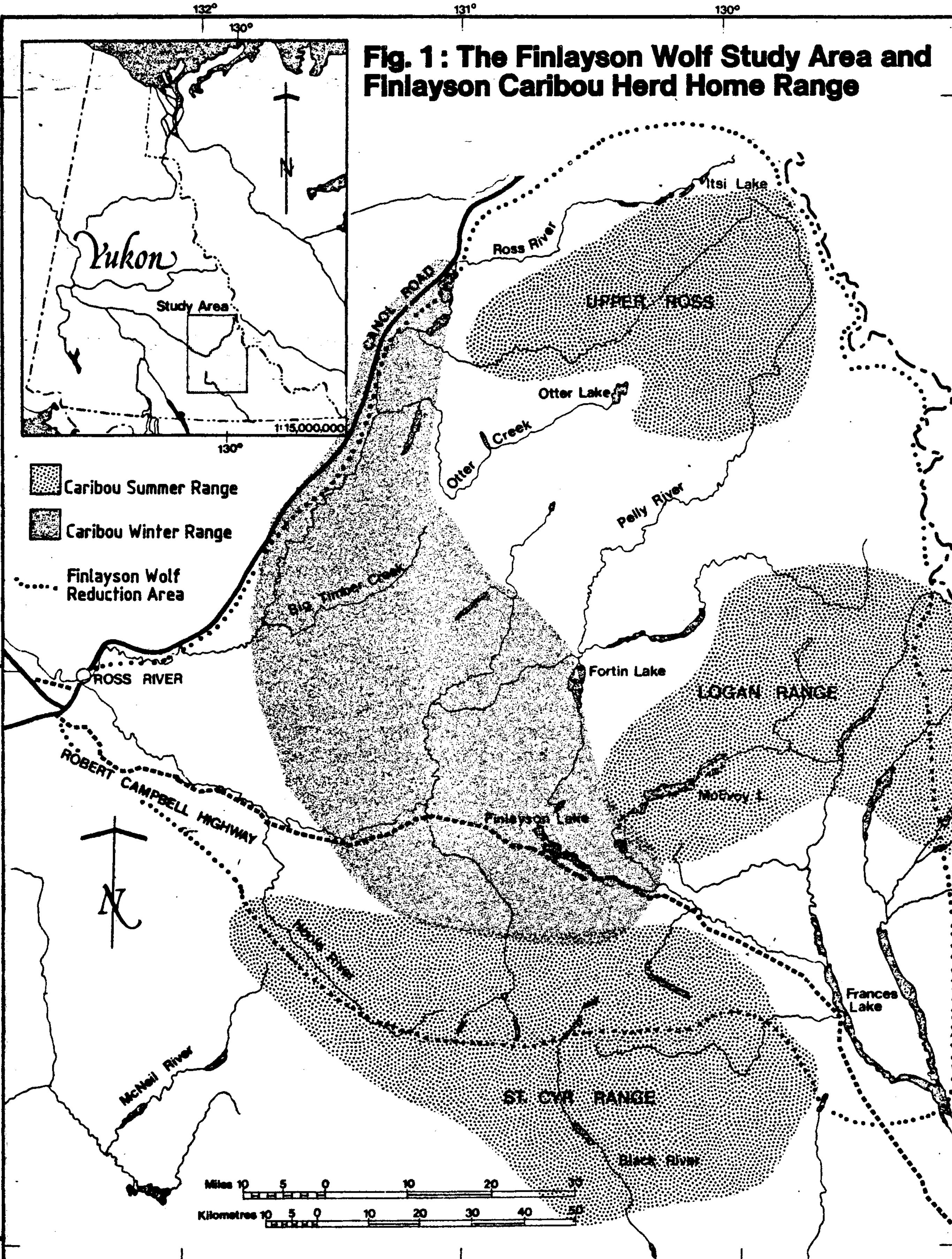


Fig. 1: The Finlayson Wolf Study Area and Finlayson Caribou Herd Home Range

the north . Oswald and Senyk (1977) provide detailed descriptions of this area, which forms portions of the Pelly River, Mayo Lake-Ross River and Itsi Mountains Ecoregions. Most of the FCH winter range lies in the Pelly Plateau and Tintina Trench, where the terrain consists of rolling upland plateaus, hills and small tableland mountain groups separated by generally broad U-shaped valleys. Valleys are vegetated by open black spruce (Picea mariana) and lodgepole pine (Pinus contorta) forests. Well-drained upland areas are dominated by white spruce (Picea glauca) and aspen (Populus tremuloides) forest. Paper birch (Betula papyrifera) is scattered throughout the lowlands and alpine fir (Abies lasiocarpa) is common in the subalpine. Lakes are common in the central study area, providing important travel areas for wintering caribou and wolves.

The St. Cyr Range in the southern study area is moderately high relief over 1500 m. The extensive subalpine zone is found from valley floors to 1350 m and is mainly vegetated by dwarf birch (Betula sp.) and willow (Salix sp.). Lichens ,sedge (Carex sp.) tussocks, ericaceous shrubs and willow dominate the alpine tundra (Oswald and Senyk 1977).

The southern flank of the MacKenzie Mountains , which forms the north and northeastern study area, is characterized by rugged high peaked mountains. Most terrain is above treeline (1350-1500 m) and subalpine willow and birch form the prevalent communities.

Precipitation increases from southwest to northeast in the study area. The St. Cyr Mountains receive about 400-500 mm annually and the northeastern study area receives 750 mm in the MacKenzie Mountain foothills (Oswald and Senyk 1977).

2. Ungulate Populations

The Finlayson Caribou herd is the predominant caribou herd in the study area. Farnell (1982) described the winter and summer distribution of the herd.

Moose are common throughout the study area. During early winter, moose concentrate in post-rutting groups in the subalpine shrub zones of most upper tributaries of the MacKenzie and Pelly Mountains (Farnell and Nette 1981). During late winter, deep snow conditions likely cause moose to move down from the subalpine areas (Markel and Larsen 1982) to lowland riparian and burn areas, often mixing with wintering caribou in the study area lowlands (Farnell 1981). Farnell (in prep.) documented that wolves shift from upland summer areas to lowlands in response to this midwinter ungulate concentration.

METHODS

The wolf population was estimated by a combination of methods: wolf packs and trails were noted during caribou surveys throughout the winter; wolf distribution information was collected from licenced aerial hunters, trappers and resident hunters; and wolf pack distribution and composition was documented during an extensive aerial hunting program carried out between March 6-12, 1983.

Trappers, private aerial and ground hunters, and government aerial hunters (GAH) participated in the wolf reduction. Private aerial hunters used primarily fixed-wing aircraft. Wolves were open to licenced aerial hunters between Jan 1 and April 30,1983 in a 28,110 sq. km area, including Game Management Subzones (GMS) 10-06 to 10-09,10-19,11-02,11-04 to 11-18,11-20 to 11-23 and 11-25. Aerial hunters were required to report all killed wolves and retrieve carcasses for necropsy.

Government aerial hunting was conducted from a Bell 206 B Jet Ranger helicopter. Twelve gauge shotguns and small calibre centre-fired rifles were used to dispatch wolves. Whenever wolf trails were encountered, the tracks were followed until the wolves were located or the trail was lost. During late-winter, snow accumulations between 50-87 cm (Farnell 1983) in the boreal forest restricted wolf movements to areas along river and creek drainages and lake margins. These areas were flown most intensively during March. Attempts were made to kill all pack members . In most cases, carcasses were retrieved and immediately skinned by Tensley Johnston, a registered trapper at Finlayson Lake. Carcasses were delivered to the Whitehorse lab and necropsied following procedures described in Hayes et al. (1985).

During game surveys, the location of all dead ungulates were documented. Whenever possible , prey mandibles were collected to determine age (Sargent and Pimlott 1959) and long bone marrow fat was sampled (Neiland 1970) to determine low physical condition.

RESULTS

1. Wolf Population

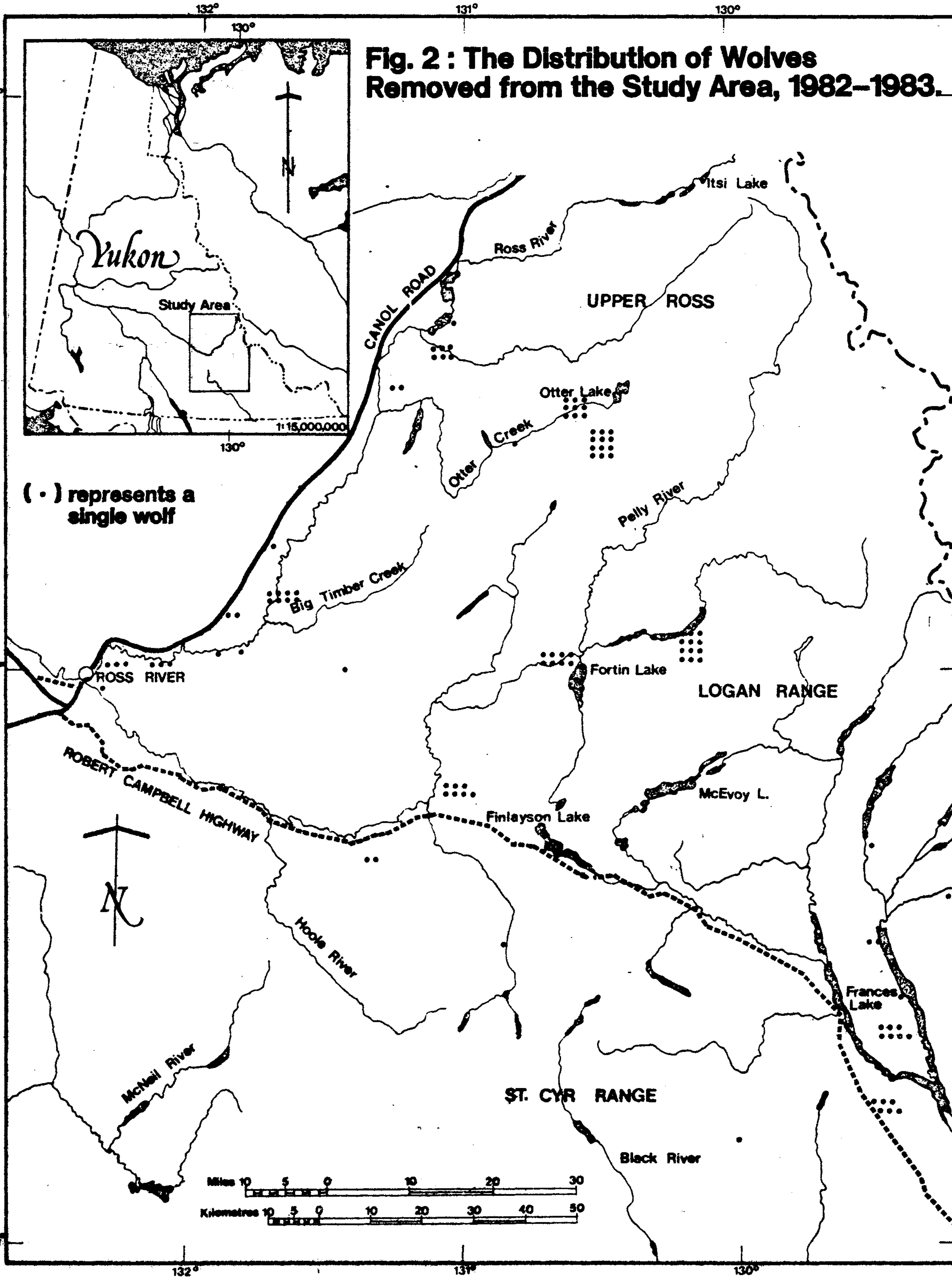
From wolf surveys and hunter reports, we estimate that about 200 wolves ranged within the FCH management area in the winter 1982-83. During late winter wolf surveys, 10 discrete packs were observed. We recorded a minimum density of one wolf / 97 sq. km in the survey area . In addition to pack wolves, we added 10 percent of the pack population to account for lone wolves (Mech 1970, Gasaway et al. 1983).

Pack membership ranged from 6 to 13 wolves. Average pack size was 9.6 wolves (SE=1.25), similar to the average pack size of 9.3 wolves found by Gasaway et al. (1983) in a naturally regulated wolf population in interior Alaska.

2. Wolf Reduction

A total of 105 wolves were killed in the FCH management area. Seventy-seven (73 percent) were killed by GAH and the

Fig. 2 : The Distribution of Wolves Removed from the Study Area, 1982–1983.



remainder were taken by private hunters and trappers (table 1). Ten packs were completly or partially removed by GAH. Three packs of 12, 6 and 11 wolves were completely removed, and the majority of wolves in six other packs were killed. Only one wolf of the six member Whitefish Pack was shot. Additionally, two lone wolves of unknown pack affiliations were removed. Departmental aerial hunters removed 77 of 98 wolves encountered and all but seven carcasses were retrieved. Figure 2 shows the distribution of the wolf harvest in the area.

With the exception of the sex of each DAH-shot wolf which was determined by field inspection, no additional biological data collected from carcasses could be assigned to packs because of improper marking after skinning.

Table 1. Wolf harvest information from Finlayson Management Area, March 1983.

Departmental Aerial Hunting

		Wolves	Sex			
Date	Packname	No. Pack	No. Shot	M.	F.	Retreived
830118	Whitefish	6	1		1	1
830228	Frances	8	6	4	2	6
830228	Big Timber	10	8			8
830306	Pelly Lake	12	12	5	7	12
830307	Solitary		1	1		1
830307	Slate Rapids	8	7	4	3	7
830308	Prevost	6	6	2	4	6
830308	Otter Lake	13	9	1	3	4
830311	Raider Lake	11	11	5	6	11
830311	Solitary	1	1		1	1
838012	Simpson	12	7	2	3	5
830319	Fortin	10	8			8
Subtotal		98	77			70
Private aerial hunters			15			
Sport hunters			5			
Trapping			8			1
Total			105			87

3.Necropsy

a. Age

Forty-three females (49 %) and 45 males (51 %) were necropsied. Table 2 summarizes the ages of 79 wolves aged by tooth cementum annuli. Fifty-two (66 %) were subadult wolves less than 24 months old, including 28 juveniles (less than 12 months old), 21 yearlings (less than 24 months old) and three unknown age subadults. Juveniles represented 36% of the sample, yearlings were 27% and adults were 34%.

Table 2. The age structure of killed wolves in the Finlayson Management Area.

Age Class	Months	Freq	Percent	Cum. Percent
Juvenile	<12	28	36	36
Yearling	<24	21	27	63
Juv. or Yrl.		3	4	67
2 year	<36	16	20	87
3 year	<48	4	5	91
4 year	<60	3	4	95
6 year	<84	3	4	99
8 year	<108	1	1	100
Total		79	100	

b.Sex

Except for yearling and two year old classes , both sexes were equally represented in most age groups. Yearling female frequency was 3 times (12) that of males (4). Two year old males (11) were twice as numerous as females (5). The comparatively small proportion of yearling males in the sample may be related to differential age dispersal in wolves. Additional data collection will be necessary to test this hypothesis.

Table 3. Finlayson wolf ages by sex.

Sex	Juv	Yrlng	Juv/Yrlng	2	3	4	6	8	Total
F (freq)	12	12	5	5	2	1	2	0	39
(%)	15	15	6	6	3	1	3	0	49
M (freq)	14	4	5	11	2	2	1	1	40
(%)	18	5	6	14	3	3	1	1	51
Total									
(freq)	26	16	10	16	4	3	3	1	79
(%)	33	20	13	20	5	4	4	1	100.

c.Weights and Measurements

Weights and external morphological measurements of adult males and females are listed in table 4. Males , with an average weight of 43 kg were heavier than females which averaged 36 kg. Male weights ranged between 36 kg (79 lbs.) to 50 kg (110 lbs); females varied between 29 kg (64 lbs.) and 45 kgs.(101 lbs). Males were also larger in contour length , chest circumference and neck circumference (table 4).

Table 4. Weights and external morphological measurements of Finlayson wolves , listed by sex.

	Females				Males			
	n	mean	min	max	n	mean	min	max
Weight (kg)	10	36	29	45	17	43	36	50
Length (mm)	10	1198	1115	1400	18	1308	1234	1460
Neck circ.(mm)	10	399	369	520	18	464	373	630
Chest circ.(mm)	10	707	648	830	18	764	672	920

d. Adipose Tissue Levels

Fat tissue levels were measured to evaluate the physical condition of each wolf . Tissue sites measured included omental fat attached to gastro-intestinal mesentery tissue, xiphoid fat and subcutaneous fat measured at sternum , rump and flank sites.

Ninety-three percent of examined wolves carried moderate to high omental fat (table 5). Xiphoid fat varied between 21 to 351 grams in females, and 41 to 374 grams in males. The presence of significant levels of xiphoid and omental fat indicated that most wolves were in healthy condition.

Some wolves carried low levels of subcutaneous fat. We expected individual variations among pack members since there are commonly social restrictions on feeding , especially among ostracized or peripheral pack members (Mech 1970). We compared subcutaneous fat to age and sex groups and found that all groups included some low level individuals.

Table 5. Omental fat levels of Finlayson wolves .

Omental fat	frequency	percent
absent	0	0
low	6	7
moderate	41	49
abundant	37	44
total	84	100

e.Stomach Contents

Stomach analysis showed that moose were the most frequently observed prey occuring in 82 percent of stomachs containing prey (table 7). Woodland caribou were found in only 8.5 percent. Forty-six percent of the wolves sampled had empty stomachs. Small mammal remains were found in only one wolf, supporting conclusions of other winter wolf food habits studies which showed large ungulates to be significantly more important than small mammals in the winter diet (Mech 1970, Nielsen 1977,Fuller and Keith 1980).

Table 7. Stomach contents of Finlayson wolves.

Contents	N	Percentage of full stomachs	Percentage of total
empty	41	0	47
moose	39	83	44
caribou	4	9	5
furbearer	1	2	1
vegetation	2	4	2
unknown	1	2	1
total	88	100	100

f.Wolf Productivity

Five previously-bred females exhibiting placental scars were collected (table 8). Four of the wolves also showed recent corpora lutea activity in ovaries indicating they had ovulated in the 1983 breeding period. Additionally, three yearlings and one two-year old wolf exhibited corpora lutea but no corpora albacantia or placental scars. This indicates they were in their first breeding year. The average last litter size, based on placental scar counts, was 4.2 embryos (SE=0.5), ranging between 3-6 per female. The youngest previously bred female was two years old and the oldest was six (table 8).

g.Prey Kill Sites

A total of 33 moose and 7 caribou mortality sites were documented during the study period (figure 3). Most observations were made during late winter caribou and wolf surveys (31), followed by incidental pilot (5) and trapper reports (4). All sites showed wolf feeding sign and we assumed that all ungulates were killed by wolves.

Eighty-one percent of the moose kill sites were found on ice, meadow or in open deciduous forests. The incidental nature of kill site searches probably biased our observations to the most visible sites.

Initial collection of incisor bars and long bones were inadequate to determine age and condition of ungulate prey. Four moose ranged between 1 to 14 years old (mean=4.4 years) and the marrow fat levels of five moose averaged 75 percent, which is substatially higher than the 10-20 percent levels found in starved moose in Alaska (Franzmann and Arneson 1976). No moose in our sample were within this starved range. Further collection would be required to determine more accurate age and condition

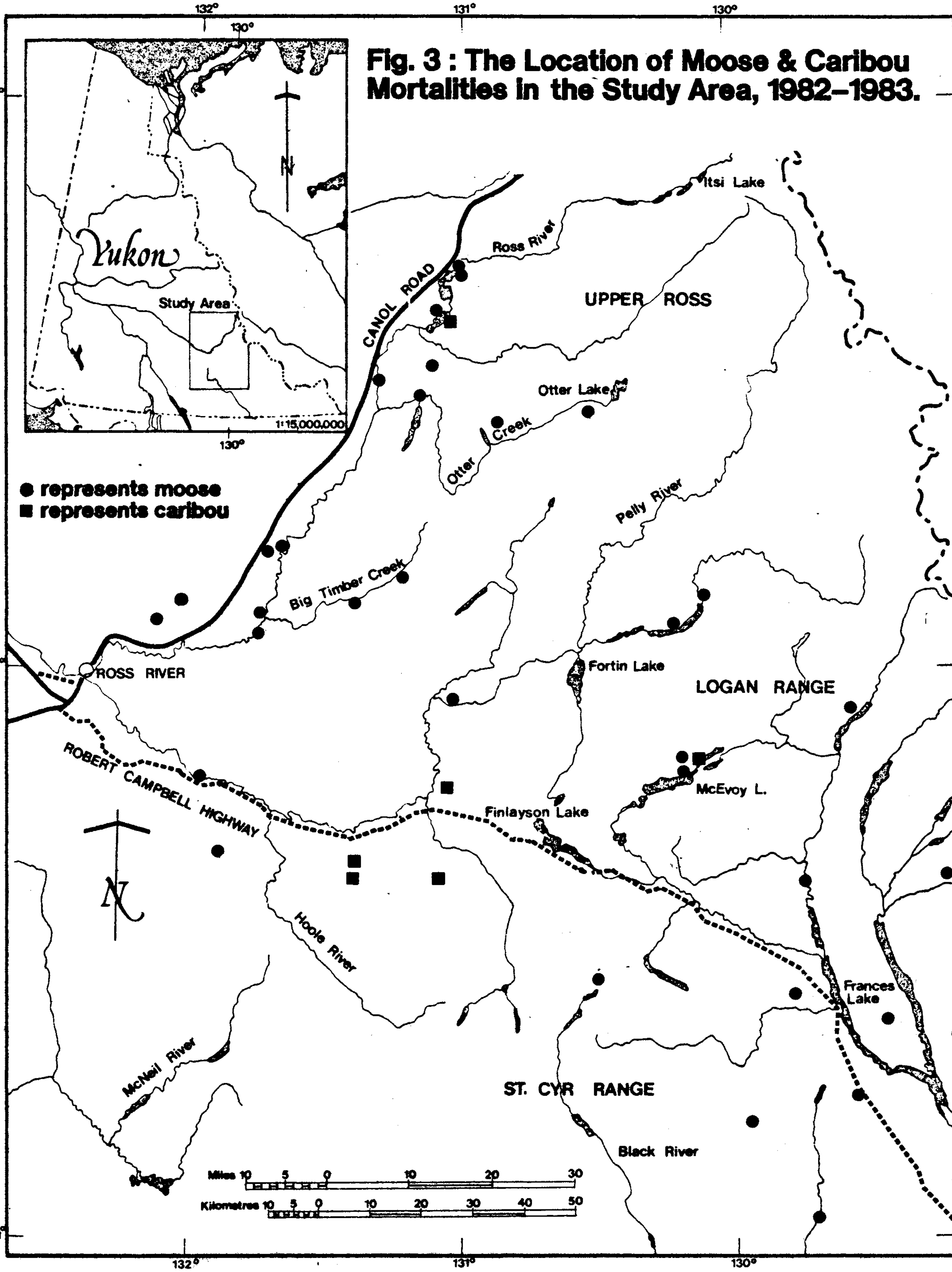


Fig. 3 : The Location of Moose & Caribou Mortalities in the Study Area, 1982–1983.
● represents moose
■ represents caribou
Yukon
Study Area
1:15,000,000
Itsi Lake
Ross River
UPPER ROSS
CANOL ROAD
Otter Lake
Otter Creek
Pelly River
Big Timber Creek
ROSS RIVER
Fortin Lake
LOGAN RANGE
McEvoy L.
Finlayson Lake
ROBERT CAMPBELL HIGHWAY
Hoole River
Frances Lake
McNeil River
ST. CYR RANGE
Black River
Miles 10 5 0 10 20 30
Kilometres 10 5 0 10 20 30 40 50
132°
131°
130°
63°
62°
61°
tcrodger : carto / graphic / design

relationships of wolf prey.

Table 8. Reproductive data from nine active females.

Age (months)	Placental scars	Corpora lutea
82	4	10
46	3	0
34	0	5
22	0	8
22	0	5
22	0	1
34	4	8
58	6	12
34	4	4

h.Radio-Cesium Studies

Wolf prey selection and consumption can be estimated by the radiocesium method (Holleman and Stephenson 1981). Cesium 137 analysis provides a relative index of late winter prey consumption by measuring the bioaccumulation of radioactive cesium transferred from prey species to wolves. Theoretically, lichen-grazing caribou accumlate much higher levels than deciduous-browsing moose (Holleman pers. comm). As a general rule, wolves feeding exclusively on moose in late winter have Cs-137 concentrations of less than 1000 Pci/kg;1000-3000 Pci/kg suggests light use of caribou ; 3000-7000 Pci/kg suggests moderate use and 7-10,000 indicates extensive use of caribou (Holleman pers. comm).

Thirty-nine skeletal muscle samples were obtained and assayed for Cs-137 (table 9). Less than half (43.6%) showed low levels, 38% showed light cesium levels between 1000-3000 pCi/kg and moderate to high levels were found in 17.9% of the wolves sampled. Most wolves were killed outside the caribou herd winter range and the low-light cesium levels are likely a result of this distribution. In the southern portion of the control area where caribou were common, wolves were left largely undisturbed due to tracking difficulty and logistical constraints. Improved sampling in this area should provide a more complete analysis of cesium levels throughout the study area.

Table 9. The distribution of radio-cesium levels from 39 wolves sampled in late winter.

pCi/kg (wet)	Level	Frequency	Percentage
0-1000	low	17	43.6
1001-3000	light	15	38.5
3001-7000	moderate	1	2.6
7001-15000	high	6	15.3
total		39	100.0

DISCUSSION

The pre-removal density of 98 sq. km/wolf indicates that a comparatively dense wolf population occupied the study area during the winter 1982-83. Unexploited and naturally-regulated wolf densities of 84 sq. km/wolf in the southern Yukon (Hayes et al. 1985) and the Tanana Flats , Alaska (Gasaway et al. 1983) probably represent the upper density limit in Alaska-Yukon interior forests. In the Finlayson area, recent wolf harvests by trappers and hunters have been low , representing less than 1-2 percent of the annual population. We conclude that wolf numbers have been naturally regulated in recent years in the study area.

Wolf population age distribution has been previously identified as an index of wolf population trends (Pimlott et al. 1969, Keith 1983), and there is sufficient evidence to show that the proportion of pups increase in exploited wolf populations. He concluded that stationary, unexploited populations had pup proportions of less than 30 percent and exploited populations showed pups comprising 30-73 percent. Using Keith's age index , the 36-40 percent pups in our sample would predict an exploited population prior to removal, contrary to our knowledge of recent low wolf harvest levels. There are a number of possible explanations. First, the Finlayson wolf population may have been an unexploited, non-stationary one during 1982-83 - the high pup proportion suggesting an increasing wolf population. If the population was an unexploited one, declining in response to reduced prey availability, we would expect that late-winter pup survivorship should be low due to intraspecific competition and mortality (Mech 1970).

Another explanation may lie in a differential vulnerability of wolf age classes to exploitation - wolf pups, being less experienced, more curious and slower than adults, may be represented in wolf removal samples in a proportion that is greater than they occur in the natural population; especially when non-selective control methods such as poisoning are used. Aerial hunting will also produce an upwardly biased pup proportion whenever partial pack removal occurs ,because the more elusive, experienced adults will be more likely to escape than pups. An example of this occured in our study. Only five breeding females were killed from 10 packs encountered by government aerial hunters. If we arbitrarily assume that all 21 escaped wolves (table 1) were adults, the pup proportion would be reduced to 28 percent. The real pup proportion probably falls somewhere between 28-40 percent. Until vulnerability factors can be incorporated in age distribution analyses, it is not possible to confidently establish the trend of our pre-removal population.

Keith's review also compared the reported exploitation rates of 13 wolf populations with the resulting post-removal trends. He concluded that declines occurred when removals exceeded about 38 percent of fall populations . He also suggested that compensatory increases in reproduction or pup survivorship permit an estimated sustained harvest of about 30 percent of fall populations. Mech

(1970) and Peterson et al. (1984) suggested that some wolf populations can sustain annual harvests of up to 50 percent. Peterson et al. (1984) showed that natural mortality , dispersal loss, and unreported harvest or human-caused mortality added an additional 18 percent over winter loss to a 25 percent reported wolf harvest on the Kenai peninsula.This suggests that most systematic wolf reduction programs underestimate the entire over-winter mortality of studied wolf populations, especially in areas where unreported trapper and hunter harvests occur. Mortality underestimations, however, may be partially compensated by a general underestimation of actual wolf numbers since it is difficult to completely enumerate a wolf population. Nevertheless, it is probably safe to conclude that a reported 38-50 percent of fall wolf numbers is sufficient to cause a population decline.

About 50 percent of the Finlayson wolf population was killed in the study period. The naturally-regulated wolf population surrounding the study area will likely provide substantial and immediate recolonization of vacant territories. Additionally, the presence of known , potentially reproductive females surviving the reduction will probably regenerate wolf numbers in 1983-84 to near pre-reduction densities .

Moose were the most important winter prey of wolves based on stomach content , Cesium-137 analysis and incidental kill observations . The low frequency of caribou kills observed , low cesium levels and minor occurence in wolf stomachs indicate they were relatively unimportant compared to moose.

Certain conditions probably biased our prey data to moose-eating wolves. In comparison to large ,readily visible moose kills, caribou kill sites were likely less visible. In late winter, caribou were foraging under the coniferous forest canopy and kills were likely missed during wolf and caribou surveys. Furthermore, tracking wolves through heavily trailed caribou winter range is difficult and wolves using these areas would less likely be encountered than wolves outside the caribou activity area. Figure 2 shows that most wolves were killed outside the core winter range of the FCH. Consequently, incidental kill observation, Cesium 137 and stomach analyses are biased toward moose-selecting wolves. Prey selection by wolves in the caribou winter range was not adequately determined in 1982-83. An increased removal of wolves in the core caribou winter range in 1983-84 will provide us with more empirical data to assess wolf prey selection in relation to ungulate distribution. The removal of peripheral wolf packs may, however, reduce wolf predation on caribou on the summer ranges where the post-calving groups receive the highest juvenile mortality (Bergerud 1978). The absence of wolves from these portions of the study area in winter suggest they move from these low density ungulate winter areas to concentrate in the lowland caribou and moose winter ranges. While we have no distribution data from summer months, wolves probably disperse from winter ranges to moose and caribou calving and post-calving areas in response to ungulate dispersals.

LITERATURE CITED

Bergerud, A.T., 1978. The status of caribou in British Columbia. Fish and Wildlife Branch, Province of British Columbia.

Farnell, R., 1982. Investigations into the status of the Finlayson Lake caribou herd, 1981 to 1982. Unpubl. Rep. Yukon Fish and Wildl. Br.

Farnell, R., and T. Nette, 1981. Moose and caribou investigations in the MacMillan-Howard's Pass development area. Unpubl. Rep. Yukon Fish and Wildl. Br.

Farnell, R., 1983. Winter caribou and wolf surveys -Finlayson management program, March 1983. Unpubl. Rep. Yukon Fish and Wildl. Br.

Franzemann, A.W., and P.D. Arneson, 1976. Marrow fat in Alaskan moose femurs in relation to mortality factors. J. Wildl. Manage. 44:583-602.

Fuller, T.K., and L.B. Keith, 1980. Wolf population dynamics and prey relationships in northeastern Alberta. J. Wildl. Manage. 44(3):583-602.

Gasaway, W.C., R.O. Stephenson, J.L. Davis, P.E.K. Sheperd, and E.O. Burris, 1983.Interrelationships of wolves, prey, and man in interior Alaska. Wildl. Monogr. 84. 50pp.

Hayes, R.D., P. Merchant, and A. Baer, 1985. Wolf population research and management studies in the Yukon, 1983 annual report. Yukon Fish and Wildl. Br. Ann, Rep.

Holleman, D.F., and R.O. Stephenson, 1981. Prey selection and consumption by Alaskan wolves in winter. J. Wildl. Manage.45(3):620-628.

Keith, L.B., 1983. Population dynamics of wolves. pages 66-77 in L.N. Carbyn (ed.) Wolves in Canada and Alaska, their status , biology and management. Can. Wildl. Serv. Rep. Ser. 45. Ottawa.

Markel, R.L., and D.G. Larsen, 1982. MacMillan pass moose surveys. Unpubl. Rep. Yukon Fish and Wildl. Br.

Mech, L.D., 1970. The wolf: the ecology and behaviour of an endangered species. Natural History Press, New York, N.Y. 384 pp.

Nielsen, C.A., 1977. Wolf necropsy report: preliminary pathological observations. Alaska Fed. Aid Wildl. Rest. Prog. Rep. Proj. W-17-8 and W-17-9. 129 pp.

Neiland, K.A., 1970. Weight of dried marrow as indicator of fat in caribou femurs. J. Wildl. Manage. 34(4):904-907.

Oswald, E.T. and J.P. Senyk, 1977. Ecoregions of the Yukon Territory. Fisheries and Environment Canada, Victoria. 115 pp.

Peterson, R.O., J.D. Woolington, and T.N. Bailey, 1984. Wolves of the Kenai peninsula. Wildl. Monogr. 88. 52 pp.

Pimlott, D.H., J.A. Shannon and G.B.k Kolenosky, 1969. The ecology of the timber wolf in Algonquin Park. Ontario Department of Lands and Forests Research, Rep. no 87. 92 pp.

Sergeant, D.E., and D.H. Pimlott. 1959. Age determination in moose from sectioned incisor teeth. J. Wildl. Manage. 23(3):315-321.