AISHIHIK AND KLUANE CARIBOU RECOVERY PROGRAM

NOVEMBER 1992 TO OCTOBER 1993

Progress Report • October 1994

PR 94 - 2

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Director, Fish and Wildlife Branch

Supervisor

The projects reported here are continuing and any conclusions are tentative. 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.

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INTRODUCTION

This report summarizes field activities carried out as part of the Aishihik and Kluane Caribou Recovery Program from November 1992 to October 1993. Because of the ongoing nature of the program, the results presented here are preliminary. Analyses and discussion of the results are therefore limited and no conclusions have been made.

BACKGROUND

The Aishihik and Kluane Caribou Recovery Program was designed to recover a declining woodland caribou (Rangifer tarandus caribou) herd and moose (Alces alces) population in the southwest Yukon. Under this program studies are being undertaken to determine the long-term effects of human hunting and wolf (Canis lupus) predation on woodland caribou, moose, and Dall sheep (Ovis dalli). Details of the study design and background information for each species are found in Hayes (1992).

The experimental area is in the southwest Yukon, roughly midway between Burwash Landing and Haines Junction (Figure 1). The traditional areas of the Kluane First Nation, Champagne and Aishihik First Nation and Tsawlnjik Dan (Carmacks), encompass this area. Moose, caribou and sheep are traditionally important subsistence food sources in this region. Untreated comparison areas for each species range throughout the Yukon (Figure 2).

Both the Aishihik and Kluane (formerly known as Burwash) caribou herds declined by about 65% through the 1980s (Gauthier 1984; Y.T.G. unpubl. data) while moose density declined by about 60% during this time (Ward and Larsen, in prep.). There was strong direction from the local communities, First Nations and the Fish and Wildlife Management Board to increase caribou and moose numbers for subsistence, cultural and spiritual uses, by controlling hunting and reducing wolf numbers.

In 1992, a public process was initiated to give direction to wolf management in the Yukon. The independent Wolf Planning Team completed a Wolf Conservation and Management Plan (WCMP) in September 1992 (Yukon Wolf Management Planning Team, 1992). It recognized that the reduction of wolf numbers could be considered as a management tool, providing strict conditions are met and recommendations are followed. The plan was adopted as government policy in December 1993.

The WCMP states that an ungulate recovery plan that uses aerial hunting of wolves can only be considered when a prey population is threatened by local extirpation

or when subsistence hunting is threatened (WCMP, Section 9.1). The recovery plan must include a 2-year hunting closure before wolf control can be considered. If populations continue to decline and there is reasonable evidence to show that wolves are an important factor, then there may be 2 years of wolf control to determine if ungulate recruitment rates double and increase to levels that could allow the populations to grow. If recruitment is substantially increased then wolf control can continue for up to 5 years. After 5 years the experimental and comparison populations must be assessed to determine the differences that could be attributed to the reduced wolf density and hunting pressure in the experimental areas. The Aishihik and Kluane herds have had subsistence hunting closures since 1990 and the implementation of a wolf reduction program can therefore be considered under the W.C.M.P. (Section 9.1.2).

All licensed hunting of the Aishihik caribou herd was prohibited following the 1990 hunting season. At the same time First Nations members curtailed their subsistence harvest. Despite these measures, the caribou population remained low and calf survival did not change (Y.T.G. unpubl. data). In other northern caribou herds and moose populations, wolf and grizzly bear (Ursus arctos) predation on adults and calves has been shown to be major factors limiting the recovery of depressed populations (Ballard and Larsen 1987; Farnell and Hayes, in prep; Fuller and Keith 1981; Gasaway et al. 1983, 1992; Larsen et al.1989; Bergerud and Elliot 1986; Gauthier and Theberge 1986).

The caribou recovery design follows scientific standards for intensive wolf regulation set out in the WCMP (Section 11.0; Yukon Wolf Management Planning Team 1992). This study is experimental, and designed so that wildlife biologists can carefully examine and learn as much as possible about the nature of the wolf-prey system through an adaptive management process (Walters and Holling 1990). We recognize that the experimental design must be adaptive due to the dynamic and changing nature of biological systems. The long-term objectives of the study are to determine why ungulates declined; if and how wolves could regulate ungulate prey density; and if weather, forage and other predators (including humans and grizzly bears) regulate prey density. The study approach includes radically altering the wolf-prey system. Both long-term and short-term responses of ungulates and wolves are being researched through a detailed series of hypotheses tests. Responses of experimental populations are being compared to ungulate populations in other areas where wolf numbers are not being reduced ('comparison' populations). Other potentially important regulatory factors, including weather and range conditions, are under study in all areas.

The long-term population goal for the Aishihik herd is 2,500 caribou. First Nations people report that caribou used to be many times more plentiful in the

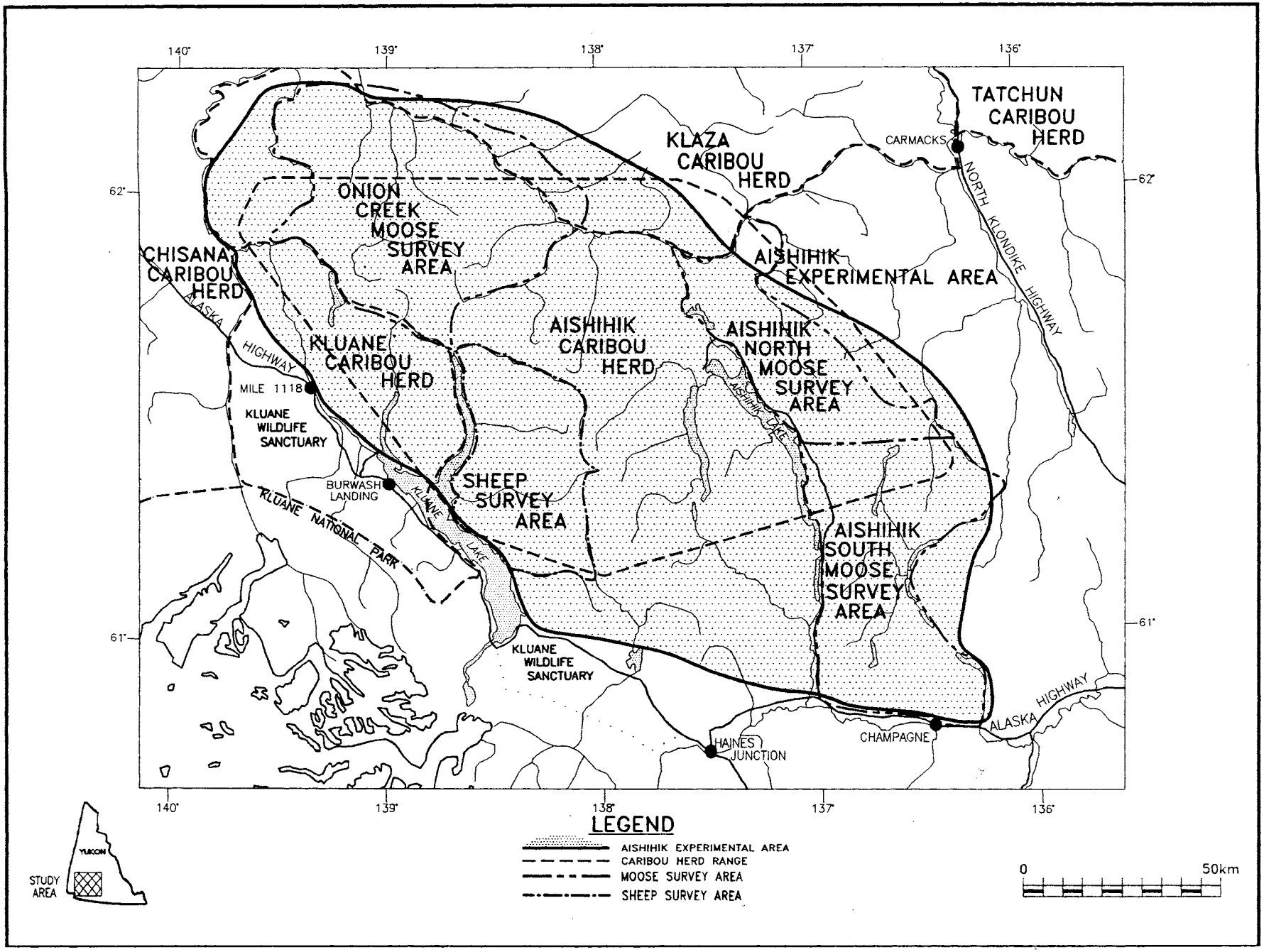

FIGURE 1. Aishihik experimental area.

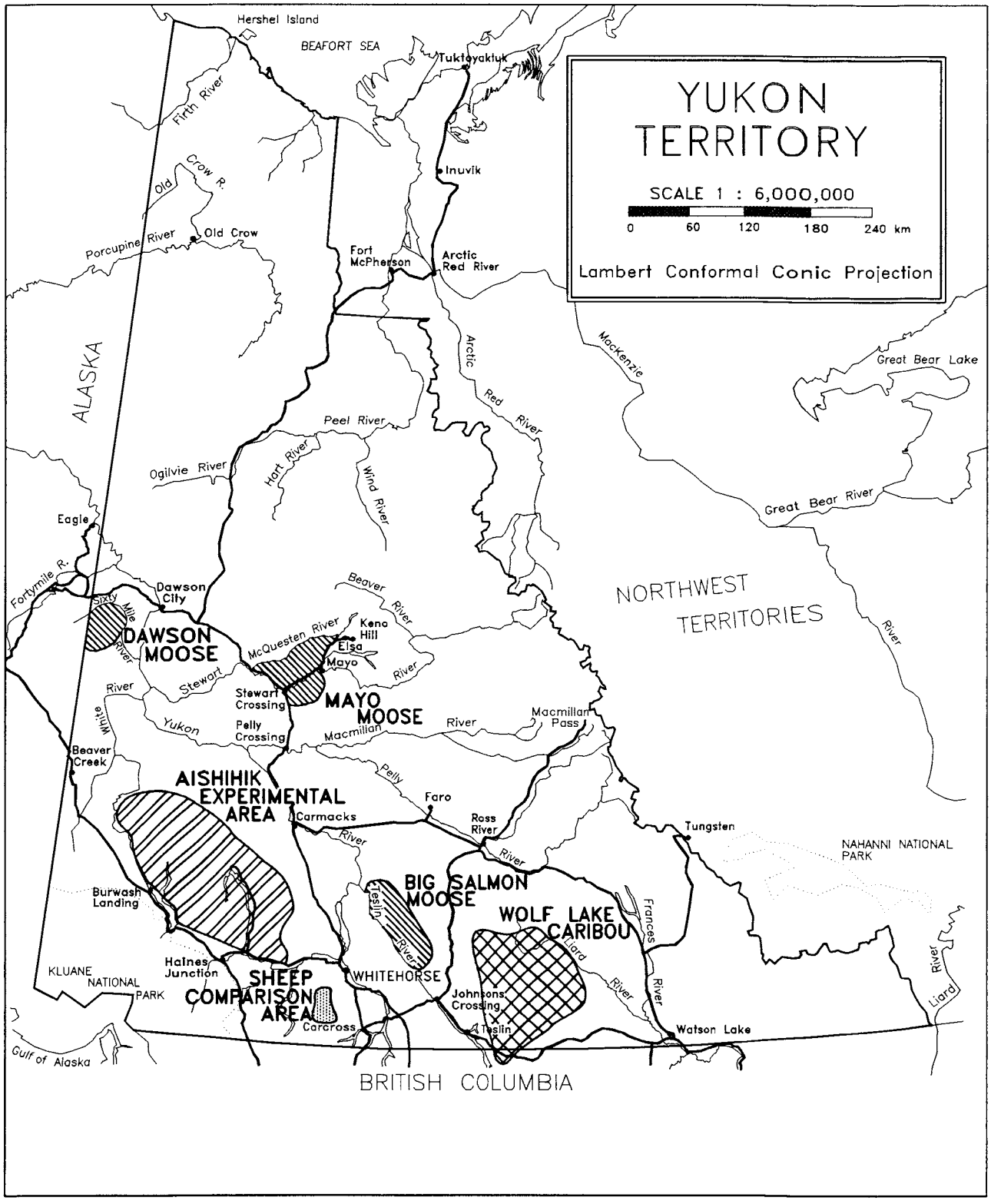

FIGURE 2. Location of comparison populations of caribou, moose, and sheep.

well below levels that they had previously experienced (Allen 1993, Johnson 1993). Theoretically, a stable caribou/wolf system can exist at a much higher caribou density (Hayes 1992) than is there now.

The long-term goal of increasing moose numbers from 2,000 to 4,000 in the Aishihik area is based on 2 considerations. First Nation people in the region believe that the densities observed in 1981 were well below levels they had previously experienced. A population of 4,000 moose in the experimental area would translate to about 200 moose/1,000 km^2, below the average moose density (218 moose/1,000 km^2) for other areas surveyed in the Yukon (Y.T.G. unpubl. data).

Adjustments of population goals for both caribou and moose will be made as habitat availability and quality assessments are made as part of the study design.

Dall sheep numbers are believed to be more influenced by stochastic events, such as weather (Hoefs and Bayer 1983), than by predation. No substantial changes in sheep population demographics in response to variable densities of wolves are expected, based on studies carried out in the Coast Mountains in the 1980s (Barichello and Carey 1988).

Wolf density will be reduced from 9 to between 1.5 and 3.0 wolves/1000 km^2 for the duration of the control period. The long-term goal is to have a naturally regulated wolf population at densities that can be supported by the prey populations, and a sustainable harvest of caribou and moose.

An interagency agreement with the Canadian Parks Service was made to mitigate the impacts of wolf control on Kluane National Park Reserve wolves (Appendix 1). This included a 10 km wide buffer zone along the western boundary of the experimental area, a joint wolf radio-telemetry program in the boundary area and in Kluane Park Reserve and Kluane Wildlife Sanctuary, and a co-operative protocol for managing park boundary wolves. Wolf packs in the buffer zone are radio-collared and their fate will depend on their territorial activities, denning locations, and predation impact on caribou in the experimental area. Wolves in the Kluane Wildlife Sanctuary are afforded the same protection as those in the park.

METHODS

Caribou

Changes in caribou density and composition can be measured using a stratified

random block sampling technique (Gasaway et al. 1986) modified for woodland caribou (Farnell and Gauthier 1988). Calf survival is assessed during post-calving (July) and rut (October) and is related as the ratio of calves per 100 cows. Post-calving observations were made 9-11 July 1993 for the Aishihik and Kluane herds and 1-3 July 1993 for the Wolf Lake herd. Rut observations were made 1-5 October 1993 for the Aishihik and Kluane herds and 25-30 September 1993 for the Wolf Lake herd.
area than they are at present and believe that the 1,500 estimated in 1981 was

Annual survival of adult caribou is measured using the staggered entry design (Pollock et al. 1989). In addition to radio-collared animals in the experimental and comparison herds, active collars in three neighbouring herds were also monitored.

Blood samples were taken to estimate condition and pregnancy rates of female caribou. Samples were taken from cow caribou 6 February to 17 March 1993 and tested for levels of progesterone. Low levels of progesterone in late winter indicate that the animal is not pregnant (Wood et al. 1986). Serum samples were sent to R. Zarnke, Alaska Dept. of Fish and Game, Fairbanks, AK. for serum antibody prevalence for selected disease agents common to caribou (Zarnke 1992).

Physical condition of caribou was judged by assessing the muscle and fat volume on the hips, ribs and shoulders at the time of capture (Gerhart et al. 1992). Maximum rating for each measure was 4, to yield a total body condition score between 0 and 12.

Moose

Moose abundance and population composition in the experimental and comparison areas are monitored using a stratified random block technique (Gasaway et al. 1986). This method provides an estimate of the total number of moose and an assessment of the accuracy and precision of the estimate. Moose abundance in all four areas was monitored before wolf control and will be re-assessed as part of the program evaluation.

Relative moose abundance in 2 portions of the experimental area that are not censused using stratified random block techniques is estimated using a fixed wing stratification technique. The number of moose seen per minute of flying in the censused areas and in these areas are compared.

Annual recruitment (the number of yearling moose entering the population) is also being measured in the experimental area and 3 comparison areas. This is done by counting the number of 10-month-old calves ("short-yearling" moose) in a sample

of at least 100 moose seen in each area in February or March. Recruitment in all 4 areas was also measured before wolf control in 1993.

Sheep

Sheep population counts are conducted using low level helicopter flights that systematically follow mountain contours (Hoefs 1978, Barichello et al. 1989). Due to the high visibility of sheep, surveys are assumed to be total counts. Based on size and horn characteristics, the sheep are sexed and aged. A sheep census was done 18-25 June 1993 in the experimental area and 2 July 1993 in the comparison areas. In 1993 the entire experimental area was surveyed.

Wolf

Wolves were censused using snow tracking techniques to determine total population size following techniques described by Stephenson (1978) and Hayes et al. (1991). Three fixed wing aircraft (2 PA 18-Supercubs, and a Maule M7) flew search routes along rivers and tributaries throughout the experimental area. All drainages were searched to their headwaters, and all mountain blocks were surveyed entirely.

Trails were followed until wolves were seen, or until trails separated and numbers could be estimated from tracks. The entire experimental area was searched once, and many areas were searched 2 to 10 times, depending on weather, terrain and distribution of ungulate prey.

During the survey period, wolf packs located by survey crews were targeted for removal by a helicopter crew. Wolf carcasses were retrieved, skinned and necropsied following procedures outlined in Hayes et al. (1991). Samples of muscle tissue were collected to be tested for their radio cesium levels. This will indicate the occurrence of caribou in their winter diet (Holleman and Luick 1978, Holleman and Stephenson 1981). Blood tests will show the incidence of important wolf diseases, including rabies, canine hepatitis virus, canine distemper, parvo virus and brucellosis. A tissue sample was collected from each wolf to be genetically analyzed through mitochondrial DNA fingerprinting (Lehman et al. 1992) at a later date. This will determine the effects of wolf control on the genetic composition of the Aishihik wolf population.

RESULTS AND DISCUSSION

Caribou

Population size

Population census of caribou herds in the experimental area could not be done in March 1993 as planned. Poor snow conditions prevented tracking and radiotelemetry relocations showed a mixing of animals from the Aishihik, Kluane

and Klaza herds in late winter. The winter distribution of many Yukon and Alaska (P. Valkenburg, A.D.F.& G. pers. commun.) caribou herds were highly unusual during 1992-93. We believe that the early arrival of winter in late September caused caribou to make more extensive migrations to wintering grounds, resulting in herds intermingling and inhabiting previously unknown wintering areas.

A population census of the Wolf Lake herd was completed 16-21 March 1993. The population was estimated to be 1249 ± 149 animals at 90% confidence. In 1987 this herd was estimated to be 664 ± 154 animals and was considered stable at that time (Farnell and McDonald 1989).

Calf survival

The overall post-calving ratio for the Aishihik herd was 45 calves/100 cows (Table 1). The distribution of calf survival during post-calving varied considerably within the range of the Aishihik herd (Figure 3). The ratio was lowest at 24 calves/100 cows (39 calves/161 cows seen) in the southern Ruby Range area (85 km^2) but was at 75 calves/100 cows (84 calves/112 cows) in the rest of the herd's range (650 km^2). In October rut counts, the calf/cow ratio was 39 calves/100 cows. This was substantially higher than the average of the 3 previous years (27, 9 and 7 calves/100 cows in October 1990, 1991 and 1992 respectively).

TABLE 1. Caribou Calf/Cow Ratios in the Aishihik, Kluane, and Wolf Lake Herds.

YEAR	MONTH	TOTAL COUNTED	CALF	COW	RATIO CALVES/100 COWS
Aishihik Herd					
1993	July	481	123	273	45
	October	556	119	305	39
1992	June	277	19	177	11
	October	583	30	409	7
1991	April	785	108	528	20
	July	509	55	377	5
	October	642	42	487	9
1990	October	543	100	347	27
1981		1,225	144	unk.	unk.
Kluane Herd					
1993	March	51	1	30	3
	July	148	26	84	31
	October	180	23	123	19
1992	October	68	0	46	0
1991	October	156	29	98	30
1990	October	143	25	79	32
1981	October	383	68	unk.	unk.

YEAR	MONTH	TOTAL COUNTED	CALF	COW	RATIO CALVES/100 COWS
Wolf Lake Herd					
1993	July	459	94	254	37
	October	596	76	340	22
1987	March	528	80	641	12
1986	October	113	14	70	20
1985	October	234	21	139	15

The Kluane herd also showed a geographic difference in calf survival at the time of the post-calving survey. Mean calf survival was 31 calves/100 cows in July. In the Kluane Wildlife Sanctuary (outside the experimental area), where most of the caribou were located, the ratio was 23/100 (14 calves/60 cows) while in the remainder of the herd's range (within the experimental area) the ratio was 50/100 (12 calves/24 cows). By October the ratio was below levels that would indicate herd growth. Empirical comparisons are limited by small sample sizes. The July calf/cow ratio was moderately high in the Wolf Lake herd (37 calves/100 cows) but fell to 22/100 during the October rut survey. No geographic differences in the calf/cow ratios were noted.

Adult Survival

Fourteen radio-collars were placed in the Aishihik herd (total active=27), 12 were placed on caribou in the Kluane herd and 29 in the Wolf Lake herd. Very few mortalities of radio-collared caribou were detected during the reporting period. In contrast to the period March 1991 to March 1992 when 13 collared caribou in the Aishihik herd died from natural causes (Appendix 2), only 1 collared animal died from March 1993 to October 1993 (the end of this reporting period). One mortality was also noted in the Wolf Lake herd.

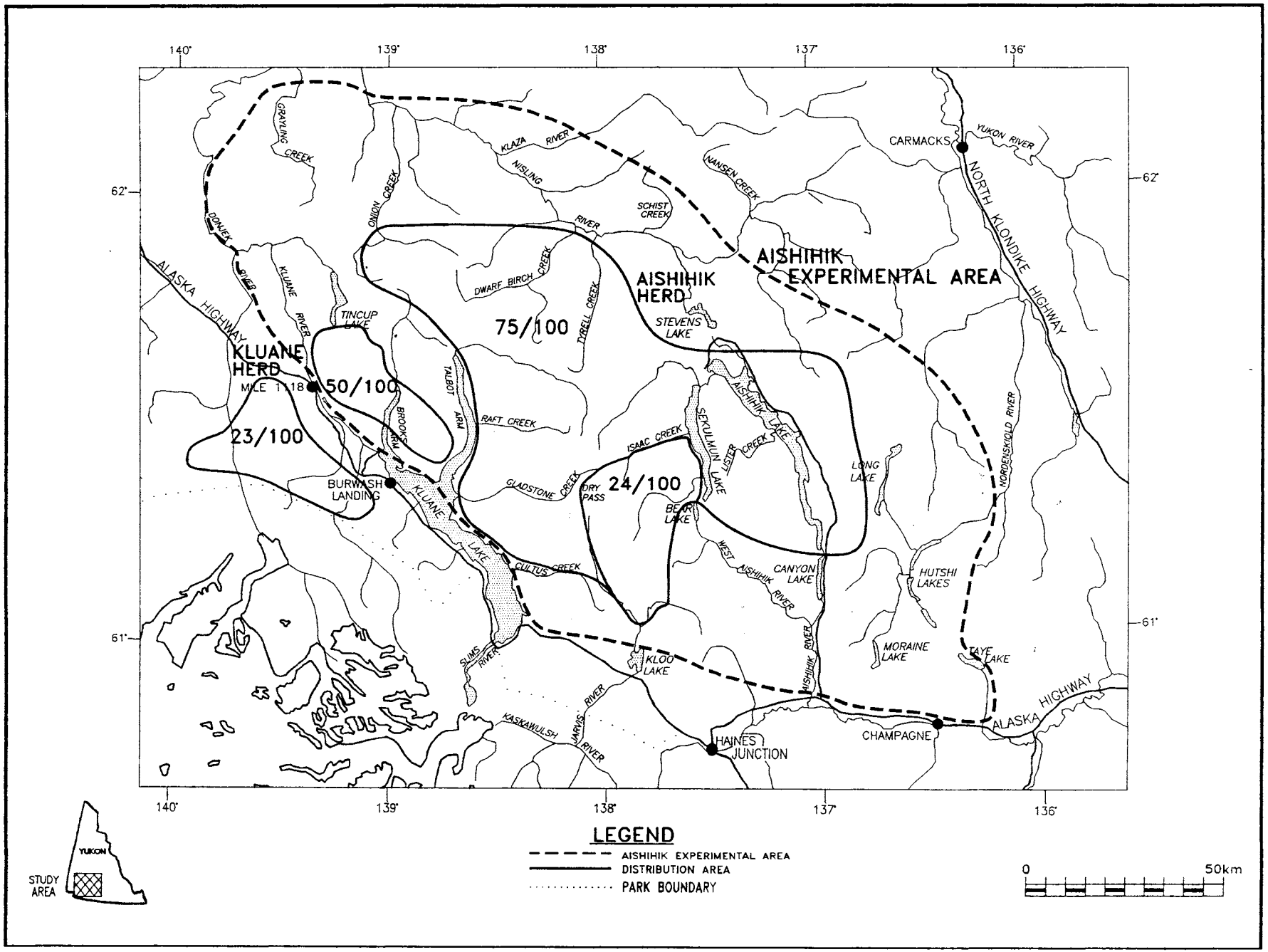

FIGURE 3. Distribution of caribou calf survival.

Pregnancy

High pregnancy rates were found in all herds (Aishihik 85%, n=13; Kluane 100%, n=7; Wolf Lake 95%, n=21) as indicated by the progesterone levels in the blood samples.

Physical Condition

A total of 50 animals were subjectively rated for body condition. Scores in all age classes in all herds were above the midpoint, with the exception of old-aged animals in the Burwash herd (Table 2). Results in that category may be an artifact of the small sample size.

Table 2. Body Condition Scores of Captured Caribou from the Aishihik, Kluane and Wolf Lake Herds, February-March, 1993.

Herd	Age Class	Average Score	Range	Sample size
Aishihik	Young	7.25	5.0-9.5	2
	Mid-age	7.75	5.0-10.0	10
	Old	7.0	----	1
Kluane	Young	6.8	4.5-11	3
	Mid-Age	6.9	4.5-8.5	4
	Old	4.0	3.0-5.0	2
Wolf Lake	Young	7.4	6.5-8.0	4
	Mid-Age	7.4	4.5-9.5	21
	Old	7.2	6.0-9.5	3

Disease Testing

Serum was tested for 10 disease agents in 8 Yukon herds (n=233). Only 9 positive antibodies were detected. Four of 71 samples from the Aishihik herd tested positive for epizootic haemorrhagic disease. These results (Appendix 3) do not show exceptional differences in disease frequencies compared to herds considered to be in good health in Alaska (R. Zarnke, A.D.F.&G., pers. commun.).

Moose

Moose recruitment (percentage of 10-month-old calves in the population) in the experimental area (Figure 1) and 3 comparison areas (Figure 2) was assessed in March, 1993. Calf recruitment was similar in all four areas, ranging from 7% to

12% (Table 3). Ten-month-old calves should make up at least 15% of the population for the population to remain stable or begin to increase (Gasaway et al. 1992).

Table 3. March 1993 Moose Recruitment Rates.

Area	Survey time (min.)	Adults seen	Calves seen	Total moose	Percent calves	Moose/ min.
Aishihik	1,510	95	11	106	10%	0.07
Big Salmon	1,192	90	10	100	10%	0.08
Mayo	997	109	15	124	12%	0.12
Dawson	910	105	8	113	7%	0.12

Sheep

Overall, the sheep population in the experimental area has remained relatively stable compared to 1974 population levels, with the exception of the Talbot Arm area (Figure 4, Table 4, Table 5). The decline was noted in all age and sex classes with proportional declines constant. Reported harvest for the last 5 years is insufficient to explain the decline (Y.T.G. unpubl. data).

Table 4. Sheep Population Information in the Aishihik Experimental Area, 1974 and 1993.

		Total Sheep	Total Adults	Rams	Nursery Sheep	Lambs	Lambs/100 Nursery Sheep
Kluane North	1993	309	272	136	136	37	27.2
	1974	337	287	79	208	50	24.0
Talbot Arm (Exp. Area)	1993	477	415	158	257	62	24.1
	1974	777	633	203	430	144	33.5
Aishihik West	1993	880	721	247	473	159	33.6
	1974	796	696	256	436	101	23.2
Aishihik East	1993	315	262	89	173	53	51.4
	1974	354	309	110	199	45	22.6

* nursery sheep include ewes, yearlings, and 2-year-old rams

TABLE 5. Sheep Survey Results from Experimental Area and 2 Comparison Areas.

YEAR	TOTAL SHEEP	TOTAL ADULTS	RAMS	NURSERY SHEEP	LAMBS	LAMBS / 100 NURSERY SHEEP
EXPERIMENTAL AREA (Talbot Arm)						
1993	477	415	158	257	62	24.1
1992	597	562	188	374	35	9.4
1989	754	592	221	370	162	43.8
1986	795	746	354	392	49	12.5
1985	963	895	384	511	68	13.3
1984	928	802	370	432	126	29.2
1983	700	641	245	396	59	14.9
1982	854	778	280	498	76	15.3
1980	980	805	251	554	175	31.6
1979	909	769	290	479	140	29.2
1974	777	633	203	430	144	33.5
ROSE MOUNTAIN						
1993	227	212	67	145	15	10.3
1992	257	239	95	144	18	12.5
1989	296	243	94	149	53	35.6
1986	189	168	56	112	21	18.8
1985	223	188	52	136	35	25.7
1984	282	214	60	154	68	44.2
1983	221	199	58	141	22	15.6
1982	209	186	55	131	23	17.6
1981	262	223	54	169	39	23.1
1980	256	203	44	159	53	33.3
1979	206	186	29	157	20	12.7
1973	161	120	47	73	41	56.2

continued...

TABLE 5 continued

YEAR	TOTAL SHEEP	TOTAL ADULTS	RAMS	NURSERY SHEEP	LAMBS	LAMBS / 100 NURSERY SHEEP
MT. SKUKUM						
1993	351	305	98	207	46	22.2
1991	590	530	129	401	60	15.0
1987	337	294	103	191	43	24.6
1985	303	265	74	191	38	19.9
1984	301	276	107	169	25	14.8
1983	342	291	112	179	51	28.5
1982	393	359	121	238	34	14.3
1973	201	151	38	113	50	44.2

* nursery sheep include ewes, yearlings, and 2-year-old rams

Numbers in the 2 comparison areas were remarkably consistent with previous results, although it appeared that a large band of rams was missed on Rose Mt.. The greater number of nursery sheep seen in 1991 is believed to be the result of an unusual shift in seasonal range use, rather than an actual change in population size.

Wolves

Population size

Between February 9 and March 17, 1993, 280 fixed wing hours and 110 helicopter hours were spent searching for and removing wolves. Survey conditions were good in the northern portion of the experimental area, where snow depth was reasonable and winds were light, allowing trails to remain evident. In the southern Ruby Range mountains (Isaac Creek, Gladstone Creek, Raft Creek, West Aishihik River), conditions were generally poor. Many of the creek headwaters were windblown and completely free of snow throughout the winter. In those areas wolf trails were typically short and difficult to follow on the hard-packed snow and open ground.

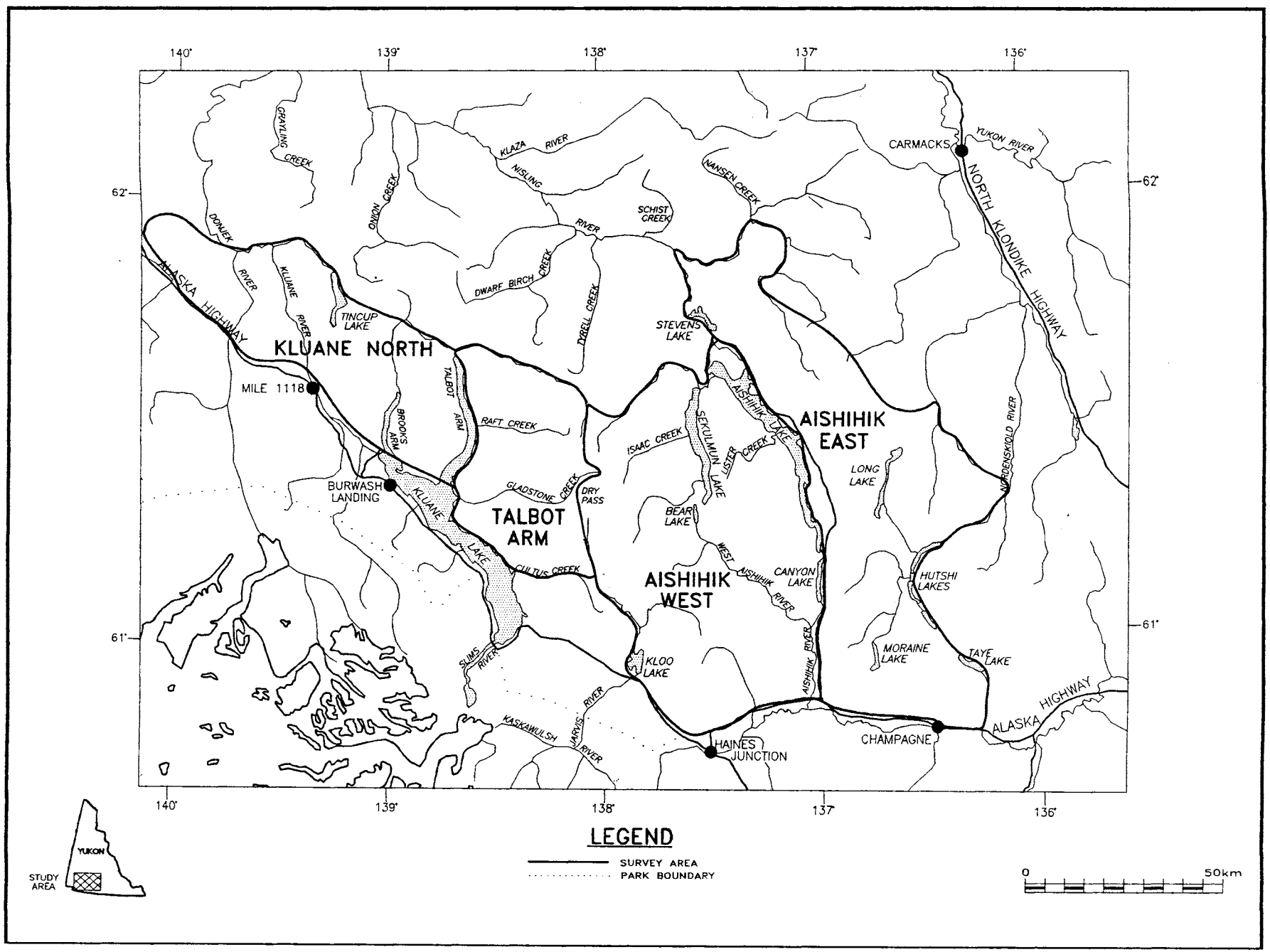

FIGURE 4. 1993 sheep survey area.

It is clear that wolf numbers declined sometime between March 1992 and February 1993 (Figures 5 and 6, Tables 6 and 7), before aerial hunting of wolves began. We estimated annual changes in late winter wolf numbers by directly comparing counts in the 15,000 km^2 core area between 1992 and 1993. A pack that ranged in a local drainage was given the same name as the pack observed there in 1992 (Table 6). Except for 2 radio-collared packs (Slims R. and Kloo Lake), we do not know if the packs were the same or if the wolves were, in fact, related. We believe that the assumption of relatedness in reasonable in most cases, because wolves in the southern Yukon are territorial (Sumanik 1987, Hayes et al. 1991).

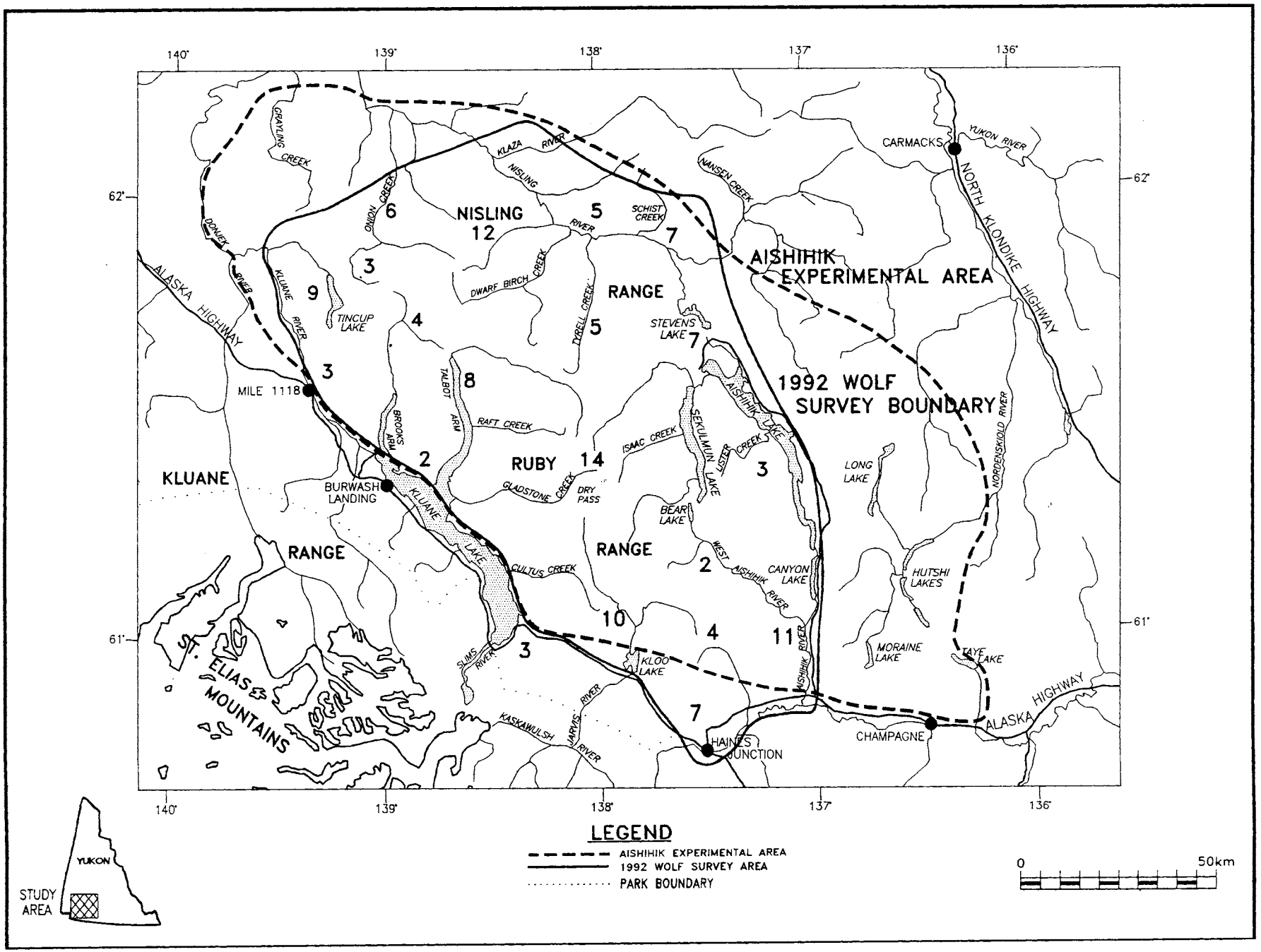

FIGURE 5. Distribution of wolves, March 1992

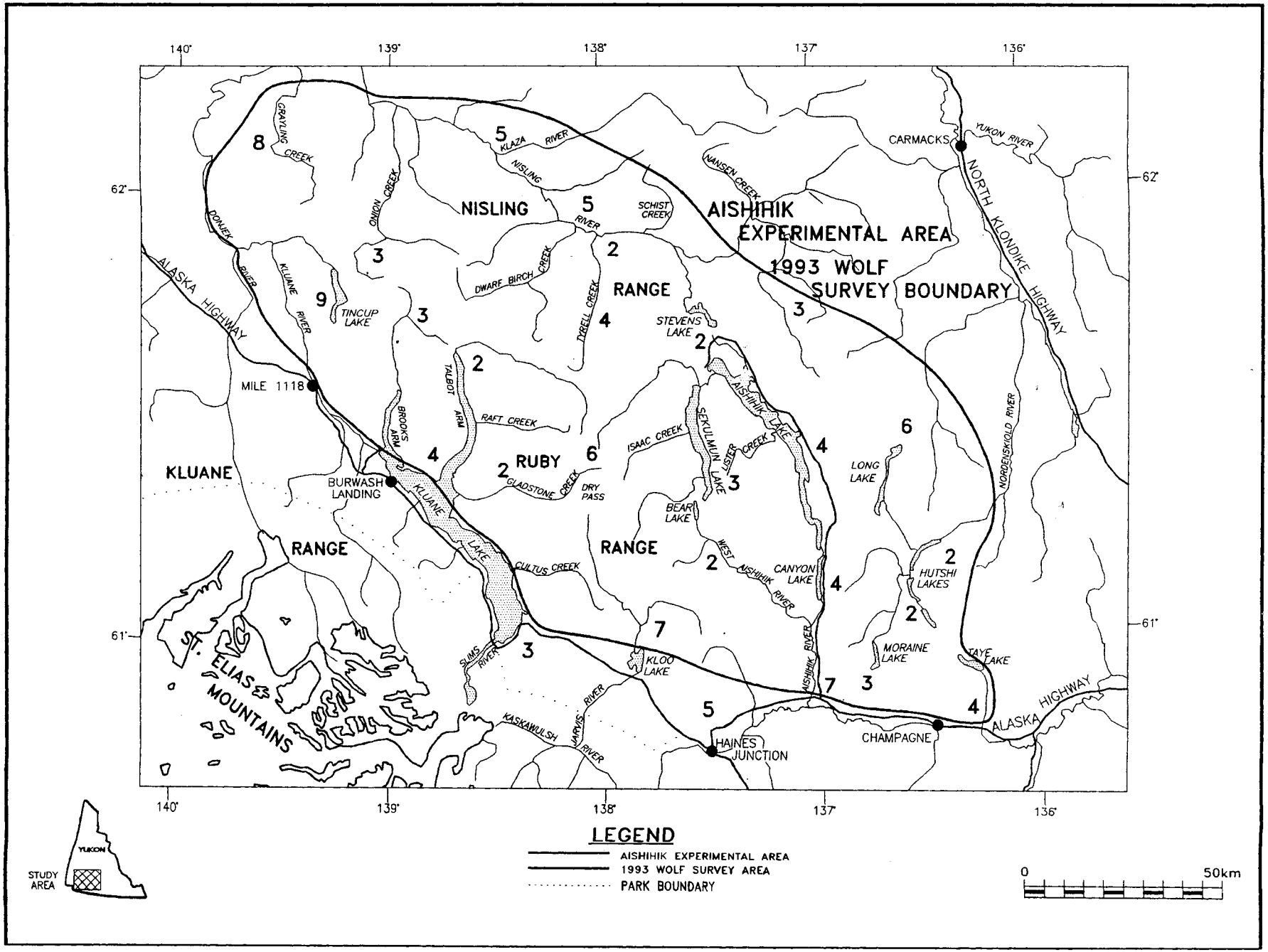

FIGURE 6. Distribution of wolves, February 1993.

TABLE 6. Summary of wolf packs observed in the Aishihik experimental area in late winter 1993, and the number of wolves removed from packs during the aerial reduction program (1992 pack size included for comparison). Note: wolf packs that have only 1 survivor are no longer counted as packs.

Pack	Number Seen 1992	Number Seen 1993	Number Killed 1993	Pack Wolves Remaining	
1992 survey area (15,000 km²)					
1. Haines Junction	7	5	5^	0	
2. Aishihik River	11#	7	1	6	
3. *Kloo Lake	10	7	4	3	
4. Gladstone	14	6	4	2	
5. Bear Lake	2	2	0	2	
6. Sekulman Lake	3	3	3	0	
7. *Cultus-Slims River	3	3	2	0	(1)
8. Schist Creek	7	2	2	0	
9. Stevens Lake	7	2	2	0	
10. Tyrell Creek	5	4	4	0	
11. Serpenthead Lake	4	3	2	0	(1)
12. Nisling River	5	5	5	0	
13. Onion Creek I	6	-			
14. Onion Creek II	12	-			
15. Tincup Lake	9	9	8	0	(1)
16. Talbot/Dwarf Birch	8	2	2	0	
17. Kiyera Lake	3	3	0	3	
18. Brooks Arm	2	4	0	4	
19. *Mile 1118	3	-			
20. Dry Pass	4	4	0	4	
-Gladstone Pair-	-	2	0	2	
	125	73			
1993 Extension area (5,000 km²)					
21. Champagne		4	4^	0	
22. Lister Creek		4	4	0	
23. Cracker Creek		3	2	0	(1)
24. Grayling Creek		8	1	7	
25. Sceptre Lake		2	2	0	
26. Terrace Creek		6	2	4	
27. Nansen Creek		3	3	0	
28. Hutshi Lake		2#	0	2	
29. Klaza River		5	0	5	
	(37)	<---37			
Total	162	110	62	44	

^ killed by public
*radio-collared pack
seen by local resident

TABLE 7. Summary of the Aishihik Wolf Population, January 1992 and February 1993.

	1992	1993
Number of pack wolves	162	110
*Total no. of wolves	178	121
Wolf density (wolves/1000 km^2)	10	6
**Mean pack size	6.3	3.8
Number of packs	29	27
Pack density (km^2/pack)	690	740

* includes 10% lone wolves
** based only on observed packs: 20 packs in 1992 and 27 packs in 1993

In the core area, we observed a 42% decline in wolves in packs, from 125 wolves in 1992 to 73 wolves in 1993. Most wolves were lost from 8 packs that had totalled 75 wolves and averaged 9.0±2.8 wolves in 1992 (Table 8). In February 1993, 26 wolves were counted among 6 packs in the same area. Four of the packs (Onion Creek I and II, Talbot Creek and Gladstone Creek) were adjacent, sharing the central Ruby Range mountains on the east side of Kluane Lake. Average pack size declined from 6.3 to 3.8 ($p=0.01$) between years. The number of packs remained stable (Table 7). The number of packs of 2-3 wolves in the core area increased from 6 in 1992 to 9 in 1993 (Table 6).

TABLE 8. Areas where wolf packs declined substantially between 1992 and 1993 in the Aishihik experimental area before intensive wolf control.

Pack	Number of wolves		Difference
	1992	1993	
Kloo Lake	10	7	-3
Gladstone Creek	14	6	-8
Aishihik River	11	7	-4
Schist Creek	7	2	-5
Stevens lake	7	2	-5
Onion Creek I	6	0	-6

Pack	Number of wolves		Difference
	1992	1993	
Onion Creek II	12	0	-12
Talbot/Dwarf Birch	8	2	-6
Total	75	26	-49

An additional 5,000 km^2 extension area that had not been censused in 1992 was censused for wolves in 1993 (Figure 6, Table 6). We assumed that wolf density did not change between 1992 and 1993. It is possible that numbers declined there also, but this could not be assessed. The estimate of the total 1992 wolf population was the sum of the core area count in 1992 (125 pack wolves and 13 lone wolves) plus the number counted in the extension area in 1993 (37 pack wolves and 3 lone wolves) -for a total of 178 wolves (Table 7).

At the conclusion of the field season in May 1993, the total number of wolves in packs had declined by 114 wolves (70%) compared to 1992 counts. The 70% reduction included the loss of 52 wolves between March 1992 and February 1993 before aerial hunting began, and the 62 wolves that were taken during the 1993 control program (Table 5). Of the 27 packs known in 1993, 10 were completely removed and 5 had all members but 1 killed. Six packs were not reduced by aerial hunting (Table 5).

Wolf Population Characteristics

Age class was determined for 46 wolves: 13 (28.3%) were pups, 4 (8.7%) were yearlings and 29 (63.0%) were adults. Sex and pelt colour were recorded for 44 wolves: 22 (50%) were female and 22 (50%) were male; 17 (38.6%) were classed as grey/tan and 27 (61.4%) were classed black/grey. Weight and physical condition analyses are in progress.

Park boundary

In March 1992, 2 study-area packs were radio-instrumented in the boundary area. The Slims River pack was 3 wolves in 1992. One Slims River wolf was trapped near the south end of Kluane Lake in January and another was shot near Burwash in February. The remaining wolf survived, but radio contact was lost during the winter after it apparently dispersed. The second pack, the Kloo Lake pack, included a radioed yearling in 1992. The pack was located in the experimental area, on the edge of the buffer on 25 February, 1993. The alpha male and female were radio-collared and the pack spent most of the spring in the Jarvis River area upstream from Kloo Lake where it denned but did not raise pups. Pack size varied from 6 to 7 wolves throughout the late winter. Because the Kloo Lake pack ranged within an important caribou calving area, all wolves except the alpha male and female were aerially shot in May. We chose to leave the adult pair in the hope that they would maintain their home range in the area and exclude Kluane Park wolf packs from moving into the experimental area where they could be shot. The adult pair continued to occupy the same territory throughout the reporting period. During the winter of 1993, the Canadian Parks Service radio-instrumented 6 wolf packs in the front ranges of Kluane Park (Canadian Parks Service unpubl. data). None of these radio-instrumented packs were known to visit the experimental area during this reporting period.

The number of wolves in the Kluane Park Reserve area decreased in 1993, but not due to aerial hunting. An uncollared, 7-member pack ranged in the Kaskawulsh River area in 1992. During early winter 1993, 5 wolves were snared at Haines Junction, in response to public complaints. We believed these wolves were from the Kaskawulsh pack, which was absent from the area in late winter 1993 (R. Breneman, Canadian Parks Service, pers. commun.).

Wolf reduction

Based on similar studies (Gasaway et al. 1983, 1992, Farnell and Hayes in prep). the 70% reduction in 1993 of the number of pack wolves should have been adequate

to depress wolf recovery in the area and reduce the impact of predation on caribou and moose survival rates. Farnell and Hayes (in prep) studied wolf responses in 5 control areas in Alaska and Yukon. They found that there was a linear relationship between the number of wolves in late-winter and the number of wolves the following winter. When wolf numbers were held to less than 20% of their pre-regulation level, the number of wolves the next winter was less than 50% of the original number. They found that the key to increasing caribou survival rates was to reduce wolf predation during the summer when calves were most vulnerable. In the Finlayson area of the Yukon (Farnell and Hayes, in prep) regulation of wolves during the March breeding period impeded reproduction and reduced the number of packs and average pack size the next winter.

The decline in wolf numbers between 1992 and 1993, before intensive regulation began, is of great importance to understanding the dynamics of the wolf/prey system. We believe that the Aishihik wolves were in a time-lag response (Hayes 1992), but it is not clear that the decline of 52 wolves in the area between 1992 and 1993 was due to declining ungulate populations. The analysis of the decline is confounded by 2 factors. First, snowshoe hares (Lepus americanus) were abundant from 1989 to 1991 (Kluane Boreal Forest Ecosystem Project 1993) and may have supported wolf pup survival beyond what the ungulate prey population could sustain. The decline in wolf numbers may have been influenced by the dramatic decline in hare numbers in 1991 and 1992. Second, in March 1993, an individual in the area was convicted of counselling to place poison during the 1992 hunting season (August-October). This was in the same area of the Ruby Range mountains where 4 adjacent packs declined from a total of 38-43 wolves in 1992 to only 8 wolves in 1993. The poison, known as Thimet (Phorate, Cyanamid Canada), a highly lethal organochloride, was recovered from a camp in the Gladstone Creek area. However, whether or not poison was actually placed in the area could not be proven; aerial searches in April 1993 found no poisoned carcasses. In March 1993, evidence of the same poison was found on the southern boundary of the experimental area.

The presence of many small wolf groups (2-3 wolves) is evidence of both a wolf population that has declined naturally in response to declining prey supply (Mech 1986) and of a highly disturbed wolf population that has undergone intensive human regulation (Gasaway et al. 1983, 1992; Hayes et al. 1991; Farnell and Hayes, in prep.). Age structure changes also occur in wolf populations that have experienced declines, with fewer young wolves in the population and a greater proportion of young adults (Farnell and Hayes, in prep.). We are currently investigating the possible natural causes of wolf population decline using blood analysis for disease, physical condition and mitochondrial DNA techniques.

FUTURE WORK

During the period November 1993 to October 1994 the following projects will be undertaken:

Caribou

1. Population census of the Aishihik and Kluane caribou herds will be done during March, 1994.
2. Calf survival in the Aishihik, Kluane and Wolf Lake herds will be determined during post-calving (July) and rut (October) surveys.
3. The number of active caribou collars will be maintained by replacing/adding collars during March. These collars will continue to be monitored throughout the year.
4. Further pregnancy and disease testing will be done at the time of capture.

Moose

1. Moose recruitment rates will be measured in the Aishihik, Big Salmon, Mayo, and Dawson areas in March.

Sheep

1. Sheep population surveys will be done in the Talbot Arm and comparison areas in June/July.

Wolf

1. The number of wolves in the Aishihik experimental area will be maintained at or less than 30% of the pre-reduction level by aerial hunting and trapping.
2. A wolf population survey will be done in the caribou comparison area (Wolf Lake) in March.
3. Limited use of non-lethal forms of wolf control in the experimental area will be considered to assess viability and possible applications.

Other

1. A habitat analysis of the experimental area will be started in early summer. This analysis will concentrate on determining the feasibility of using new remote sensing technology to quantify snow cover and winter range.
2. An evaluation of the effects of wolf control on the calf survival of caribou and moose will be done. The continuation of the program will be determined following this assessment.

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APPENDIX 1. Kluane area wolf research and management agreement.

Kluane Area Wolf Research and Management Agreement

THE YUKON DEPARTMENT OF RENEWABLE RESOURCES
AND
CANADIAN PARKS SERVICE, KLUANE NATIONAL PARK RESERVE
December 6, 1992

It is known that wolves freely move between Kluane National Park Reserve (KNPR) and the Yukon Game Management Zone (GMZ) 5. The management objective of the Canadian Parks Service (CPS) is to preserve naturally-regulated wolves in KNPR, and the objective of the Yukon Department of Renewable Resources (DRR) is to temporarily reduce wolf populations in adjacent GMZ 5 to enhance the recovery of the Aishihik caribou herd. The CPS is concerned that the wolf control program conducted by DRR adjacent to KNPR's boundary will adversely affect the natural integrity of the wolf population that presently utilize the Park and Sanctuary area. This interagency agreement will provide mechanisms to reduce the potential conflict between the two agencies different management objectives.

This agreement sets guidelines to ensure that each agency cooperatively plans and discusses all technical aspects of wolf management in KNPR-GMZ 5 boundary wolf packs, as long as wolf controls apply. Both agencies agree that conservation is the management priority for KNPR-GMZ 5 boundary wolf packs.

CPS and DRR agree that wolves in the Kluane Front Ranges of the Park and Kluane Game Sanctuary from Haines Junction to the Donjek River require special management to ensure they are protected and not accidentally or unnecessarily killed in the GMZ 5 control program. To achieve this, both agencies agree to a cooperative radio-tagging and monitoring program for KNPR wolves beginning in 1992. This must meet the CPS requirements under EARP and the Research/Collecting Permit guidelines. The purpose of the research is to determine actual pack home range boundaries and their actual or potential impacts on the Aishihik caribou herd in GMZ 5.

CPS will require the preparation of a terms of reference and a detailed study design prior to any research being conducted in the Park area. Following the identification of radio-instrumented pack home ranges, decisions about control of these wolves will be determined only after there is suitable evidence that an important part of their range is inside GMZ 5 and the wolves impact caribou on summer or winter range. No wolves will be destroyed in KNPR, and the Kluane Game Sanctuary or the buffer area (as described on the attached map) as part of the GMZ 5 wolf control program. The control of any radio-tagged wolf pack utilizing the Park and/or the Game Sanctuary will only happen when specifically agreed to in writing by identified representatives of both agencies, following full consultation.

FW4/Dir1/Parks
93 01 08

The criteria to determine that a wolf pack will not be culled in GMZ 5 will be:

1. if they den in the Park or Game Sanctuary or;

2. if the wolves or pack spend greater than 50% of their time in the Park or Sanctuary, based on a minimum of 30 locations throughout the year, and;

3. there is no reasonable biological evidence to determine that a boundary wolf pack is having an impact on the Aishihik caribou herd.

CPS agrees to allow aircraft carrying DRR staff to fly inside the Park boundaries for the purposes of monitoring radio collared wolves. On all occasions DRR staff will inform CPS of their general activities in the area before flying and report the results of all to CPS upon completion. For all aircraft landings within the boundaries of KNPR, DRR staff will obtain a CPS landing permit prior to the flight occurring and will provide space for a CPS employee to accompany the flight.

CPS will fund up to $16,000.00 for aircraft charters for Park staff to radio collar wolves in the area in and adjacent to KNPR in the 1992-93 fiscal year. CPS has budgeted $16,000.00 each year for monitoring and radio collaring wolves over the following three fiscal years. CPS has also received additional research funding for three years beginning in the 1993 fiscal year. CPS will continue to pursue additional funding for subsequent years of this wolf control. DRR will provide technical advice and materials used in collaring wolves. DRR will also monitor the wolves collared in and adjacent to the Park while conducting their monitoring in GMZ 5. CPS will monitor wolves on an opportunistic basis in this area. DRR and CPS will share all biological related information for this project and will further discuss methods of sharing a compatible database.

GENERAL

There will be an annual review of this agreement by the two agencies. At the consent of both agencies, CPS and DRR, other interest groups may attend any meeting conducted under the auspices of this agreement.

Nothing in this agreement shall be construed as obligating either party to expend specific resources or to undertake any specific projects. This is essentially an agreement to ensure that each agency continues to communicate their intended management actions

and to respect each others management mandates and objectives. Both agencies are to try to obtain funding to equally share the cost to the monitoring program of wolves utilizing KNPR, the adjacent Game Sanctuary and buffer area.

Director Jan 11/93
Department of Renewable Resources
Government of Yukon

Superintendent Jan, 11, 1993
Kluane National Park Reserve
Canadian Parks Service

FW4/Dir1/Parks
93 01 08

APPENDIX 2. Radio-collaring data for the Aishihik caribou herd February 1991 to December 1993.

DATE	COLLAR	SEX	AGE	CAPTURE LOCATION	STATUS	NO. OF RELOCATIONS
91/02/25	DD-47	♀	Adult	Albert Creek	Dead 91 April	3
91/02/25	DD-52	♀	Adult	Albert Creek	Dead 92 June	7
91/02/25	DD-81	♀	Adult	Albert Creek	Dead 92 June	7
91/02/25	DD-73	♂	Immature	Albert Creek	Alive	16
91/02/25	DD-51	♂	Immature	Albert Creek	Alive	16
91/02/25	DD-32	♂	Immature	Albert Creek	Alive	16
91/02/25	DD-73	♀	Adult	Albert Creek	Alive	17
91/02/25	DD-63	♀	Adult	Albert Creek	Dead 92 June	7
91/02/25	DD-66	♂	Immature	Albert Creek	Dead 92 June	7
91/02/25	DD-49	♂	Immature	Albert Creek	Dead 92 Nov.	10
91/03/31	DD-96	♀	Adult	Albert Creek	Alive	17
91/03/31	DD-00	♂	Immature	Albert Creek	Alive	17
91/03/31	DD-01	♂	Immature	Albert Creek	Dead 91 May	1
91/04/01	DD-02	♂	Immature	Albert Creek	Dead 93 Jan.	11
91/04/01	DD-97	♀	Adult	Albert Creek	Dead 93 July	15
91/04/01	DD-98	♂	Immature	Albert Creek	Dead 91 May	1
91/04/01	DD-04	♀	Adult	Albert Creek	Alive	17
91/04/01	DD-95	♀	Adult	Albert Creek	Alive	17
91/04/01	DD-99	♀	Adult	Albert Creek	Dead 91 May	1
91/04/01	DD-94	♂	Immature	W. Aishihik	Alive	17
91/12/10	EE-20	♀	Adult	W. Aishihik	Dead 93 March	3
91/12/10	EE-47	♀	Adult	W. Aishihik	Dead 93 March	8
91/12/10	EE-21	♀	Adult	W. Aishihik	Dead 93 March	8
91/12/10	EE-01	♀	Adult	W. Aishihik	Dead 92 May	2
91/12/11	EE-99	♀	Adult	W. Aishihik	Dead 92 May	2

DATE	COLLAR	SEX	AGE	CAPTURE LOCATION	STATUS	NO. OF RELOCATIONS
91/12/11	EE-24	♀	Adult	W. Aishihik	Dead 92 Dec.	6
91/12/11	EE-22	♀	Adult	W. Aishihik	Dead 92 May	2
91/12/11	EE-23	♀	Immature	W. Aishihik	Alive	12
91/12/11	EE-98	♀	Adult	W. Aishihik	Alive	12
92/01/07	EE-25	♂	Immature	Grace Lake	Dead 93 Dec.	12
92/01/07	EE-19	♂	Adult	Grace Lake	Alive	12
93/02/06	FF-17	♀	Adult	Grace Lake	Alive	5
93/02/06	FF-16	♀	Immature	Grace Lake	Alive	5
93/02/06	FF-19	♂	Adult	Grace Lake	Alive	5
93/02/07	FF-22	♀	Adult	Grace Lake	Alive	5
93/02/09	FF-25	♀	Adult	Talbot Creek	Alive	5
93/02/09	FF-20	♀	Adult	Talbot Creek	Alive	5
93/02/10	FF-23	♀	Adult	Talbot Creek	Alive	5
93/02/10	FF-18	♀	Adult	Talbot Creek	Alive	5
93/02/22	FA-41	♀	Adult	Issac Creek	Alive	5
93/02/22	FA-49	♀	Adult	Issac Creek	Alive	5
93/02/22	FA-33	♀	Adult	Mt. Bisel	Alive	5
93/02/22	FA-38	♀	Adult	Mt. Bisel	Alive	5
93/02/22	FA-42	♂	Immature	Mt. Bisel	Alive	5
93/03/17	FA-36	♂	Immature	Kiyera Lake	Alive	5

APPENDIX 3. Serum antibody prevalence of 10 selected infectious disease agents in Yukon caribou herds.

	YEAR AND HERD												
DISEASE AGENT	1980	1988	1989	1990	1991	1992	1993						
	BCH	KCH	TCH	ELH	ACH	FCH	ACH	BCH	KCH	TCH	FCH	BPH	WLH
Infectious bovine rhinotracheitis	0/15[a]	0/3	0/2	0/7	0/72	1/28	0/18	0/12	0/4	0/4	1/20	1/20	0/28
Bovine viral diarrhea	0/15	0/3	0/2	0/7	0/71	0/27	0/18	0/12	0/4	0/4	0/20	0/20	0/28
Parainfluenza 3	0/15	0/3	0/2	0/7	0/71	0/27	0/18	0/12	0/4	0/4	0/20	0/20	0/28
Respiratory syncytial virus	ND[b]	0/3	0/2	0/7	0/63	0/27	0/18	0/12	0/4	0/4	0/20	0/20	0/28
Epizootic haemorrhagic disease	0/15	0/3	0/2	0/7	4/71	0/28	0/18	0/12	0/4	0/4	0/20	0/20	0/28
Bluetongue	0/15	0/3	0/2	0/7	0/18	ND	0/18	0/12	0/4	0/4	0/20	0/20	0/28
Brucella spp	0/15	0/3	0/2	0/7	0/72	ND	0/18	0/12	0/4	0/4	0/20	0/20	0/28
Leptospira interrogans	ND	0/3	ND	0/7	0/71	ND	0/18	0/12	0/4	0/4	0/20	1/20	1/28
Q fever	ND	0/3	0/1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Contagious ecthyma virus	ND	0/3	0/2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

a = Number positive/number tested
b = No data

BCH = Burwash Caribou Herd
KCH = Klaza Caribou Herd
TCH = Tatchun Caribou Herd
ELH = Ethyl Lake Herd
ACH = Aishihik Caribou Herd
FCH = Finlayson Caribou Herd
BPH = Bonnet Plume Herd
WLH = Wolf Lake Herd