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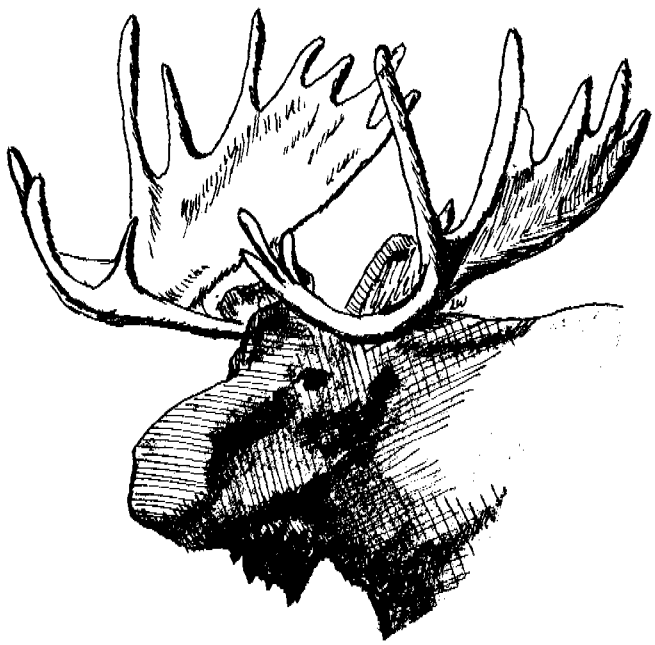
ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

LOWER SUSITNA VALLEY MOOSE POPULATION IDENTITY STUDY

By Jack C. Didrickson and Kenton P. Taylor



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Final Report
Federal Aid in Wildlife Restoration
Projects W-17-8 and W-17-9, Job 1.16R

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FINAL REPORT (RESEARCH)

State: Alaska

Cooperators: Jack C. Didrickson and Kenton P. Taylor

Project Nos.: W-17-8&W-17-9 Project Title: Big Game Investigations

Job No.: 1.16 R Job Title: Lower Susitna Valley Moose Population Identity Study

Period Covered: December 15, 1975 to June 30, 1977

SUMMARY

Forty-nine adult moose were marked with individually identifiable collars, including 24 radio-collars and 25 visual-collars, in the Peters-Dutch Hills portion of Alaska's Game Management Subunit 16A during November 1975. In 1976, the radio-collared moose were tracked weekly and a search for visually-collared moose was conducted at the same time. In August 1977, aerial radio tracking was terminated after 624 radio collar and 82 visual collar sightings were made for a total of 706 observations.

An average age of 3.4 years for eight males and 7.4 years for 25 females was determined from teeth taken from moose during collaring.

Three winter ranges were identified in the study area; Kahiltna Glacier Moraines, Peters Hills burn and Bunco-Home Lake area on the Tokositna River. Average distance between winter and summer range was 13 km (range 3-19 km) for female radio-collared moose. Winters during 1975 and 1976 were considered mild. Seven of the eight cows that wintered southwest of Little Peters Hills gained approximately 300 meters in elevation as they moved over Black Creek summit to summer in the headwaters of Peters Creek tributaries.

Six of nine radio-collared females exhibited traditional use of calving areas by returning to the previous year's calving area. The average distance between 1976 and 1977 calving areas was 3.6 km for the six females.

Females exhibited their longest movements during calving, averaging 10.7 km (range 2 km - 26 km). Many females calved outside their normal summer range, waiting to move when calves could follow or they had been lost.

Of four radio-collared bulls, three confined movements to 8 by 20 km areas. The remaining bull traveled extensively in a 16 by 32 km area.

In November 1975, when radio-collaring began, seven of 18 radio-

collared females were observed with 8 calves. These 18 cows were observed with 19 calves in spring 1976, but by fall 1976, only seven calves remained. In spring 1977, 14 radio-collared cows were observed with 14 calves. By 15 August 1977 at least nine calves remained (64 percent).

Between 17 November 1975 and 15 August 1977, six instances of mortality were noted. Two deaths were of unknown causes, two visually-collared moose were harvested by hunters and two instances of predation were noted. A female brown bear with two yearling cubs was observed eating a radio-collared female and her calf near Cache Creek. A wolf killed and fed on a radio-collared female in the Kahiltna River drainage.

Comparing radio-collared moose data with Alaska Department of Fish and Game sex and age composition counts, a discrepancy was noted regarding calf/cow ratios. Calf/cow ratios were noted to vary from 44.4 calves/100 females in November 1975 in radio-collared moose, to 23.6 calves/100 females in December 1975 (Alaska Department of Fish and Game sex and age composition count data). In August 1977, 71.4 calves/100 females were noted in radio-collared females, but by November 1977 Alaska Department of Fish and Game sex and age surveys revealed 38.5 calves/100 females, suggesting underestimation of calf crops by aerial surveys.

CONTENTS

BACKGROUND

Hunter interest in Alaska's Game Management Unit 16 has increased steadily, and potentially conflicting land uses have been proposed. Except for sex and age composition ratios in selected drainages, little information is available on moose (*Alces alces*) populations in this area. Winter and summer ranges as well as rutting and calving areas must be understood in order to identify critical habitats and minimize land use conflicts. The initial phase of this study was directed at a population of moose that has a fall distribution in the Peters and Dutch Hills, a portion of Alaska's Game Management Subunit 16A.

A single road system which begins on the Parks Highway and ends between the Peters and Dutch Hills is the primary hunter access to Subunit 16A. Boats are used in increasing numbers on the Susitna and Kahiltna Rivers which border the area on the east and west. Some airboats have also utilized the Tokositna River which constitutes a portion of the north boundary of Unit 16A. Aircraft, however, are used infrequently by hunters because there are few landing strips in the area, and lakes for float equipped planes are not extensively used at this time. ATV and other off-road vehicular traffic has been low in the past, probably due to the swampy nature of the area. The closure of moose seasons before snowfall has prevented the use of snowmachines, which were popular in the past.

The Alaska Department of Fish and Game has several years' sex and age moose composition counts from the Peters and Dutch Hills area. Bull/cow ratios have fluctuated from 25.5/100 in 1967 to 30.0/100 in 1975. Calf/cow ratios have also fluctuated from a low of 23.6/100 in 1975 to a high of 51.2/100 in 1970. The area periodically experiences severe winters and it appears that winter kill does occur, although it has not been documented.

STUDY AREA

The study area includes the Peters Hills, Little Peters Hills and Dutch Hills on the south side of the Alaska Range, 33 km west of Talkeetna and 56 km south of Mt. McKinley. It is bounded on the north and east by the Tokositna River and on the west by the Kahiltna River. To the south lies a vast area of mature birch (*Betula papyrifera*) and white spruce (*Picea glauca*) forest interspersed with areas of open muskeg and stands of black spruce (*Picea mariana*). The Little Peters Hills, Peters Hills, and Dutch Hills are low rolling mountains less than 1500 m elevation which form the southern foothills of Mt. McKinley. Sub-alpine areas are comprised of large tracts of alder (*Alnus* spp.) and willow (*Salix* spp.), interspersed with spruce stands and open grasslands. The Tokositna and Kahiltna River valleys are both comprised of extensive stands of alder mixed with open meadows, gravel flats and ponds. An old burn is located on the west side of the Little Peters Hills and is dominated by heavily browsed birch and willow cover, most of which is within reach of browsing moose. The terminal and lateral glacial moraines of the Kahiltna Glacier are dominated by young stands of mixed willow and alder.

OBJECTIVES

To delineate populations and sub-populations of moose on the west side of the lower Susitna Valley, to assess their seasonal movement patterns and to examine parturition and survival of moose calves.

PROCEDURES

Under S & I Job 1.1, 49 moose were captured and marked using helicopter darting techniques between 13 and 17 November 1975 (Table 1). Initially dosages of 25 mg of Anectine (Succinylcholine chloride) per moose were used, but drug associated problems caused this dosage to be reduced to as low as 20 mg for males and 22 mg for females. An attempt was made to mark each animal with red streamers held in the ear by a numbered ear tag. Hair samples for mineral analysis were taken from each animal and an incisor tooth was collected for age determination when time permitted. When an incisor was not taken, an estimate of the age of the moose was made based on tooth wear.

Twenty-five moose (18 adult females and 7 adult males) were fitted with numbered neck collars visually identifiable from the air (Franzmann et al. 1974). Twenty-four additional moose (18 females and 6 adult males) were fitted with radio collars supplied by the AVM Instrument Company, Champaign, Illinois. Each collar was equipped with an SB 2 transmitter and an internal whip antenna. These 40 km-range transmitters are powered by low temperature lithium batteries with a theoretical life span of 48 months. The transmitter and battery pack were imbedded in dental acrylic with the transmitter enclosed in a hermetically sealed can; the entire unit was waterproof. Each transmitter emitted a pulsed signal on frequencies between 150.800 and 151.090 MHz.

Collaring antlered moose presented a unique problem because the drug utilized has little or no effect on the neck musculature. Initial attempts to place open-ended collars on antlered moose resulted in a

Table 1. Numerical designation, sex and age of moose in Game Management Unit 16 fitted with visual-collars or radio-collars.

Radio Collared Moose			Visually Collared Moose		
Numerical Designation	Sex	Age	Numerical Designation	Sex	Age
5527	M	NA*	1	F	12
5528	M	2	2	F	NA
5529	M	NA	3	F	11
5530	M	3	4	F	NA
5531	F	7	5	F	NA
5532	F	NA	6	F	1
5533	F	3	7	F	5
5534	F	6	8	F	8
5535	F	4	9	F	NA
5536	F	9	10	F	NA
5537	F	NA	11	F	7
5538	F	11	12	F	NA
5539	M	1	13	F	12
5540	M	7	14	F	4
5541	F	10	15	F	NA
5542	F	10	16	F	4
5543	F	11	17	F	8
5544	F	NA	21	F	7
5545	F	10	76	M	6
5546	F	12	77	M	NA
5547	F	NA	80	M	NA
5548	F	NA	82	M	NA
5588	F	6	83	M	1
5589	F	4	84	M	NA

* Not available.

loss of time and placed the individual who bolted the collar together in a precarious position. Very large antlers were a particular problem because the individual could be caught between the swinging antlers and the body of the recumbent animal. After working on a few antlered animals and realizing the drug down-time was too short to permit accomplishing all of the collections and also to bolt on the collars, we utilized a teflon-coated carpenter's hand saw to remove the antlers. This procedure allowed us to prefabricate the collars and slip them onto the animal easily. Prior removal of the antlers required less time than bolting the collars on moose and lessened the possibility of an accident.

Locations of collared moose were monitored approximately once a week using either a PA-18 or a PA-11 aircraft equipped with a Hy-Gain directional antenna connected to an AVM receiver. A 100 microampere meter is an integral part of the receiver and a remote 100 microampere meter is situated above the instrument panel in view of the pilot. This arrangement allows the pilot to find the area in which the radio-collared moose is located in the most expeditious manner.

Moose not observed during one week were the first to be searched for the following week. On occasion, inclement weather conditions prevented flights for an entire week. Whenever possible, moose were visually located, and their locations were plotted on 1:63,360 USGS maps. Searches were concurrently conducted for visually-collared and radio-collared moose. In addition, locations of visually-collared moose observed during a moose sex and age composition survey on 2 December 1975 were also plotted. During parturition observers noted when collared females were first seen with calves and whether or not they had the calf with them in subsequent observations. The location was also recorded, in an attempt to determine loyalty to calving areas.

FINDINGS

Attempts to observe moose movements on the Kenai Peninsula resulted in 200 observations of 185 visually-collared moose over a 21-month period (LeResche 1970). The proportion of radio-collared (624 observations of 24 moose) to visually-collared moose observations (82 observations of 21 moose) in this study is greater than seven-to-one. It is obvious that the use of a radio signal to bring the biologist into the immediate area of the radio-collared moose greatly increases the opportunity to sight the animal. In fact, a large number of individual sightings of visually-collared moose, were made only because they were in association with radio-collared moose. It is usually difficult, and at times impossible, to see a radio-collared adult moose even though its general location is known, particularly in the summer, when high grass and dense alder combine to form an effective barrier to sighting the animal from the air. If a visually-collared moose were in such a patch of alder, it simply would not be seen. The radio receiver, however, is accurate enough to locate the radio-collared moose within 200 yards, regardless of whether or not the animal can be seen; a definite location can thus be made. Visually-collared moose were often found at a later date with radio-collared moose (Fig. 1) that were collared in the same area and within the same small pods. The chances of sighting the visually-

Figure 1. Visually-collared and radio-collared locations.

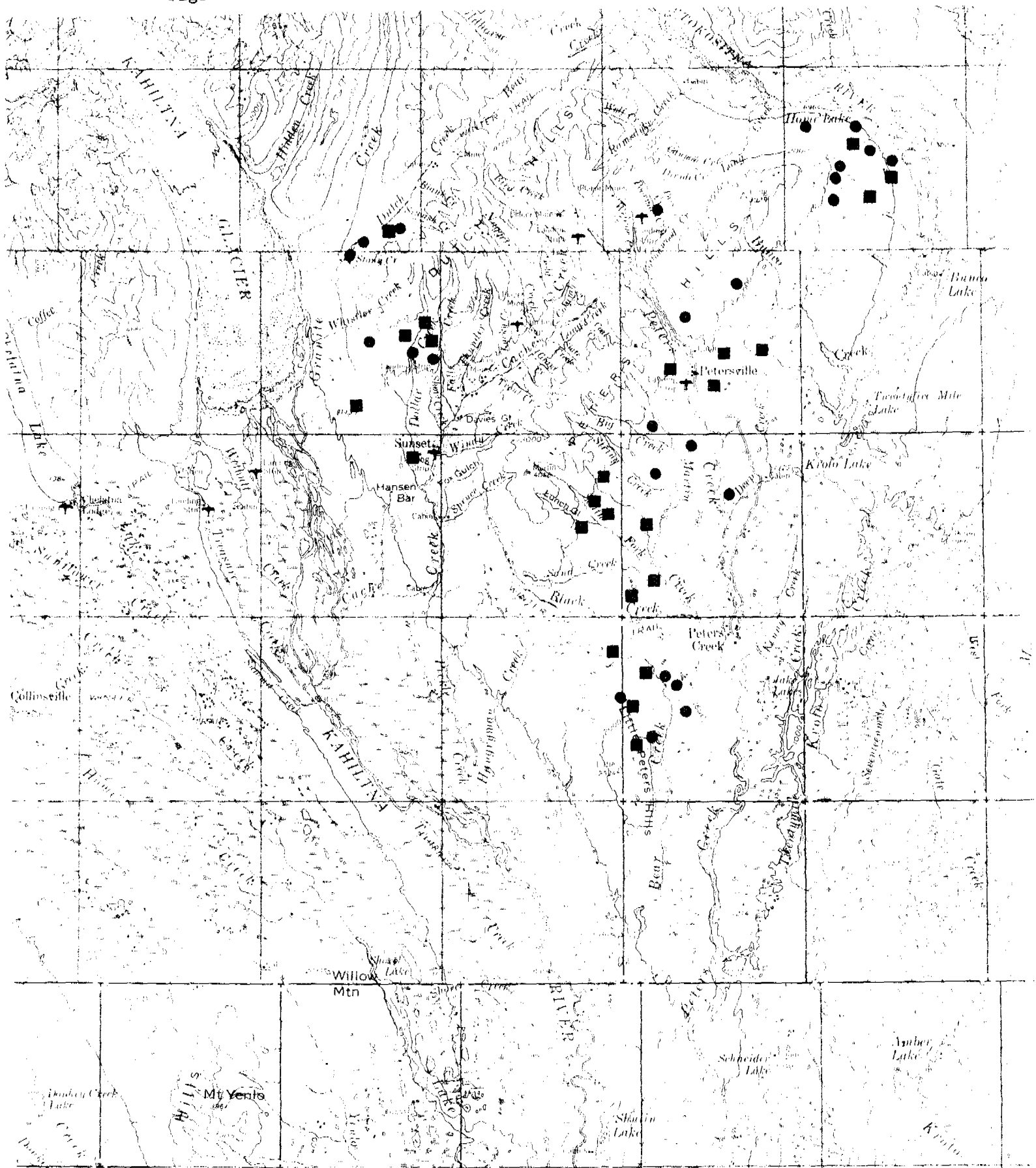

Figure 1. Locations of moose in Game Management Subunit 16A when collared November 13-17, 1975.

● Visual-collar locations
■ Radio-collar locations

Figure 2. Migrations from winter to summer range.

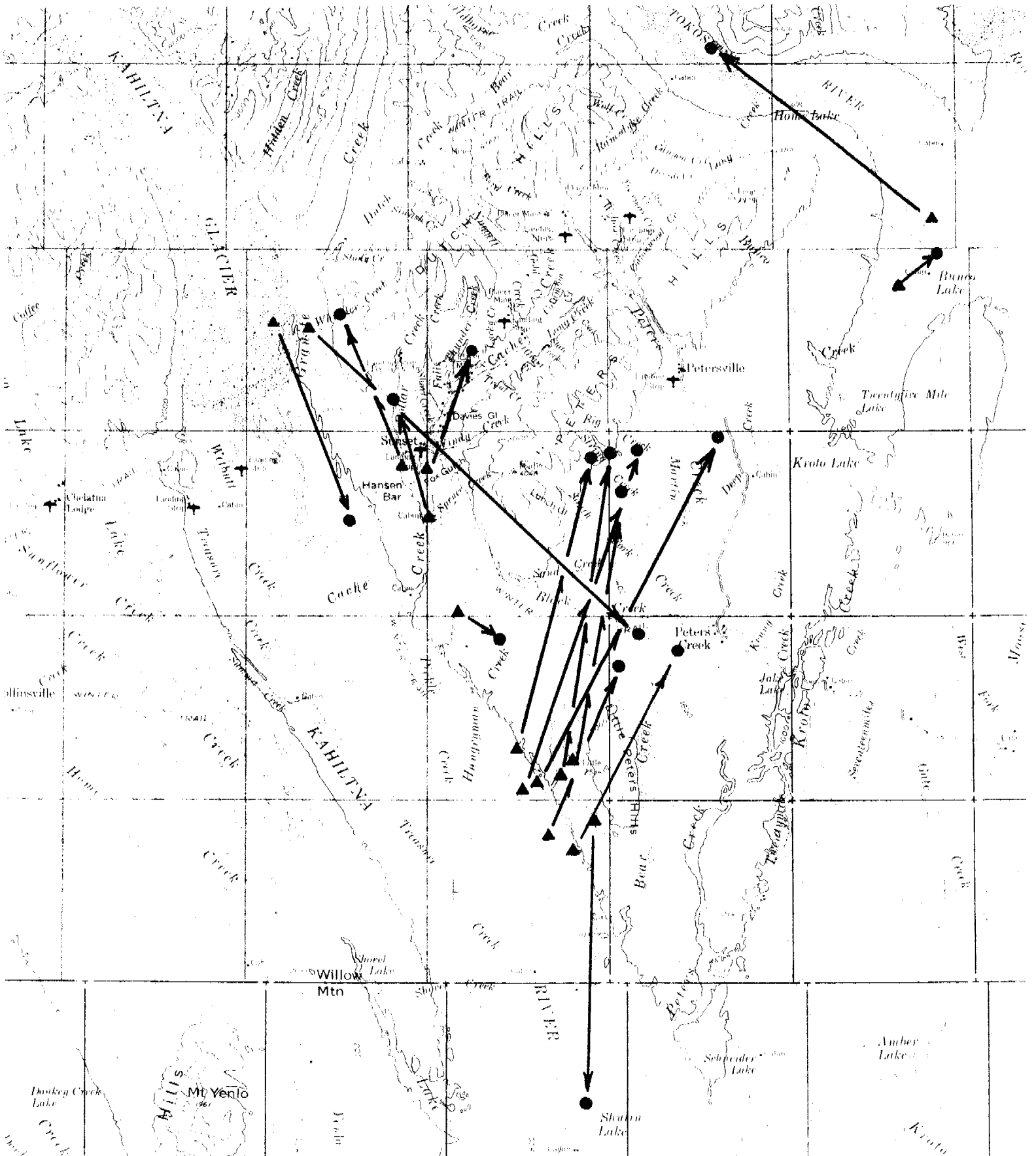

Figure 2. Winter to summer range in Peters-Dutch Hills during 1976.

● Approximate location 8/15.
▲ Approximate location 2/15.
Locations plotted are taken from closest date of survey flight.

collared moose were subsequently much increased. Had visual collars been placed on all of the moose it is doubtful that the total number of observations made would have been as great as the observations made on the 25 visually-collared moose. For example, only three of the visually-collared moose were seen between 19 April and 30 June. During the same period, however, 155 observations of radio-collared moose were made, illustrating the greater usefulness of radio collars.

Age Composition

At the time of collaring, an incisor tooth was extracted from each moose if time permitted. Thirty-three moose were aged, resulting in an average age for eight males of 3.4 years. One hundred and ten males aged on the Kenai between 1968 and 1975 averaged 4.9 years (Bailey et al. 1978). The mean age of males is generally lower as the bull/cow ratio declines. Because bull/cow ratios in the Peters Hills have been equal to or greater than those on the Kenai during the 1970's we suspect our small sample size of male ages is biased. Twenty-five females in the Peters Hills had an average age of 7.5 years (range 2-12) which is comparable to that for 27 females along the upper Susitna River 60 miles east which averaged 6.7 years (Taylor, unpubl.) and to 66 females in other portions of Unit 13 which averaged 7.6 years (Ballard, unpubl.). No antlerless hunts were held in any of these areas for several years prior to data collection which may partially explain the significant difference between mean ages of the two sexes. Differential mortality between the sexes during severe winters may also be a factor.

Movements

Seasonal movements between ranges vary greatly (LeResche 1974). Migrations from 2 to 10 km were reported in Minnesota by Berg (1971), while in the Northwest Territories, moose movements up to 170 km have been recorded where changes in elevation were minimal. VanBallenberghe (in press) reported seasonal migrations in excess of 45 km to be common north of Glennallen, Alaska. Taylor and Ballard (in prep.) noted minimal seasonal movements in areas of rugged terrain, but documented migrations up to 103 km where there was little elevational change. Winter and summer ranges overlap in some areas of the Peters Hills.

Migrations of moose in this study from winter to summer range in 1976 are illustrated in Fig. 2. Spring migratory movements were relatively short, as many females calved in the vicinity of their winter range. The average distance between winter and summer ranges for the radio-collared cows was 13 km (range 3 to 19 km). Because migrations were relatively short, no commonly used routes were identified. Seven of the eight cows that wintered southwest of the Little Peters Hills gained approximately 300 m in elevation as they moved up and over Black Creek summit to summer in the headwaters of the Peters Creek Tributaries. Cows wintering near the Kahiltna Glacier moved along the sidehills east of the river in the old burn area and ranged in relatively small areas near timberline throughout the summer. Three females that wintered along Cache Creek near Hansen's Bar moved upstream to summer at higher elevations within 8 km of their winter range. Those females collared

along the Tokositna River remained along the floodplain, moving up into the side hills only during the rutting season.

Studies in other parts of North America (Phillip et al. 1973 and Roussel et al. 1975) indicate bull moose generally range over greater distances than do females. Three of the four radio-collared bulls in this study confined their movements to an area less than 20 km by 8 km (Fig. 3). The fourth, a three-year-old bull, traveled extensively throughout the study area, covering an area approximately 16 km by 32 km. The greatest movement activity was observed just prior to and during the rutting season. Movements of this three-year-old bull were more extensive than those of any of the radio-collared cows.

The most significant movements of the radio-collared cows occurred during the calving season (Fig. 4). The average distance between pre and post calving locations for 14 females was 10.7 km (range 2 km to 26 km). Many females calved outside their normal spring and summer range. Most remained in very confined areas until they has lost their calves or the calves were apparently strong enough to return with the cow to her normal summer range.

Winter and Summer Ranges

Chatelain (1951) concluded that the single most important limiting factor to moose population growth in the Susitna River Valley was the lack of adequate winter range. Three important wintering areas were identified during the course of this study. The lateral and terminal moraines of the east side of the Kahiltna Glacier from Granite Creek to Cache Creek, the west side of the Little Peters Hills, and the Tokositna River from Bunco Lake to Home Lake provided winter range for most of the moose inhabiting the Peters-Dutch Hills. It is probable that portions of the Kahiltna winter range are shared with moose from Sunflower Basin and possibly Mt. Yenlo, as densities have exceeded four moose per square mile in some winters. Virtually all vegetated slopes of the Peters Hills at and above timberline provide lush summer range for moose, and as fall approached, pre-rutting concentrations of 30+ moose were often seen along the south facing slopes of Black Creek summit and above Bunco and Swan Lakes.

Calving Areas

Traditional use of areas for calving has been documented by many studies throughout Alaska (Bishop 1969, LeResche 1972). Cows that migrate considerable distances between winter and summer ranges often return to within 10 km of their previous year's calving area prior to parturition. This traditional use of calving areas was exhibited by six of the nine cows in the Peters Hills that had calves in both 1976 and 1977 (Fig. 5). Calving was widely dispersed throughout the study area during both seasons in elevations ranging from 180 to 600 m, with a two-year average of 425 m. The average distance between 1976 and 1977 calving locations for the six cows that remained relatively faithful to their 1976 calving areas was 3.6 km. No areas of highly concentrated calving activity were identified.

Figure 3. Movements of radio-collared bulls.

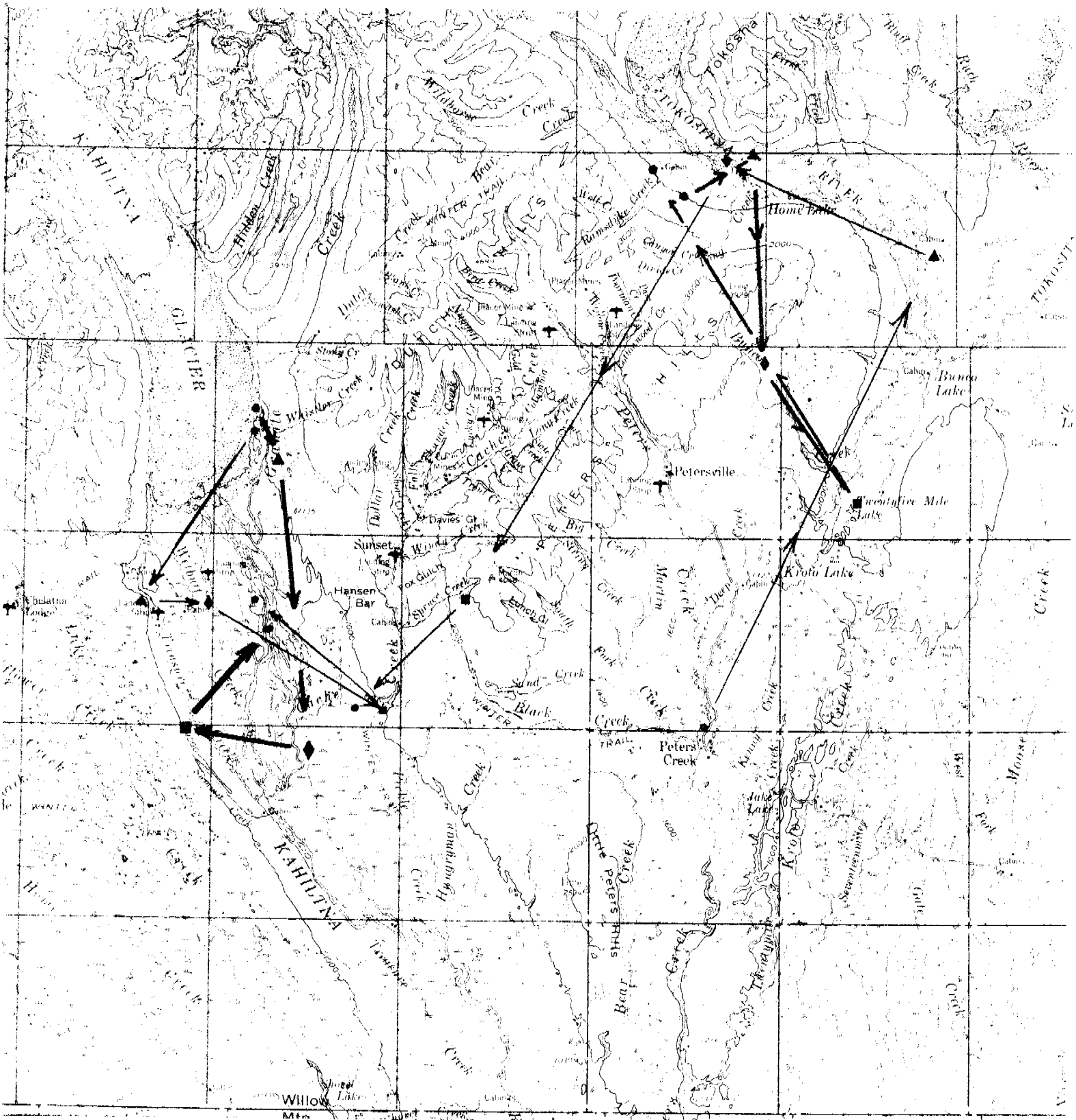

Figure 3. Movements of four radio-collared bulls in Peters-Dutch Hills from 2/15/76 to 2/15/77.

- ● Approximately 2/15.
- ▲ Approximately 5/15.
- ♦ Approximately 8/15.
- ■ Approximately 10/15.

Locations plotted are taken from closest date of survey flight.

Figure 4. Movement of cows pre and post calving.

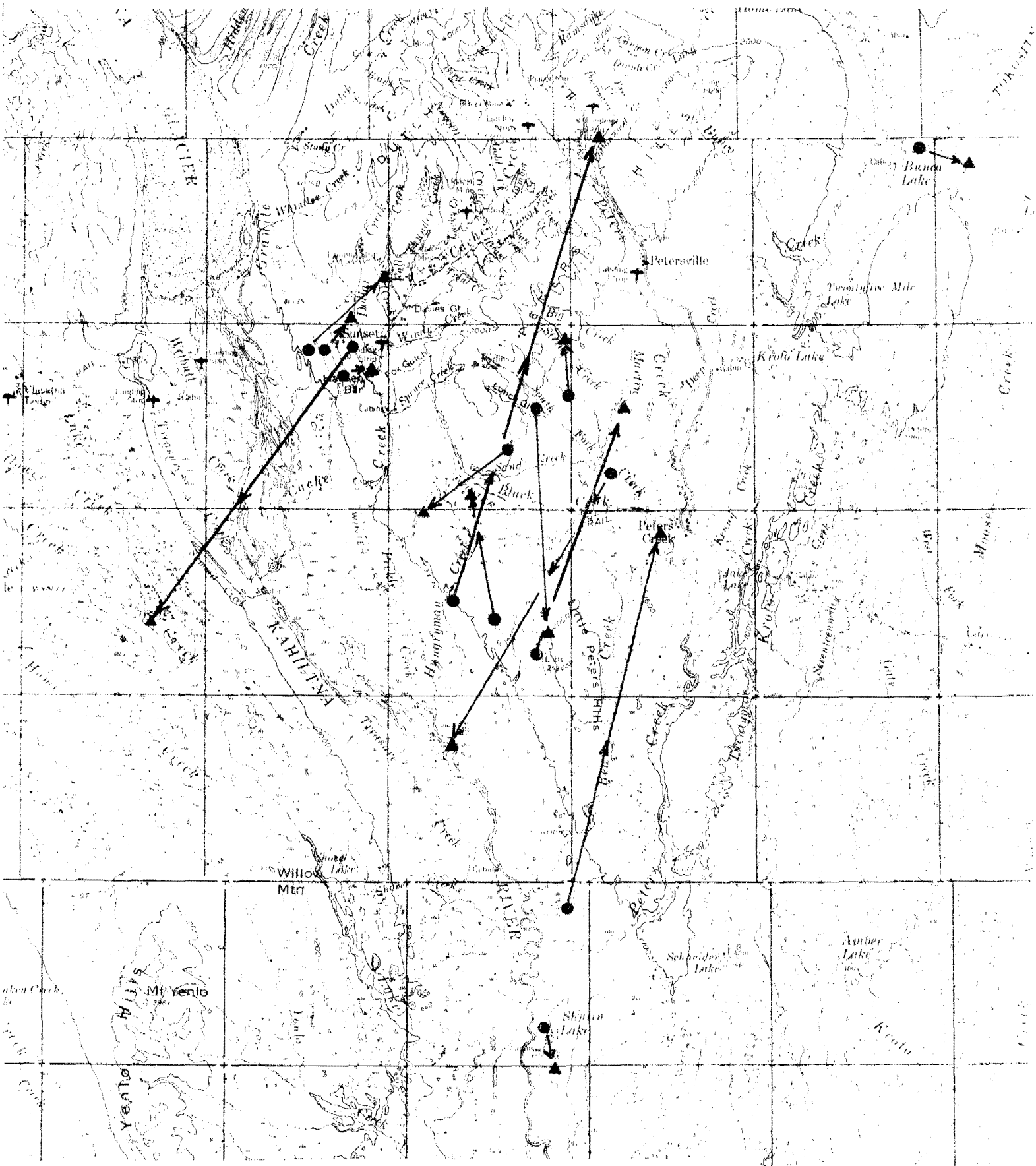

Figure 4. Movements of cows associated with calving during 1976 in Peters-Dutch Hills.

● Pre-calving location.
▲ Post-calving location.

Figure 5. Traditional use of calving areas.

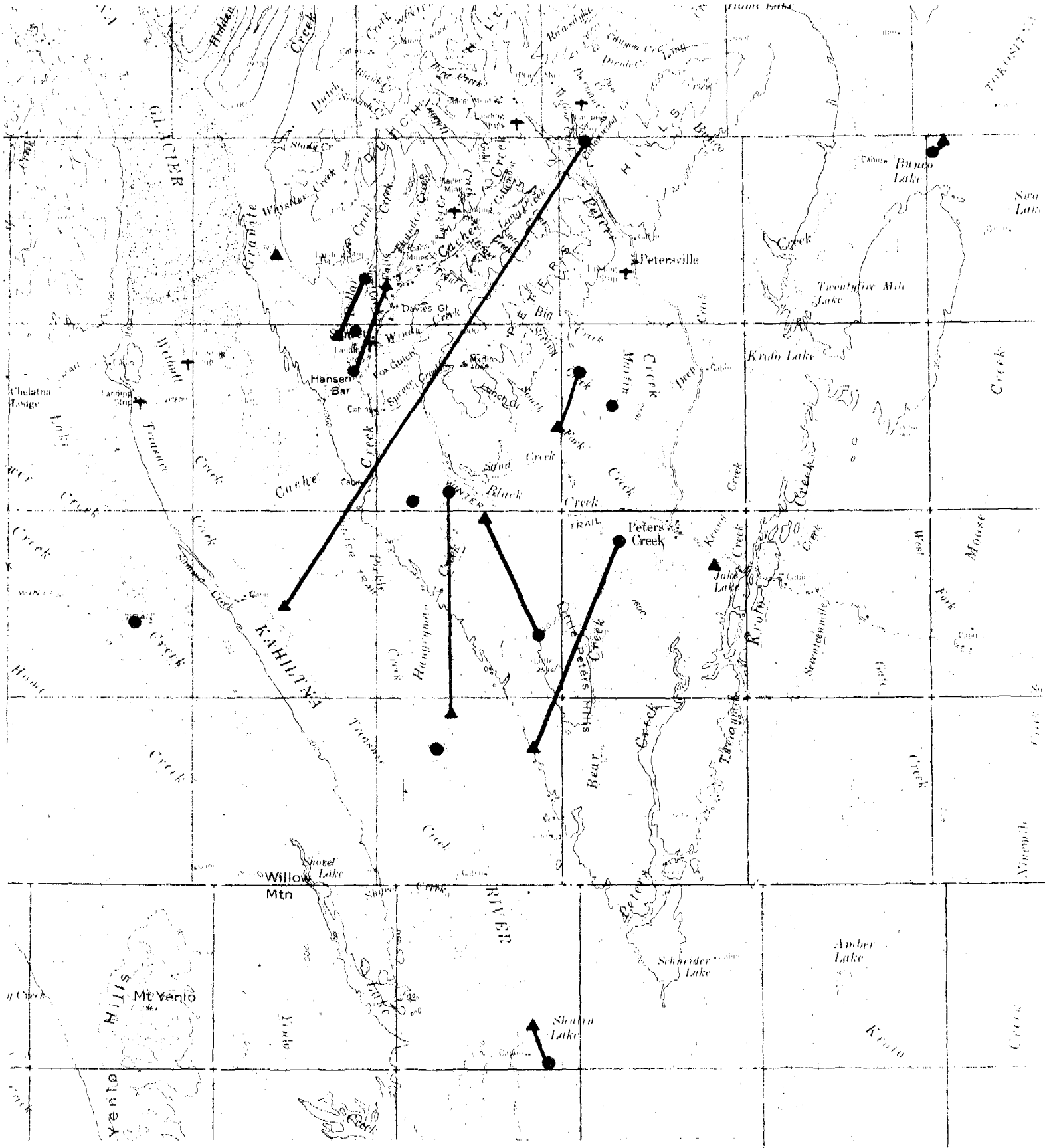

Figure 5. Locations of calving areas in Peters-Dutch Hills during 1976 and 1977.

● 1976 calving areas.
▲ 1977 calving areas.
/ Indicated calving areas of same female.

Calf Productivity and Survival

Radio-tracking surveys were flown most intensively during late May and early June in an attempt to record the productivity of the Peters Hills moose population. An effort was made during each survey throughout the year to visually observe the calves along with the radio-collared cows. Productivity data obtained from visually-collared females were sparse and will not be included here.

Seven of the 18 radio-collared females were accompanied by calves when they were collared (Table 2) in November 1975. One set of twins and a single calf were never observed again after the collaring procedure took place. Of the five calves remaining in fall 1975, four survived the 1975-76 winter.

In spring 1976, the 18 females were observed with 19 calves, including five sets of twins. Most calf mortality (77 percent) occurred prior to 15 August. No sets of twins remained by 15 August. Two calves were lost from the sample during the September hunting season when their mothers were found dead from unknown causes. Of the seven calves remaining in the fall, at least six (86 percent) made it through the winter. The seventh cow with calf was not located during the April survey. Both the 1975-76 and 1976-77 winters were considered to be very mild in the Susitna Valley.

Fourteen calves were born to the remaining 14 cows in the spring of 1977. Three cows had twins and three were never observed with calves. By 15 August there were at least nine calves remaining (64 percent). Two females with calves were not visually observed during the final survey.

Of the eight females with calves in fall 1975, five (63 percent) gave birth to calves in 1976 and 1977. Of the 14 females alive in both 1976 and 1977, nine (65 percent) gave birth to calves both years. Number 5542 was the only one of the 18 radio-collared females never seen with a calf. Her age was determined by tooth cementum lines to be 10 years when captured; six of the radio-collared females were 10+ years old. The percentage of twins per female with calf was 36 percent in the summer of 1976 and 27 percent in 1977. No cow had twins more than once in the two calving seasons they were observed.

A comparison was made between the radio-collared moose and Alaska Department of Fish and Game sex and age composition surveys (Table 3). The initial radio-collared moose had produced 44.4 calves/100 females and 33.3 percent calves in the herd in November 1975, while Alaska Department of Fish and Game surveys conducted in December 1975 revealed 23.6 calves/100 females and 15.3 percent calves in the herd. In spring 1976, the radio-collared females still maintained 23.5 calves/100 females and 19 percent calves in the herd.

Coady (1974) stated that "Time required to sight collared moose in closed canopy habitats was two to four times greater than that for animals in open canopy habitats. Cows with calves occurred in the

Table 2. Productivity and survival of radio-collared moose and calves in the Peters-Dutch Hills Study Area during 1975, 1976 and 1977.

		1975 Calves		1976 Calves				1977 Calves			Adult
Collar#	Sex	Nov.	Apr. 1	Post Calving	Aug. 15	Nov. 15	Apr. 1	Post Calving	Aug. 15	Living/ Dead	Date died and cause
5527	M	-								N/A	11/19/75 Lost collar
5528	M	-	-	-	-	-	-	-	-	Living	
5529	M	-	-	-	-	-	-	-	-	Living	
5530	M	-	-	-	-	-	-	-	-	Living	
5531	F	0	0	1	1	1	1	0	0	Living	
5532	F	0	0	2	1	N/A				Dead	9/29/76 Unknown
5533	F	1	1	2	0	0	0	1	1	Living	
5534	F	0	0	2	1	1	1	1	1	Living	
5535	F	1	1	1	0	0	0	1	Unk.*	Living	
5536	F	1	1	N/A						Dead	4/27/76 Wolf kill
5537	F	0	0	0	0	0	0	2	2	Living	
5538	F	0	0	1	1	N/A				Dead	9/29/76 Unknown
5539	M	-	-	-	-	-	-	-	-	Living	
5540	M	-								N/A	2/2/76 Lost collar
5541	F	0	0	0	0	0	0	1	1	Living	
5542	F	0	0	0	0	0	0	0	0	Living	
5543	F	1	1	1	1	1	1	0	0	Living	
5544	F	1	0**	1	1	1	1	2	0	Living	
5545	F	0	0	2	0	0	0	1	0	Living	
5546	F	0	0	1	0	0	0	1	1	Living	
5547	F	2	0**	1	1	1	1	1	1	Living	
5548	F	0	0	1	1	1	Unk.*	2	2	Living	
5548	F	0	0	1	N/A					Dead	6/15/76 Bear kill
5589	F	1	0	2	1	1	1	1	Unk.*	Living	
Total calves		8	4	19	9	7	6	14	9	4 adult mortalities	
Percent survival			N/A**		47%	37%	32%		64%		

* No visual observation of cow or calf during last flight.

** These calves were abandoned after tagging operation and percent survival could not be computed.

Table 3. Radio-collared moose productivity data, Peters-Dutch Hill, in Alaska's Game Management Subunit 16A, November 1975-November 1977.

Area	Females	Calves	Calves /100 females	Incidence of twins per 100 cows with calf	Calf % herd
Peters Hills 11/75	18	8	44.4	0	33.3
Peters Hills 12/75*	309	73	23.6	1.3	15.3
Peters Hills Spring/76 (1975 calves)	17	4	23.5	0	19.0
Peters Hills Spring/76	17*	19	112.0	35.7**	90.4
Peters Hills Late Fall/76	15	5	33.3	0	26.3
Kahiltna Flats 3/77*	397***	61	-	7.0	13.3
Peters Hills Spring/77	14	6	42.8	0	33.3
Peters Hills 8/77	14	10	71.4	20.0	35.7
Peters Hills 11/77*	364	140	38.5	8.7	22.5

* Aerial sex and age composition survey, not radio data.
** Out of 14 females producing calves, five produced sets of twins.
*** Adults; bulls had dropped antlers.

smallest groups during fall and required the longest time to locate. Visibility biases associated with differential habitat selection and group sizes of lone cows, cows with calves and bulls may decrease the accuracy and precision of aerial surveys." This study also noted the same discrepancies. In 1976, when the calf percentage in the herd of radio-collared moose was 90.4 in spring and 26.3 by late fall, Alaska Department of Fish and Game sex and age composition surveys revealed the same ratio to be 13.3 by March 1977 for 458 moose observed on the Kahiltna River flats. No sex and age composition count was conducted in fall 1976 due to poor weather conditions. In August 1977, 71.4 calves/100 females and 35.7 calves in the herd of radio-collared moose were noted. By November 1977 an Alaska Department of Fish and Game sex and age composition survey indicated 38.5 calves/100 females and 22.5 percent calves in the herd in a sample of 624 moose. As noted earlier, most mortality occurs early in the year, prior to August. Little mortality of calves with radio-collared females was noted during the two mid winters of the study.

A consistent underestimation of calf crop may be occurring during Alaska Department of Fish and Game sex and age composition surveys. Radio-collared moose sample sizes are small, but year to year data are consistent in revealing higher calf/cow ratios.

Data accumulated since the collaring operation reveal that females with calves tend to move to lower altitudes sooner than females without calves. Since most moose were captured near timberline and a large segment of the population was still at higher elevations, this would bias results toward a higher calf/cow ratio in the radio collar sample. However, no effort was made to pursue animals with calves as opposed to those without. A spotter plane with pilot and observer was used to locate moose for the helicopter, so spotting a cow with a calf presumably would be easier than spotting lone animals, and collaring crews would have been directed to them first. Generally speaking, moose were spotted, pursued and collared as close together as time and space would allow.

Adult Mortality

Since 17 November 1975, six deaths of collared moose have been reported. On 27 April 1976 female #5536 was killed by wolves (*Canis lupus*). On or about 10 June 1976 female #5588 and her calf were eaten by three brown bears (*Ursus arctos*). In September 1976 dead females #5538 and 5532 were seen from the air near String Creek and South Fork Creek, respectively. The cause of these two deaths is unknown. It was not until winter that an observer could land and examine the carcasses, which had to be dug out of the snow. Female #5538 was 12 years old at the time of her death. Two visually-collared moose were harvested by hunters during the course of the study, male #76 was killed in September 1976, and female #21 was killed in September 1977.

MANAGEMENT CONSIDERATIONS

During the period of this study, 13 November 1975 to 15 August 1977, both radio-collared and visually-collared moose moved out of the study

area only briefly and in all cases, returned. The natural boundaries of the Kahiltna and Tokositna Rivers used in the study should also be used to manage this moose population. Presently, the area known as Game Management Subunit 16A designated by the Alaska Fish and Game Board meets that description. None of the moose movements in a southerly direction went beyond Schulin Lake, however, and Subunit 16A's description continues south for six additional townships. It should be noted, however, that no natural boundaries exist to create a new southern half of Subunit 16A.

Winter ranges identified in this study should be considered for inclusion in critical habitat considerations; particularly the Kahiltna Glacier Moraines and the burn area west of the Little Peters Hills. It is probable that the McKinley Park southern extension will occupy some of the area in the study. In the event that occurs, those moose populations will probably not be harvested in numbers sufficient to allow winter range to recover. It would be appropriate and important to continue monitoring this herd to document winter die-offs should they occur.

Predation appears to have had some influence on this moose population, with the bulk of losses occurring between parturition and 3 months of age. Additional study of calf losses during this period would be necessary to better understand the causes of these losses.

Examination of continuing Alaska Depatment of Fish and Game sex and age composition counts in areas where future radio-collaring of moose will occur may reveal information which will corroborate discrepancies noted in this study. Consistent underestimations of calf/cow ratios would have an impact on game regulation proposals for sport hunting as well as fiscal considerations in further research.

It is probable that many portions of Game Management Unit 16 should be managed on a population basis if the information is collected on movements, productivity, survival and sex and age compostion data that are presently used to manage Subunit 16A's moose population.

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PREPARED BY:

Jack C. Didrickson

Game Biologist III

Kenton P. Taylor

Game Biologist II

APPROVED BY:

_____

Director, Division of Game

SUBMITTED BY:

Karl Schneider

Regional Research Coordinator

Donald E McKnight

Research Chief, Division of Game