FALL, WINTER AND SPRING ABUNDANCE AND GEOGRAPHIC DISTRIBUTION OF MOUNTAIN GOATS ON THE BRADLEY RIVER WINTER RANGE

by

DAVID A. HOLDERMANN

FINAL REPORT

Submitted to the Alaska Energy Authority

May 1991

Alaska Department of Fish and Game

Division of Wildlife Conservation

333 Raspberry Road

Anchorage, Alaska 99518

SUMMARY

The Alaska Energy Authority (AEA) began construction of a large hydroelectric generating facility near Bradley Lake, on the southern Kenai Peninsula in 1986. The facility is scheduled to begin operation by September 1991. There were concerns that mountain goat (*Oreamnos americanus*) use of traditional winter ranges near the impoundment might be adversely impacted and AEA contracted with the Alaska Department of Fish and Game (ADF&G) to assess the impacts of project development on overwintering mountain goats. Objectives of the study were to determine the number, sex and age composition, and geographic distribution of goats on the Bradley Lake and Bradley River winter ranges and to determine if this goat population was impacted by construction of the Bradley Lake Hydroelectric Project (BLHP). Mountain goats winter primarily on steep slopes along the north shore of Bradley Lake and along a 3-mile stretch of Bradley River downstream from Bradley Lake.

It appeared that both the southern Kenai Peninsula regional goat population and the overwintering Bradley Lake study population increased in abundance between 1986 and 1990. Goats were present on the Bradley Lake winter range between October and June, however peak use was between December and April. During January through April most goats were found on steep broken cliffs along the west side of Bradley River Canyon. Parturient females were generally the first animals to disperse from the winter range.

There were two instances in which it seemed that mountain goats temporarily avoided portions of their normal range in response to construction activities. In one case, fall migration appeared to be disrupted because of intense construction activity within a goat movement corridor. In the second instance, goats were absent from a normally occupied area at a time when noisy construction activities, including drilling and blasting, were occurring nearby. However in both cases normal use patterns resumed after cessation of construction activities.

In general, no significant detrimental impacts of the BLHP on mountain goats were detected during this study. Indeed, the population within the study area appeared to increase as did the regional population. Little alteration or destruction of mountain goat habitat occurred because of project construction. It is possible, unless closely regulated, that secondary effects of project development related to increased public access could have more impact on the local mountain goat population than did initial project construction. However, the potential is now present to utilize this improved access, in a positive manner, to view and study mountain goats.

INTRODUCTION

The AEA began construction of a 90 MW hydroelectric generating facility in the Bradley Lake area located 25 miles northeast of Homer along the west slope of the Kenai Mountains in 1986 (Figure 1). The project design consists of an earth dam at the outlet of Bradley Lake and a 2.8 mile tunnel through a mountain to a penstock and powerhouse located at Sheep Point in upper Kachemak Bay (Figure 2). The facility is scheduled to begin operation by September 1991.

The greatest project-related impacts to mountain goats were expected to occur near the lake impoundment within the Bradley River winter range (Holdermann 1983). Mountain goats overwinter on steep slopes along the north shore of Bradley Lake and along a 3-mile stretch of Bradley River immediately downstream from the outlet of Bradley Lake (Holdermann 1987a). Smith and Van Daele (1987) investigated the impacts of hydroelectric development on mountain goats inhabiting summer range at Terror Lake on Kodiak Island, but no Alaskan studies had previously addressed major physical disturbance on winter range.

The BLHP Mitigation Plan (November 1985) proposed that AEA provide funding to ADF&G to conduct a 3-year monitoring study (1986-1989) to assess the impacts of construction activities on overwintering mountain goats. A monitoring study was designed by ADF&G and approved by AEA in February 1986. In 1989, ADF&G and AEA agreed to extend the study through July 1990 because of a 13-month construction shutdown (May 1987-July 1988). This report provides the findings of the mountain goat monitoring study that began in May 1986 and continued through August 1990.

ACKNOWLEDGEMENTS

I am especially grateful to helicopter pilots Jim Sink, John Osgood, Jim Dell and Don Fell of Maritime Helicopters, Homer, Alaska, and to Supercub pilots Larry Rodgers and Vern Lofstedt of Southcentral Air, Kenai, Alaska and Bill Wiederkehr of Wiederkehr Flying Service, Palmer, Alaska for their masterful execution of goat surveys in some of North America's most splendid and unforgiving mountain terrain. Special thanks are due to Audrey Rearden, Margie Meachum and Mary Ann Fell of Maritime Helicopters for their cheerful dispositions, for frequently working me into the flight schedule on short notice and for accepting late TR's. Dave Trugen, AEA Environmental Field Officer, provided valuable insights and assistance throughout all phases of the study; it was a pleasure to work with a professional of his caliber. John Smith, Project Service Manager for the hydroelectric project, was helpful in providing flight support early in the study. Greg Bos and Karl Schneider (ADF&G) and Tom Arminski (AEA) were instrumental in securing project funding and reviewed earlier progress reports. Supervisors Ted Spraker, Carl Grauvogel and

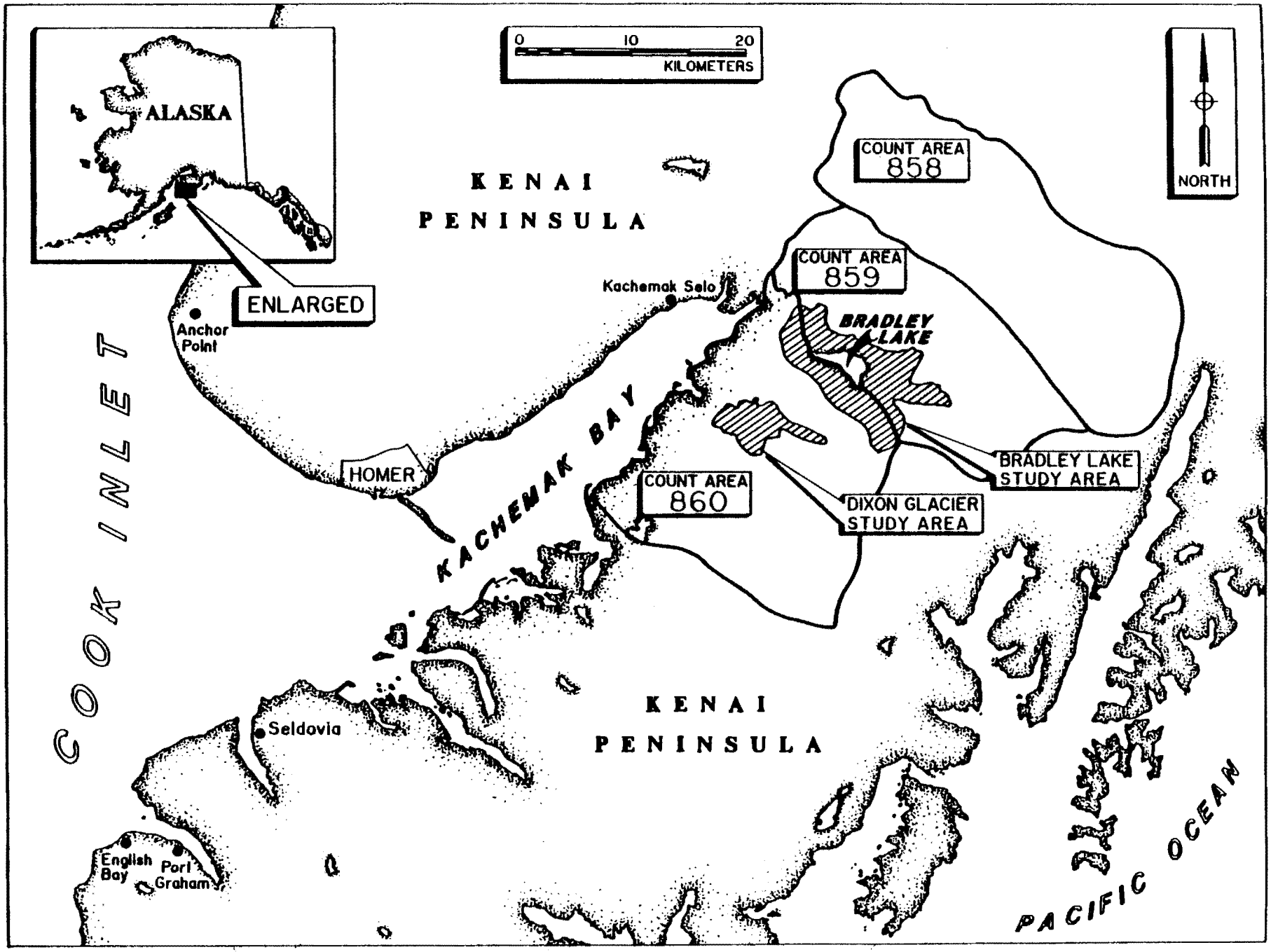

Figure 1. Southern Kenai Peninsula with locations of the Bradley Lake and Dixon Glacier study areas and nearby mountain goat count areas.

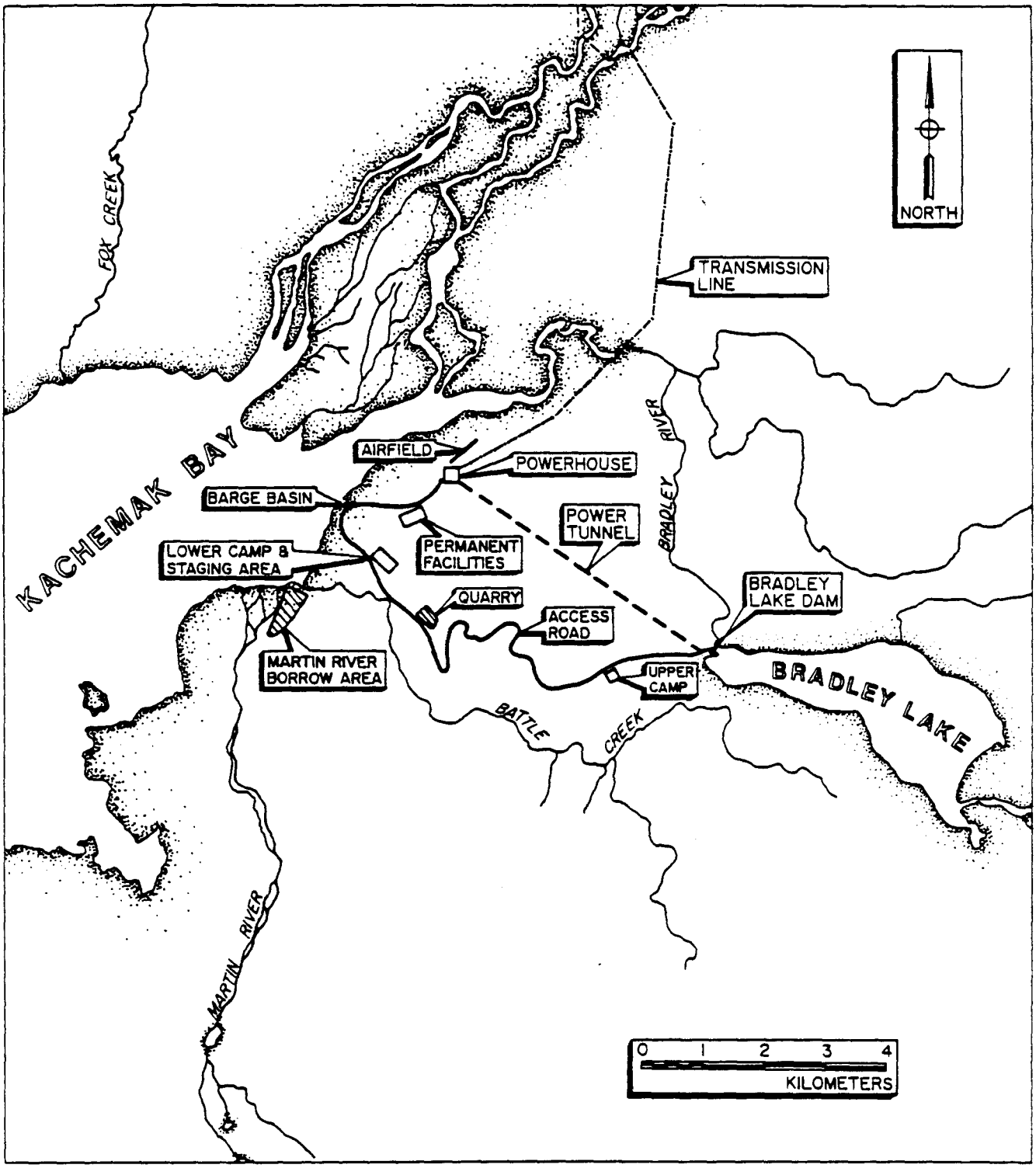

Figure 2. Schematic of the Bradley Lake hydroelectric development.

John Trent deserve special thanks for providing support and encouragement in innumerable ways throughout the study, including reminding me about past due progress reports. I am forever indebted to 2 very special ladies in the Homer ADF&G office, Marnee Bowden and Jan Gillham, for covering many of my duties while I was off having fun in a helicopter or not having fun report writing. Lynn Whitmore of Technetics, Homer, Alaska produced finished illustrations for earlier reports when I know he would have much rather been drifting a fly past wild steelhead on the Anchor River. Dennis McAllister prepared figures for this report. Special thanks to Sheryle West (ADF&G) who is not only a great typist, but always made sure that my jobs never got down too low in her work basket.

OBJECTIVES

The objectives of this study were (1) to determine the number, sex and age composition and geographic distribution of goats on the Bradley River and Martin River winter ranges, and (2) to assess whether goat populations were impacted by activities associated with construction of the BLHP.

STUDY AREAS

The study areas were located on the lower Kenai Peninsula along the west slope of the Kenai Mountains and included portions of the Bradley River and Martin River drainages (Figure 1). The rugged morphologic character of these mountains is the result of recent and ongoing glaciation. The mountains rises abruptly out of Kachemak Bay and the lower Fox River Valley, ascending through complex ridges and peaks to ice fields which straddle the range divide. Glacial-fed river valleys, oriented northwest-southeast, transect the western slope at fairly regular intervals. Peaks and ridges are sheer and sharply cut near the heads of valleys, becoming more rounded toward the base of the western slope. Elevations range from sea level to 5,500 ft. The climate in the vicinity of Bradley Lake is maritime with an annual mean precipitation of 79.7 inches (G. Clagget, unpubl. data, USSCS, Oct. 1983-Oct. 1986).

The Bradley Lake study area included major portions of the ridges on either side of Bradley Lake and the Bradley River Canyon and adjacent hilly plateaus. The Dixon Glacier study area was located near the terminus of Dixon Glacier and included the Martin River Canyon. Bradley Lake served as the treatment area (overwintering goats were exposed to hydroelectric construction activities), and the undisturbed range at Dixon Glacier served as the control area.

Winter ranges at Bradley River and Martin River are located in narrow, steep-sided, northwest-southeast oriented canyons at elevations between 600-2,100 ft. Canyon topography generally

consists of a glacially planed, bedrock dome area that drops off into broken cliffs, benches and steep vegetated slopes with a narrow floodplain and cascading river at the bottom. At the Bradley River winter range, alpine heaths, represented by crowberry (*Empetrum nigrum*), bearberry (*Arctostophylos* spp.), alpine blueberry (*Vaccinium uliginosum*), diapensia (*Diapensia lapponica*), moss heath (*Cassiope stellariana*) and dryas (*Dryas octopetala*) occur at elevations above 1,600 ft. Vegetated slopes between 600-1,600 ft elevation are dominated by alder (*Alnus crispa*) thickets which are interspersed with small openings that support a mixture of subalpine grasses and forbs. Grasses and forbs are particularly prevalent around the rims and lower margins of cliffs. Bluejoint (*Calamagrostis canadensis*) is the dominant grass on moist or wet soils; whereas, fescue (*Festuca altaica*) dominates drier sites. Sitka spruce (*Picea sitchensis*) occur in krummholz form above 1,000 ft elevation as isolated individuals or clumps, and lower elevations are dominated by mature spruce forests.

METHODS

The status of mountain goat populations occurring along the west slope of the Kenai Mountains from Fox River to Grewingk Glacier (Figure 1, count areas 858, 859 and 860) were assessed by fix-winged surveys prior to the initiation of Bradley Lake development (1983-86) and in 1990, 4 years after construction began. Surveys were conducted from a Piper PA-18 Supercub between 0530-1030 hours and between 1830-2200 hours in July and August. Within each count area, all potential alpine habitat above 2,000 ft elevation was surveyed by flying terrain contours, each spaced successively higher at 700-1,000 ft intervals. Mountain goats were counted and classified as either adults (ie. > 1.2 years old) or kids, and these data were recorded on standardized survey forms. The location of each goat observation was plotted on a scale 1:63,360 USGS topographic map; data forms and maps were filed at the ADF&G office in Homer for reference.

Aerial surveys of the Bradley Lake and Dixon Glacier study areas were made from a Bell 206 (Jet Ranger) helicopter. Goats were located by systematically searching along terrain contours, each spaced successively higher at 700-1,000 ft intervals. An attempt was then made to hover the helicopter close enough to each group to determine the sex and age class of individuals. Sex and age criteria developed by Nichols (1978) and refined by Chadwick (1983) were used. Age classes included kid, yearling, and adult (ie. 2 years or older). Data concerning the sex, age class, habitat type, and elevation were recorded on a standard form for each individual or group. Mountain goat locations were plotted on a scale 1:63,360 USGS topographic maps during the flight and later transferred to office maps for a permanent record.

Mountain goats on the Bradley River winter range were counted and classified from the ground during 22-25 May 1986 and 3-5 June

1987. Most observations were made from a high dome located on the west rim of the canyon between 0630-2100 hours. This location provided a good view of occupied winter range on both the west and east sides of the Bradley River. Goats were located and observed with the aid of an 8 x 30 binocular and a spotting scope with a 15-45x zoom lense. The sex and age class of each individual were determined using the criteria of Nichols (1978) and Chadwick (1983). Information pertaining to the sex, age class, group size, affiliation, activity, habitat type, and elevation were entered in a field notebook. The locations of mountain goats were plotted on scale 1:63,360 USGS topographic maps.

RESULTS

Regional Mountain Goat Abundance

Estimated minimum mountain goat population size in the upper Kachemak Bay region, based on ADF&G management surveys in count areas 858, 859, and 860 (Figure 1), increased from 329 to 463 goats (+41%) during the period of hydroelectric dam construction (1986 - 1990) (Table 1). Minimum population density in these count areas increased from 2.0 to 2.8 goats/ mi^2. Kid:100 adult ratios ranged from 33 to 37, which are indicative of increasing goat populations on the Kenai Peninsula (Holdermann 1987).

General Survey Statistics

Site specific analysis of mountain goat population characteristics and geographic distributions were based on 18 helicopter surveys and 2 ground surveys of the Bradley Lake study area, and 9 helicopter surveys of the Dixon Glacier study area. During the study, 742 goats observations (632 classified, 85%) and 376 goats observations (349 classified, 93%) were counted at Bradley Lake and Dixon Glacier, respectively (Tables 2 and 3). Counts obtained during any particular survey were likely underestimates of true population size because of difficult sighting conditions. Goats were sometimes found in timbered areas which made accurate counts difficult. During winter, animals were missed because of the difficulty of sighting white goats on a snowcovered landscape. Neither the Bradley Lake or Dixon Glacier study areas were closed populations and the number of mountain goats present varied because of movements into and out of the study areas, at least on a seasonal basis.

Table 1. Comparison of pre-construction (1983-1986) and construction (1990) mountain goat counts and minimum densities derived from fix-winged surveys conducted along the west slope of the Kenai Mountains between Fox River Canyon and Grewingk Glacier (ie. count areas 858, 859, and 860), Game Management Subunit 15C, Kenai Peninsula, Alaska.

Period	Date	Count area	No. adults	No. kids	Total	Minimum density[a]
Pre-Construction	29 July 1986	858[b]	63	24	87	15
	30 July 1983	859[c]	81	35	116	24
	10 Aug. 1985	860[d]	97	29	126	21
	Totals		241	88	329	
Construction	15 Aug. 90	858[b]	72	23	95	16
	13 Aug. 90	859[c]	128	44	172	36
	14 Aug. 90	860[c]	149	47	196	33
	Totals		349	114	463	

a goats/mi^2
b Fox River Canyon to Sheep Creek Canyon
c Sheep Creek Canyon to Bradley Lake
d Bradley Lake to Grewingk Glacier

Table 2. Helicopter counts and Classifications of mountain goats in the Dixon Glacier study area Game Management Subunit 15C, Alaska from 9 May 1986 to 24 May 1990.

Date	Adults[a]			Yearlings	Kids	Unclassified	Total
	Billies	Nannies	Unk.				
5 October 1986	12	17	2	4[b]	13[c]	0	48
10 November 1986	8	10	1	2[b]	15[c]	22	58
28 April 1987	13	13	0	3[b]	9[c]	3	41
3 June 1987	18	14	0	12[c]	7[d]	0	51
11 December 1987	8	20	3	5[c]	7[d]	0	43
7 June 1988	15	12	0	6[d]	7[e]	2	42
18 January 1989	5	20	0	2[d]	9[e]	0	36
24 May 1990	19	18	0	13[f]	7[g]	0	57
Totals	98	124	6	47	74	27	376
Mean	12	16	1	6	9	9	47

[a] adults ≥ 2 years old
[b] 1985 cohort
[c] 1986 cohort
[d] 1987 cohort
[e] 1988 cohort
[f] 1989 cohort
[g] 1990 cohort

Table 3. Helicopter and ground counts and classifications of mountain goats in the Bradley Lake study area, Game Management Subunit 15C, Alaska from 9 May 1986 to 24 May 1990.

Date	Adults[a]			Yearlings	Kids	Unclassified	Total
	Billies	Nannies	Unk.				
9 May 1986[b]	--	--	19	--	--	--	19
22-25 May 1986[b,c]	17	2	1	0	3[e]	0	23
5 October 1986	6	4	0	3[d]	4[e]	0	17
16 October 1986	8	6	0	1[d]	2[e]	0	17
10 November 1986	11	9	1	5[d]	3[e]	0	29
11 December 1986	--	--	--	--	2[e]	47	49
10 February 1987	--	--	--	--	1[e]	22	23
27 April 1987	8	11	0	4[d]	6[e]	2	31
3 June 1987	9	14	0	3[e]	7[f]	5	38
3-5 June 1987[b,c]	10	11	1	4[e]	7[f]	0	33
16 October 1987[c]	6	5	0	0[e]	2[f]	6	19
11 December 1987	14	28	0	6[e]	13[f]	2	63
4 March 1988	12	13	0	1[e]	11[f]	0	37
16 May 1988	4	6	5	4[f]	1[g]	3	23
7 June 1988	15	21	2	10[f]	11[g]	2	61
23 December 1988	6	8	0	2[f]	5[g]	13	34
17 January 1989	11	4	0	1[f]	1[g]	3	20
30 October 1989	19	26	1	4[g]	18[h]	2	70
29-30 December 1989	18	31	1	8[g]	18[h]	3	79
24 May 1990	19	18	0	13[h]	7[i]	0	57
Totals	193	217	31	69	122	110	742
Mean[j]	11	13	5	5	6	9	37

[a] adults ≥ 2 years old
[b] only Bradley River Canyon surveyed
[c] ground survey
[d] 1985 cohort
[e] 1986 cohort
[f] 1986 cohort
[g] 1988 cohort
[h] 1989 cohort
[i] 1990 cohort
[j] mean was calculated by omitting those surveys in which no animals were observed.

Dixon Glacier

Seasonal Characteristics of Mountain Goat Abundance, Population Composition and Geographic Distribution

Surveys were completed too infrequently to determine the relationships of mountain goat abundance between seasons at Dixon Glacier. December-April surveys indicate a minimum of 43 and 36 mountain goats overwintered on the Dixon Glacier range in 1987 and 1989, respectively (Table 2). The highest counts were obtained in November 1986, 58, and May 1990, 57.

Classifications were sufficiently complete (ie. at least 90% of the sample classified) for 7 of the Dixon Glacier surveys to estimate the seasonal sex and age composition of the study area population (Table 4). Adults comprised from 64% (May-early June) to 68% (December-April) of the observed goats. The adult sex ratio favored females during October (1.4:1), and December-April (2:1), but favored males during May-early June (1:1.3), possibly as the result of movement of parturient females out of the study area. Yearlings and kids represented from 8% (December-April) to 21% (May-early June) and from 15% (May-early June) to 27% (October-November) of the observed populations, respectively.

During winter (December-April), mountain goats on the Dixon Glacier study area were found primarily on the steep, southwest facing cliffs along the Martin River (Figure 3). A few animals were observed along both the terminus and the northwest, lateral margin of Dixon Glacier. During surveys made during the kidding period (24 May-7 June) it appeared that a transition between winter and summer ranges was occurring Many animals remained on winter range (Figure 4) however most nannies about to give birth appeared to disperse. Nannies with newborn kids were observed on both sides of the Martin River canyon (elevations 1,000-2,000 ft) as well as along the steep, southwest-facing ridge flanking Dixon Glacier (elevations 3,000-4,000 ft) (Figure 4).

Bradley Lake Study Area

Seasonal Characteristics of Mountain Goat Abundance, Population Composition and Geographic Distributions

Within the Bradley Lake study area mountain goat abundance followed a seasonal pattern, with considerable variation between seasons (Table 3). Goat numbers increased during October-November ($\bar{x}$ = 30, range = 17-70), peaked in December ($\bar{x}$ = 56, range = 34-79), were lowest during January-April ($\bar{x}$ = 28, range = 20-37) and then increased again in May-early June ($\bar{x}$ = 52, range = 38-61).

Classification data were sufficiently complete (ie. at least 90% of the sample classified) for 10 of the Bradley Lake surveys to determine seasonal sex and age composition of mountain goat

Table 4. Comparison of seasonal sex and age composition of mountain goats observed in the Dixon Glacier study area, Game Management Subunit 15C, Alaska from 5 October 1986 to 24 May 1990.

Period[a]	Adults[b]				Yearlings		Kids		Unclass.		Total	
	Billies	Nannies	Unk.	All								
	N	N	N	%	N	%	N	%	N	%	N	%
October	12	17	2	65	4	8	13	27	0	--	48	100
December - April[d]	26	53	3	68	10	8	25	21	3	3	120	100
May - early June[e]	52	44	0	64	31	21	21	14	2	1	150	100

[a] Used only surveys in which at least 90% of sample were classified
[b] Adults ≥ 2 years
[c] 5 October 1986 survey
[d] included 28 April 1987 and 18 January 1989 surveys
[e] included 3 June 1987, 7 June 1988 and 24 May 1990 survey

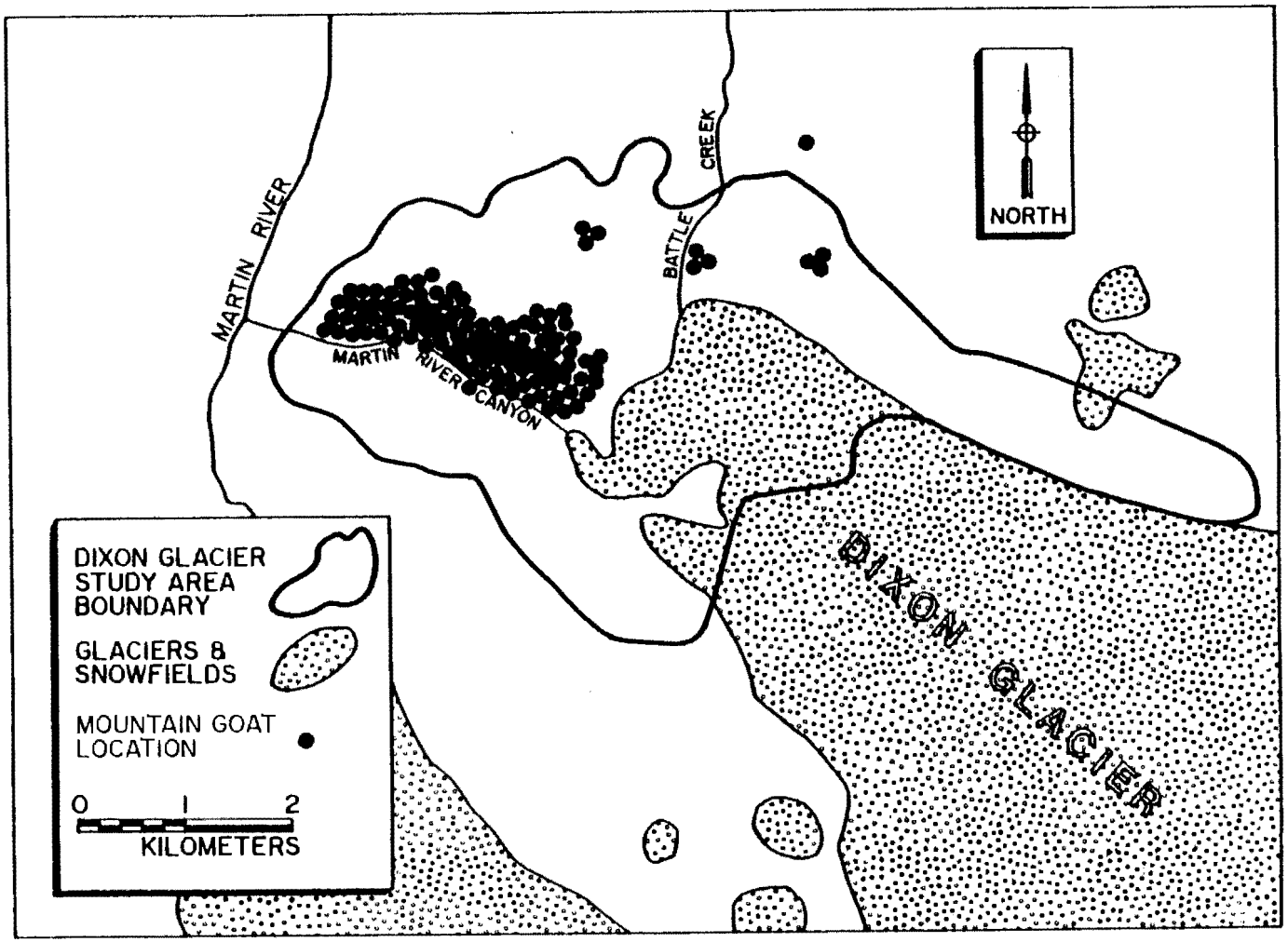

Figure 3. Distribution of mountain goat sightings during winter, 1 December-15 April, on the Dixon Glacier study area.

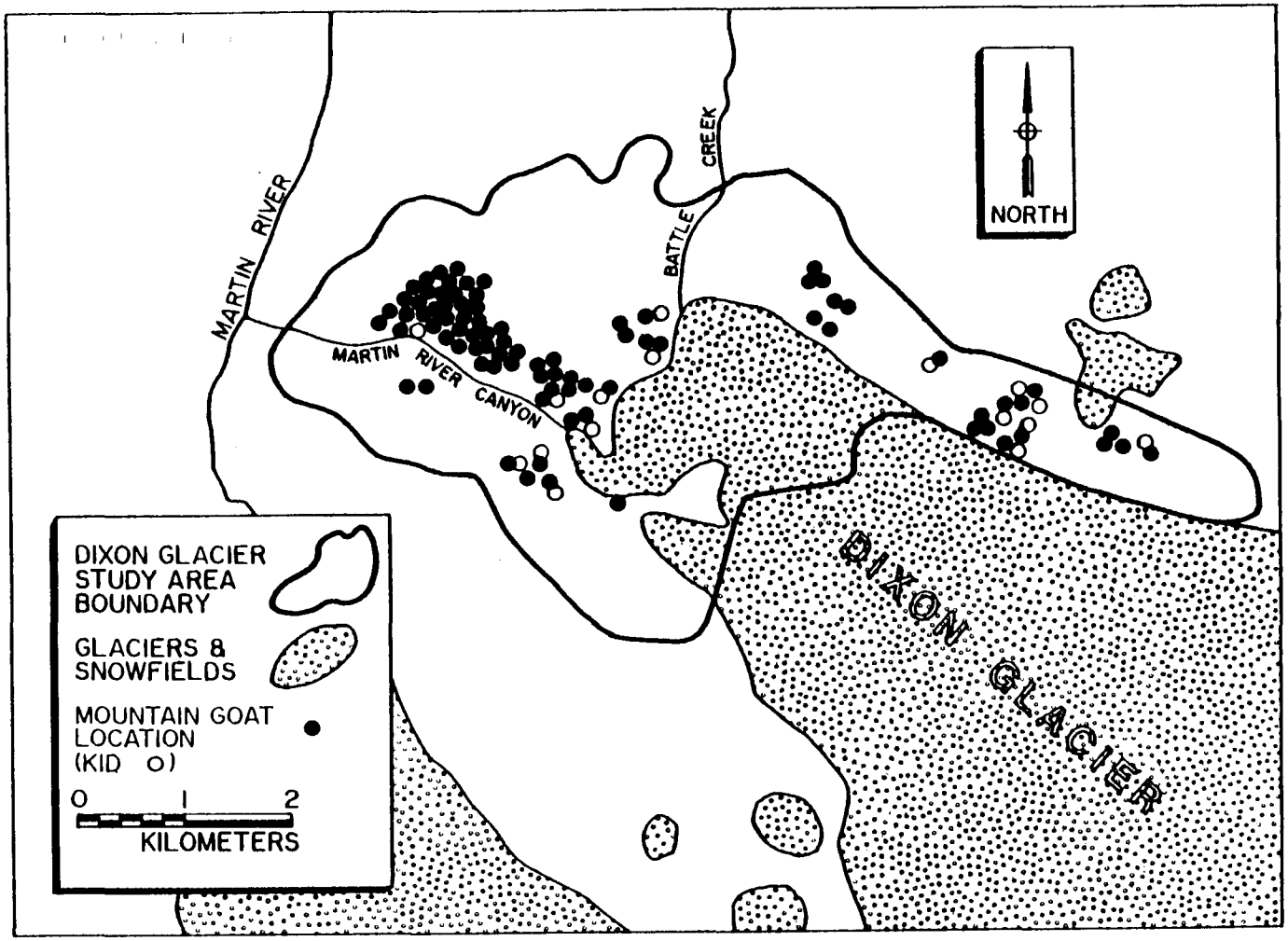

Figure 4. Distribution of mountain goat sightings during the kidding period, 21 May-15 June, on the Dixon Glacier study area.

populations (Table 5). Adults comprised from 64% (May-early June) to 68% (October-November) of the sampled populations. Adult sex ratios were either at (October-November) or near (January-early June) unity, except during December when females outnumbered males 2:1. Yearlings represented 19% and 7-10% of the May-early June and October-April populations, respectively. Conversely, percent kids was lowest in May-early June (15%), and increased progressively from October-November (20%) through January-April (25%).

Seasonal patterns in the geographic distribution of mountain goats within the Bradley Lake study area were also evident. During October-November, the majority of goats occupied transitional alpine ranges along the ridges on either side of Bradley Lake between 2,000-4,500 ft elevation (Figure 5). These ranges were situated between summer ranges located in the upper portions of the Bradley River drainage and the Bradley River Canyon to the west. Small numbers of goats also began appearing on the Bradley River winter range during October.

Within the Bradley Lake study area, mountain goats wintered primarily on south-facing slopes near the northwest corner of Bradley Lake and along the upper 3 miles of the Bradley River canyon collectively referred to as the Bradley River winter range (Figure 6). During this study, mountain goats exhibited 2 different patterns of geographic distribution in December. In 1986 and 1987, at least 98% of the goats observed in the study area were located on the Bradley River winter range at elevations below 2,000 ft. However, 94% and 49% of the observed goats still remained on the transitional ranges north and south of Bradley Lake during December 1988 and 1989, respectively, with the remainder occupying the Bradley River winter range (Figure 6). During January-April, 91% (n = 111) of the observed goats were found on the Bradley River winter range at elevations below 1,700 ft. During spring many goats still occupied the Bradley River winter range with the remainder occurring along the ridges north and south of Bradley Lake up to 4,000 ft elevation (Figure 7). During the kidding period (Figure 8), most nannies with newborn kids in 1987 and 1989 were observed on very steep transitional ranges between 3,000-4,000 ft elevation. In 1988 nannies and newborn kids were evenly distributed between the west side of the Bradley River winter range and transitional ranges.

Bradley River Winter Range

Seasonal Characteristics of Mountain Goat Abundance and Geographic Distribution

Some mountain goats were present on the winter range in October during 2 (1986 and 1989) of the 3 years in which surveys were conducted that month. The observed goat population at Bradley River peaked in December (range = 49-64 goats) and then declined

Table 5. Comparison of seasonal sex and age composition of mountain goats observed in the Bradley Lake study area, Game Management Subunit 15C, Alaska from 5 October 1986 to 24 May 1990.

Period[a]	Adults[b]											
	Billies	Nannies	Unk.	All	Yearlings		Kids		Unclass.		Total	
	N	N	N	%	N	%	N	%	N	%	N	%
October - November[c]	44	45	2	68	13	10	27	20	2	2	133	100
December[d]	32	59	1	65	14	10	31	22	5	3	142	100
January - April[e]	20	24	0	65	5	7	17	25	2	3	68	100
May - early June[f]	34	39	2	64	23	19	18	15	2	2	118	100

[a] Used only surveys in which at least 90% of sample were classified
[b] Adults ≥ 2 years
[c] included 5 October 1986, 16 Oct. 1986, 10 Nov. 1986 and 30 Oct. 1989 surveys
[d] included 11 December 1987 and 29-30 December 1989 surveys
[e] included 27 April 1987 and 4 March 1988 surveys
[f] included 3 June 1988, 7 June 1988 and 24 May 1990 surveys

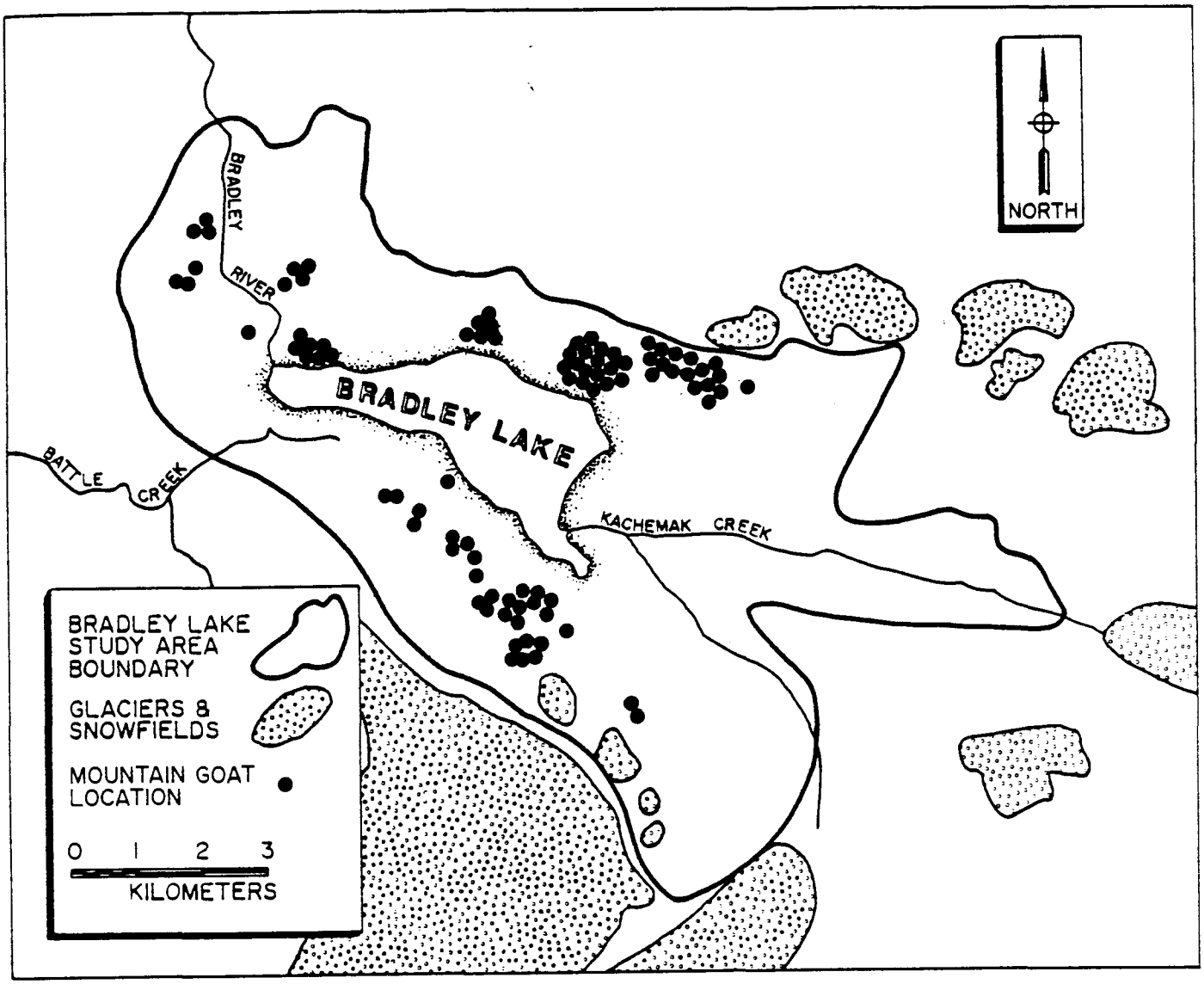

Figure 5. Distribution of mountain goat sightings during fall, October-November, on the Bradley Lake study area.

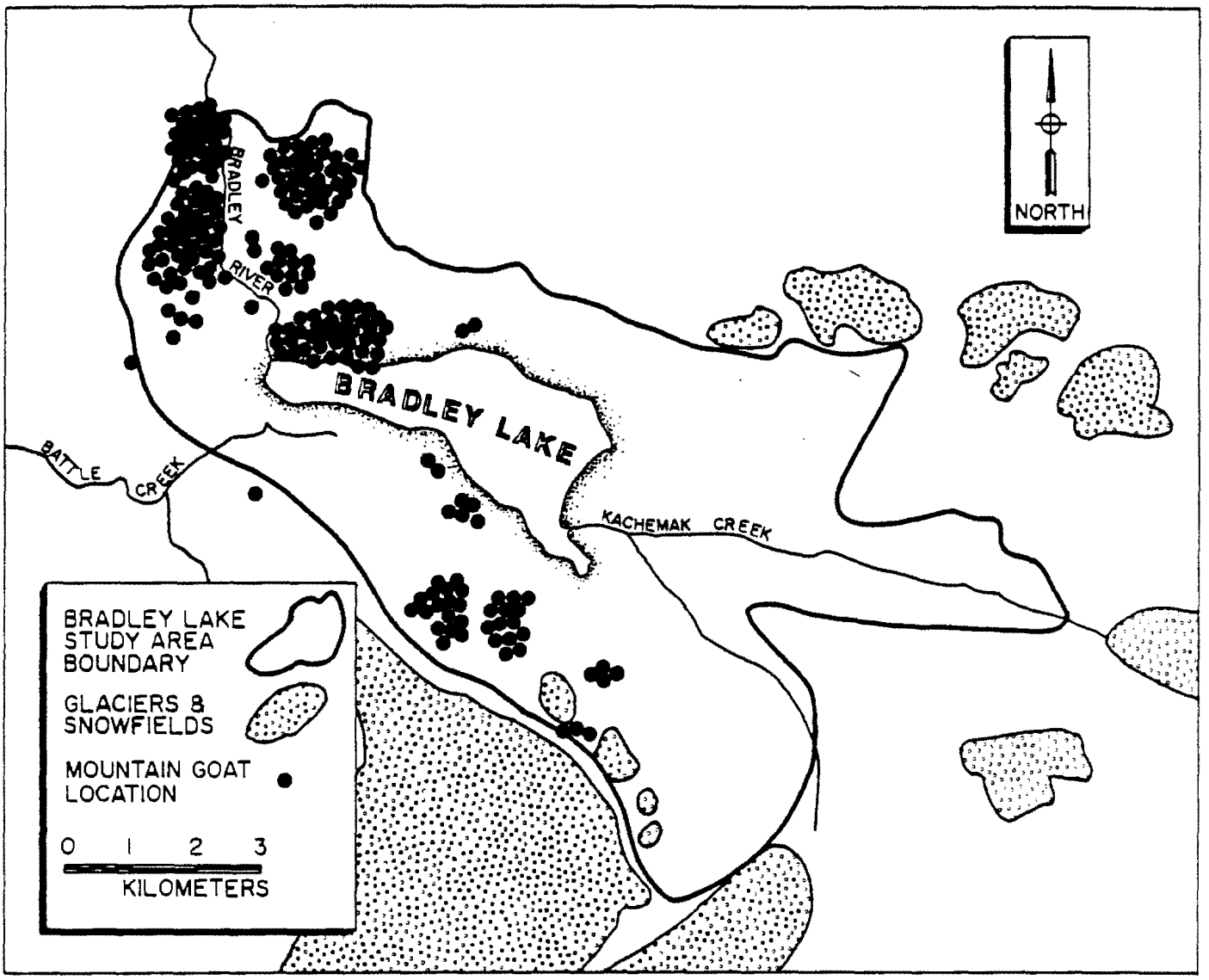

Figure 6. Distribution of mountain goat sightings during winter, 1 December-15 April, on the Bradley Lake study area.

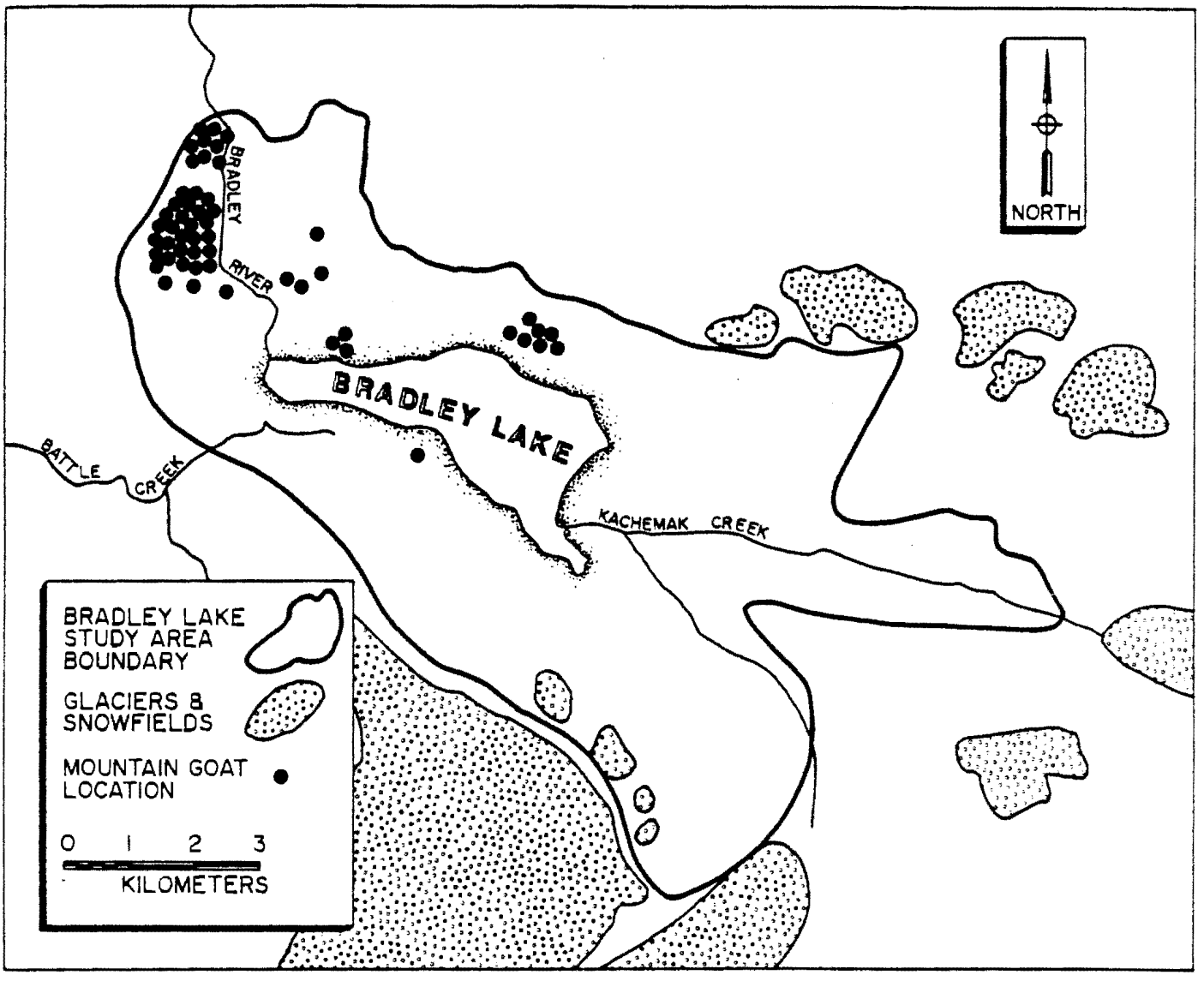

Figure 7. Distribution of mountain goat sightings during spring, 16 April-20 May, on the Bradley Lake study area.

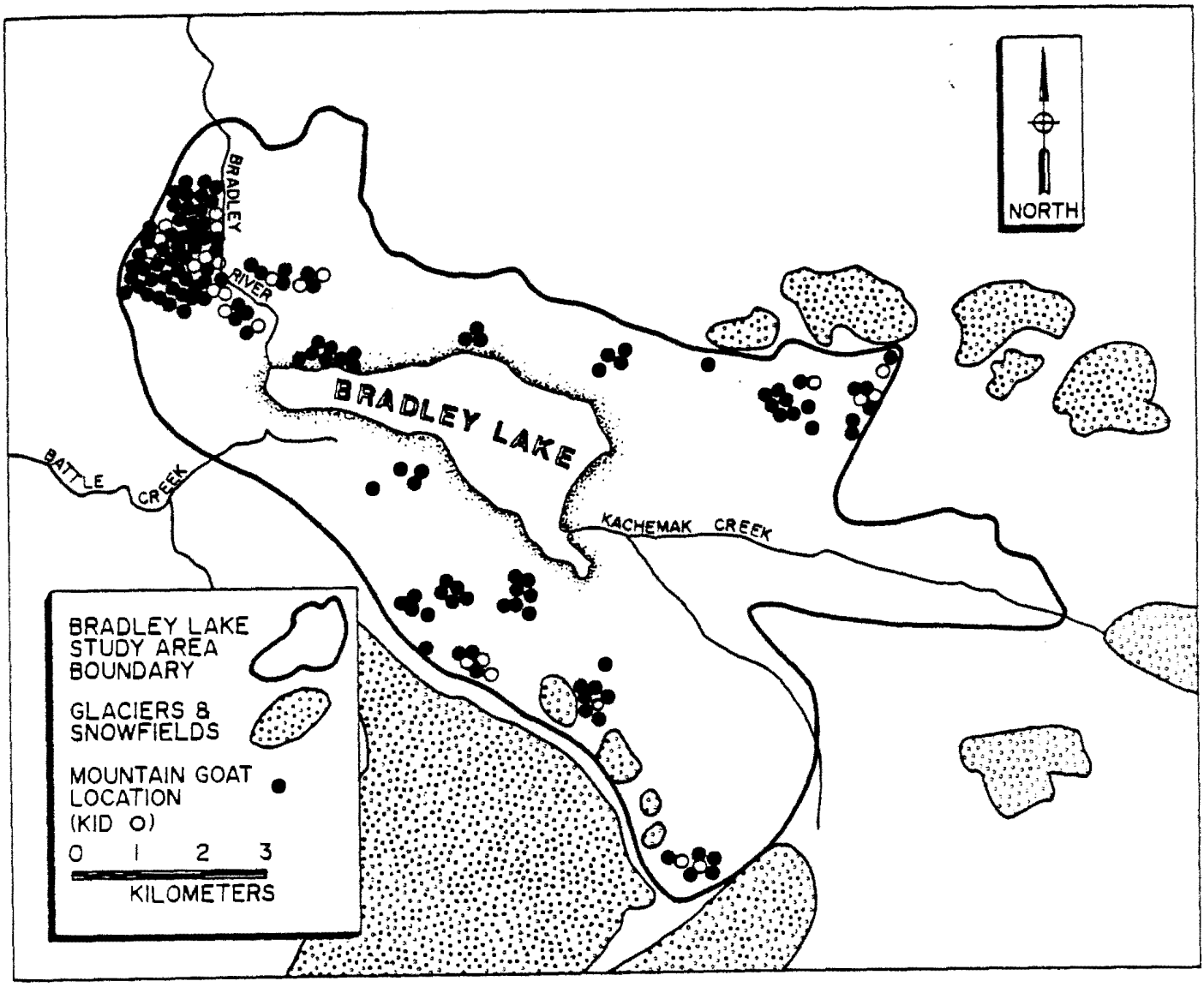

Figure 8. Distribution of mountain goat sightings during the kidding period, 21 May-15 June, on the Bradley Lake study area.

to between 20 and 37 goats during the January-April overwinter period. Based on these observations, it was estimated that the actual overwinter population ranged between 30-35 goats in 1987, 40-50 goats in 1988, 25-30 goats in 1989 and 30-35 goats in 1990. The 1990 estimate of overwinter population size is based on the 26 goats that still occupied the range on 24 May 1990. Between 26 (1990) and 30 (1987) mountain goats remained on the winter range through early June.

Mountain goats were observed approaching the winter range along 2 primary corridors. A northern corridor passed along a broad, bedrock ridge overlooking the north shore of Bradley Lake, while a southern corridor traversed the steep ridge south of the lake and across a series of rolling hills leading to the winter range. During the period, October-December, the number of goats observed on the east side of Bradley River Canyon generally exceeded the number seen on the west side. Commonly used sites for this period included the dome above the northwest corner of Bradley Lake and the hilly, bedrock plateaus on either side of the Bradley River Canyon. Generally, goats assumed their overwinter geographic distribution by January, which was markedly different from the October-December distribution. During January-April, most goats occurred on 2 sections of steep, broken cliffs along the west side of Bradley River Canyon. Goats remained in these areas through early June, but also expanded their distribution to the cliffs on the west side of the canyon and to the dome located above the northwest corner of Bradley Lake during spring. Goat trails leading across the Bradley River were observed in the snow on several occasions indicating that exchange between the east and west sides of the canyon was probably common. It was assumed that all goats dispersed from the Bradley River winter range by late June.

Evaluation of Effects of Hydroelectric Construction Activities on Mountain Goat Abundance and Geographic Distribution

Numbers of goats observed at the Bradley Lake study area during December surveys generally increased between 1986-1989 (Table 3). However, trends in Bradley Lake goat abundance over time for other seasons either were not apparent or could not be determined because of incomplete data. No trends in mountain goat abundance were apparent in the Dixon Glacier study area.

Total numbers of goats observed during December surveys on the Bradley River winter range closely followed the increasing trend previously reported for the nearby management count areas. Total number of goats observed during May-early June was relatively stable between 1986-1990.

Patterns of seasonal geographic distributions suggest that on 2 occasions goats may have temporarily avoided portions of their range that were near hydroelectric construction activities. In the first instance, migration of goats onto the west side of the

Bradley River winter range during October-December 1986 was delayed, possibly because of heavy construction activities along the main access road between Battle Creek delta and the main dam site at Bradley Lake. During the expected period of fall migration, heavy construction activity was ongoing along the upper segment of the access road that crossed the main goat movement corridor connecting transitional fall ranges south of Bradley Lake and the west side of the Bradley River winter range. In 1986, goats did not move onto the west side of the winter range until sometime between 10 November and 11 December. By 11 December 1986, only 10 goats occupied the west side of the range compared to 25 goats on both 11 December 1987 and 29 December 1989. The observed winter population on the west side eventually increased to 21 and 22 goats on 10 February and 27-28 April 1987, respectively.

Secondly, between 5 October 1986-3 June 1987, mountain goats were absent from the bedrock dome and cliffs located at the northwest corner of Bradley Lake that are immediately above the main dam site. During this period, the final segment of the main access road, including a temporary bridge across upper Bradley River, was completed, and construction of a diversion tunnel at the outlet of Bradley Lake was begun. Work on these projects included drilling and blasting of bedrock with high noise levels. Woodward and Clyde (1984) reported that the northwest bedrock dome area was heavily used by goats during the period November 1983-February 1984, and goats were again observed there in January 1985 (D. Holdermann, pers. observ.).

Abnormal goat abundance and geographic distribution were also observed on the Bradley River winter range during the 1988-89 winter period. During 23 December 1988 and 17 January 1989 surveys, only 3 and 17 goats were located on the winter range, respectively, and total numbers of goats in the Bradley Lake study area were also depressed. Numbers of goats at Dixon Glacier on 18 January 1989 were also below previously observed levels. Although construction activities were in progress at the main dam site from mid July-November 1988, it was believed that higher than usual numbers of mountain goats remained on the fall range south of Bradley Lake because of early, unusually deep snow accumulation (1-1.5 m) along travel corridors leading to the winter range. The presence of a wolf pack along the east rim of the Bradley River canyon in December may also have affected mountain goat distribution (Holdermann 1990).

Mountain goats continued to use most traditional sites on the Bradley Lake winter range during the construction phase covered by this study (October 1986-May 1990). Goat tracks that crossed the upper segment of the main access road were reported in November 1986 (D. Trugen, AEA unpubl. data) and also observed during the 30 October 1989 helicopter survey. On 4 March 1988, after an 11 month suspension of construction activities, 3 goats were again seen on the dome and cliffs located above the northwest corner of Bradley Lake. Furthermore, 7, 26 and 7 goats

were observed at the same location on 30 October and 29 December 1989 and on 24 May 1990, respectively, during a period when heavy construction activities occurred at the Bradley Lake dam site.

Conclusion and Recommendations

No significant impacts of the BLHP on mountain goats inhabiting the Bradley River winter range were detected during this study. During the period of dam construction (1986-1990), the number of mountain goats observed on the winter range increased during December and remained stable during May-early June. However, assessment of the changes in goat abundance during January-April was inconclusive after 1988 due to insufficient data. Mountain goat geographic distributions within the winter range were consistent between years with some initial changes that appeared to be related to project construction activities. During the 1986-1987 overwinter period, ongoing access road construction appeared to delay movement of mountain goats onto the west side of the winter range, and goats did not use portions of their traditional range that were within 1.0 mi of bedrock drilling and blasting operations at the outlet of Bradley Lake. However, goats appeared to accommodate to these activities after the first construction season (July 1986-May 1987). These findings are consistent with the responses of a goat population on summer range to hydroelectric development at Terror Lake on Kodiak Island (Smith and Van Daele 1987). Initial construction related impacts of the BLHP on mountain goats may have been negligible because a relatively small amount of winter range was altered or destroyed.

The real value of this study is that it provides baseline information concerning seasonal changes in abundance, sex and age composition and geographic distribution of mountain goat populations that use the Bradley River and Dixon Glacier winter ranges. Over time, the secondary effects of hydroelectric project development related to enhanced public access and attendant human pressures may have more serious negative impacts on goats than initial project construction. Subsequently, these data will provide a valuable reference point to evaluate the secondary effects of Bradley Lake hydroelectric development on mountain goats.

Two potential threats to Bradley River goats are foreseen as a result of the newly constructed project access road between Battle Creek and Bradley Lake. First, construction of a road to Bradley Lake greatly increases the likelihood of eventually overharvesting goats that winter along the Bradley River, even under carefully controlled permit hunting. Drawing and registration permits for the 2 hunt areas that currently cover the Bradley River range (ie. 859 and 860) will be increasingly sought by hunters who are interested in relatively easy and inexpensive access to goats. Correspondingly, a greater proportion of the total goat harvest from hunt areas 859 and 860

will be taken along the easily accessed portions of the Bradley River range. This scenario can be avoided while still allowing for maximum hunting opportunity in the greater parts of hunt areas 859 and 860 by creating a separate hunt area to cover the Bradley River winter range. Conservative, allowable harvest levels based on goat subpopulation size could then be determined, and the hunting of goats could be safely managed. This recommendation should implemented immediately to protect the local population from overharvest and to maintain consistent hunting standards.

Secondly, it is anticipated that public interest in fall/winter outdoor recreation at Bradley Lake will be high, which has the real potential to introduce large numbers of people into critical portions of the winter goat range. Wildlife managers and recreational specialists need to work closely to develop recreational plans that will minimize human disturbance of goats in critical habitats such as breeding, wintering and kidding areas. The operation of ground vehicles such as 3- and 4-wheelers and snowmachines in these areas should be prohibited. The ADF&G and the AEA should pursue an agreement which specifies that aerial surveys of the Bradley River and Dixon Glacier study areas would be repeated in 1995, 2005 and 2015. Results of these surveys would be compared to trends in abundance in nearby management count areas in order to evaluate the long-term impact of the hydroelectric project on goats.

Finally, the Bradley River winter range is capable of providing wildlife enthusiasts and natural scientists with opportunities to view, photograph and study mountain goats in a breathtaking environment. It was discovered during the course of the study that a bedrock dome located approximately 1 mile northwest of the Bradley Lake outlet makes an excellent ground observation point for goats wintering along the canyon rim and cliffs on the west side. The recreational plan for the BLHP should judiciously develop this and similar opportunities for the public to use and appreciate wildlife.

In retrospect, modification of several aspects of study methodology would have improved the assessment of hydroelectric project construction on mountain goats. First, winter surveys should have been conducted more frequently, since the magnitude and regularity of seasonal fluctuations in abundance indicated that the Bradley River goat population most closely approximated a "closed" population with minimal egress or ingress during January-April. Thus, comparisons of winter surveys would have been the most useful measure of project development on goat abundance. It is also recommended that in the future that similar studies incorporate the use of radio-telemetry. Radio-telemetry would provide additional information on degree of population closure, extent and pattern of movements, range fidelity and survival.

LITERATURE CITED

Alaska Power Authority. 1985. Bradley Lake Hydroelectric Project: Mitigation Plan. Juneau. 181 pp.

Chadwick, D. H. 1983. A beast the color of winter. Sierra Club Books, San Francisco. 208 pp.

Holdermann, D. A. 1983. An assessment of the impact of the Bradley Lake Hydroelectric Project on selected wildlife populations. Unpublished Report. Alaska Dep. Fish and Game. Juneau. 78pp.

Holdermann, D. A. 1987. Fall, winter and spring abundance and distribution of mountain goats on the Bradley River winter range. Unpublished progress report to the Alaska Power Authority. Alaska Dep. Fish and Game. Juneau. 30pp.

Holdermann, D. A. 1990. Fall, winter and spring abundance and geographic distribution of mountain goats on the Bradley River winter range. Unpublished progress report to the Alaska Energy Authority. Alaska Dep. Fish and Game. Juneau. 33pp.

Nichols, L. 1978. Mountain goat aerial survey technique evaluations. Alaska Dep. Fish and Game. Fed Aid in Wildl. Rest. Proj. Rep. Proj. W-17-9 and W-17-10 (1st half). Jobs 12.2R and 12.3R. Juneau. 31pp.

Smith, R. B. and L. J. Van Daele. 1987. Terror Lake Hydroelectric Project Final Report on Mountain Goat Studies. Unpublished report submitted to the Alaska Power Authority. Alaska Dep. Fish and Game. Juneau. 38pp.

Woodward-Clyde Consultants. 1984. Moose survey report. Under contract to Stone and Webster Engineering Corporation. Prepared for the Alaska Power Authority.