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BLACK BEAR PREDATION ON MOOSE

BY
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Volume I
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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Charles C. Schwartz and Albert W. Franzmann

Project Nos: W-17-11 and W-21-1 Project Title: Big Game Investigations

Job No.: 17.3R Job Title: Black Bear Predation on Moose

Period Covered: July 1, 1978 through June 30, 1980

SUMMARY

Movements of 16 and 19 radio-collared black bears from 1978 and 1979, respectively, are presented and discussed. The average home range for all females was 2055$\pm$1242 ha, varying from 1150$\pm$742 for females with cubs, 3077$\pm$1468 for females with yearlings, and 2217$\pm$1156 for for juvenile females. Home ranges for adult males (127.4$\pm$50.6 km^2) were significantly ($P>0.05$) larger than those of females. Bear movements in relation to the Moose River moose calving area and areas rehabilitated with LeTorneau tree crushers are presented and discussed. Black bears resident within the study area did not make extensive trips to the calving grounds during the calving season, but remained within their home ranges. Black bears appeared to avoid areas crushed for moose browse rehabilitation and reasons for this behavior are discussed.

Preliminary estimates indicated black bears occur at a density of 1 bear per 430.5 ha. Methods used to estimate density are given.

Morphometric, blood physiology and drugging information is also listed, but no assessment was available for this report.

Analysis of brown bear movement and home range data, coupled with sightings of unmarked brown bears, indicated that brown bear density was very low on the northern Kenai lowlands.

CONTENTS

BACKGROUND

Based upon population estimates from stratified random counts (Evans et al. 1966) moose (*Alces alces*) populations on the Kenai Peninsula have steadily declined in the past 5 years. Factors contributing to this decline include long-term deterioration of vegetation (Oldemeyer et al. 1977), increased adult mortality from wolf (*Canis lupus*) predation (R.O. Peterson, pers. comm.), highway accidents, hunting and poaching, and encroachment of human developments on suitable habitat. In addition, there was little or no recruitment into the population during the early 1970's as result of heavy winter mortality.

High calf mortality has been documented on the Kenai Peninsula (LeRoux 1975) and at the Moose Research Center (MRC) (Franzmann and Arneson 1973, 1974, 1975). Studies of moose calf mortality on the Kenai Peninsula (Franzmann and Bailey 1977, Franzmann and Schwartz 1978, Franzmann et al. 1980) indicated that black bears (*Ursus americanus*) and brown bears (*U. arctos*) killed a substantial portion (40%) of the new calf crop. Black bear predation has been observed elsewhere on the Kenai Peninsula (Lucas 1932, Palmer 1939, Chatelain 1950) and near Palmer (LeResche 1968). Prior to the moose calf mortality study, however, no effort had been made to document the extent of this mortality on moose on the Kenai Peninsula. As outlined in the Kenai Peninsula Predator-Prey project (Franzmann and Bailey 1977), studies were initiated in 1977 to assess the impact of black and brown bear predation on moose calves.

This bear study started in fall 1977, but major field work did not get underway until summer 1978 (Franzmann and Schwartz 1978). The initial objectives of the study centered around bear movements, densities, and food habits as they related to moose calf mortality. Results of our first year's field work indicated that: (1) brown bear densities on the northcentral Kenai Peninsula were very low, (2) brown bear movements were extensive, and the time and effort required to locate them was great, (3) moose calf mortality resulting from brown bear predation was low, (4) radio-collaring black bears at random throughout the large moose calf study area did not provide detailed information on black bear densities, and (5) additional information on black bear movements, in relation to season and vegetation types, were required. For these reasons, the bear segment of the predator-prey study was modified to intensify our field efforts with black bears within a discrete study area, and eliminate all attempts to monitor brown bears until the need for such studies became evident.

OBJECTIVES

To determine the population density, age structure, and productivity of the black bear population within the study area at the Moose Research Center (MRC).

To determine seasonal movements and habitat usage by resident bears within the study area.

To evaluate seasonal, temporal, and spatial aspects of bear movements as they relate to moose calving areas at the Moose River Flats and Willow Lake areas.

To evaluate seasonal usage and avoidance of the Willow Lake and MRC 1947 moose-bear browse rehabilitation areas by black bears.

STUDY AREA

The MRC black bear study area is located on the Kenai National Moose Range (KNMR) on the northwestern Kenai Peninsula lowlands (Fig. 1). Detailed descriptions of the study area appear in Oldemeyer et al. (1977) and LeResche and Davis (1973). The central study area was defined as a 49 mi^2 (127 km^2) unit surrounding the MRC within the extensive 1947 Kenai burn. This area supports a mosaic of vegetation types interspersed with many lakes and ponds. A 254-ha portion of the study area contained 624 individual stands ranging in size from 0.2 to 18.4 ha (LeResche et al. 1973). Remnant stands of mature forest comprised 46 percent of this area and were extremely fragmented comprising 411 stands distributed throughout the area. The large number of stands and their irregular shapes represented tremendous amounts of ecotone--112 km in the 2.5 km^2 area. As stated by LeResche et al. (1973) "this 2.5 km^2 by no means represents an extreme case, but rather is a fair sampling of the entire 260 km^2 area affected by the (1947) burn."

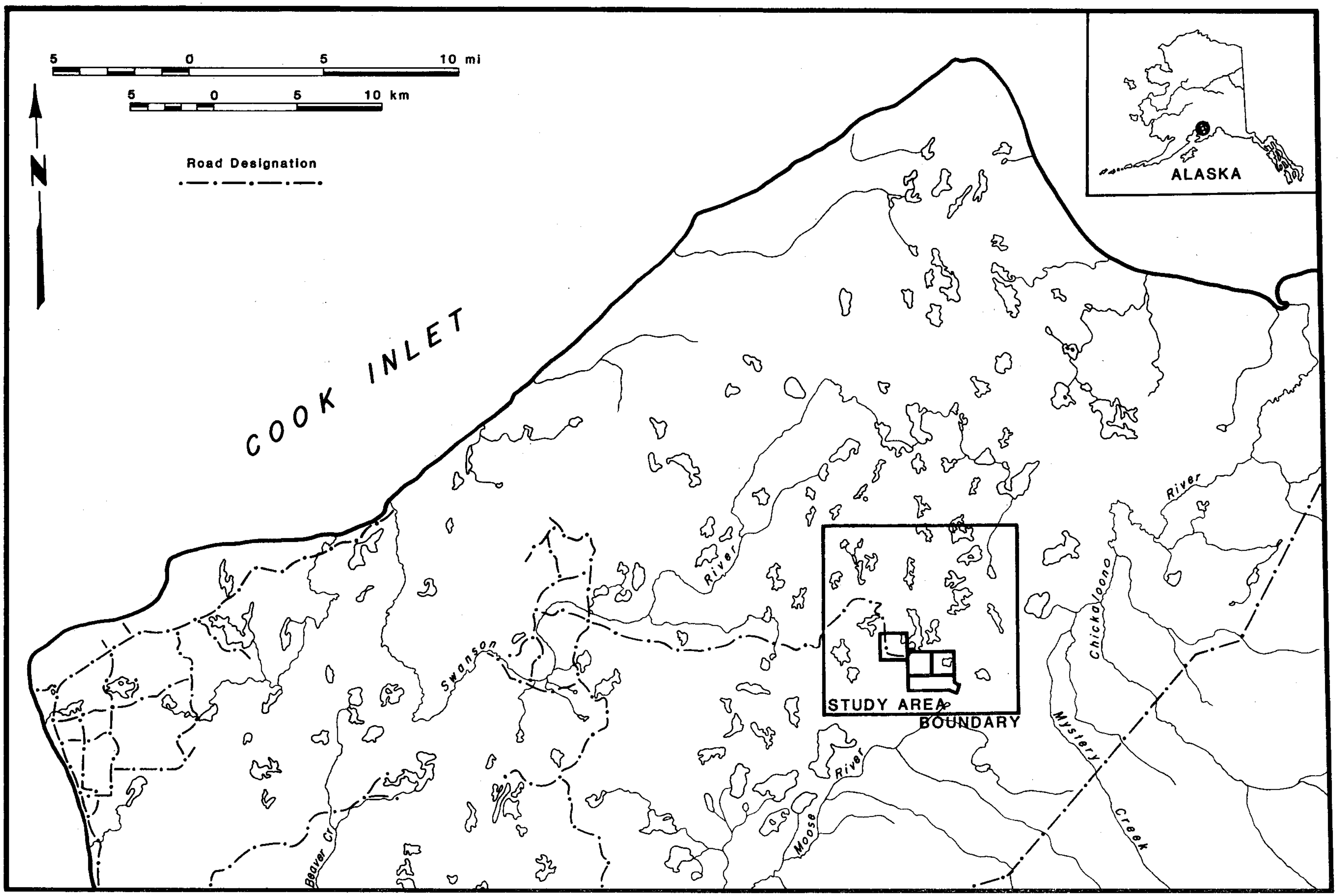

Fig. 1. Moose Research Center Study Area, Kenai Peninsula, Alaska.

A detailed vegetation map of the study area is being constructed by personnel of the KNMR, but was not complete for this report.

Within, or adjoining, the MRC black bear study area, three areas (Fig. 2) were enhanced for moose with LeTourneau tree crushers (Oldemeyer 1977, Oldemeyer et al. 1978). The three areas were: (1) Willow Lake rehabilitated area, (2) south MRC area, and (3) Mystery Creek rehabilitated area.

Vegetation in the Willow Lake area, prior to crushing, was mixed stands of white spruce (*Picea glauca*), aspen (*Populus tremuloides*), and paper birch (*Betula papyrifera*). Topography of the area was gently rolling to undulating with several small to medium size (0.1-2.0 ha) lakes and bogs. During winter 1974-75, 461 ha were crushed in the form of a "doughnut" (Fig. 3). The "doughnut-hole" which was not crushed was approximately 182 ha and was predominately 1947 burn regrowth (112 ha) and mature birch-aspen forest (70 ha).

Vegetation in the south MRC area prior to crushing was predominately black spruce (*Picea mariana*) and aspen regrowth. There were also small stands of mature birch-aspen forest. Topography of the area was relatively level in the broad lowlands, to gently rolling in the uplands. During winter 1975-76, approximately 584 ha were rehabilitated. The pattern of crushing was different from that of the Willow Lake area, in that several uncrushed strips and uncrushed mature forests were alternated with crushed areas (Fig. 4).

The Mystery Creek area was dominated by black spruce and aspen regrowth prior to crushing. It is a drier site than the other two crushed areas and is relatively level. During winters 1976-77 and 1977-78, 945 and 910 ha were crushed, respectively. The pattern of crushing was generally large blocks, separated by narrow strips of uncrushed regrowth or mature forest.

PROCEDURES

Black bears were captured with barrel traps (L. Rogers, pers. comm.) systematically located throughout the study area. These traps were constructed from two 55-gallon steel barrels welded together end-to-end and fitted with a sliding steel door and wooden trigger mechanism. During spring 1979, we cleared 18 km of seismographic trails within the study area to allow for a more uniform distribution of trap sites. Barrel traps were also used on existing roads at the MRC (Fig. 5). Additional bears residing within the study area were darted from a helicopter (Bell Jet Ranger) with a projectile syringe fired from a Cap-Chur gun (Palmer Chemical and Equipment Co., Douglasville, GA).

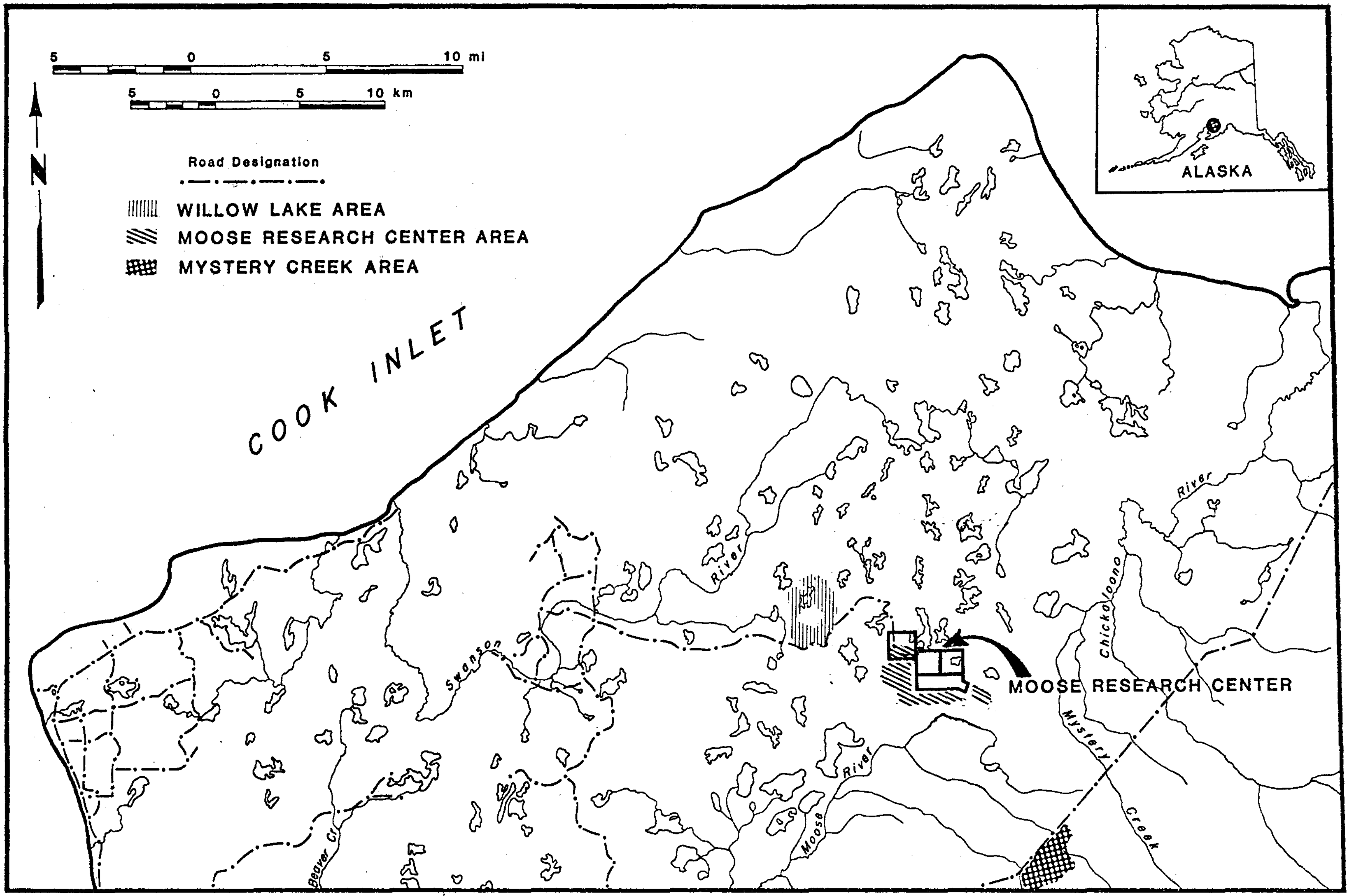

Fig. 2. Locations of areas rehabilitated for moose with LeTorneau tree crushers.

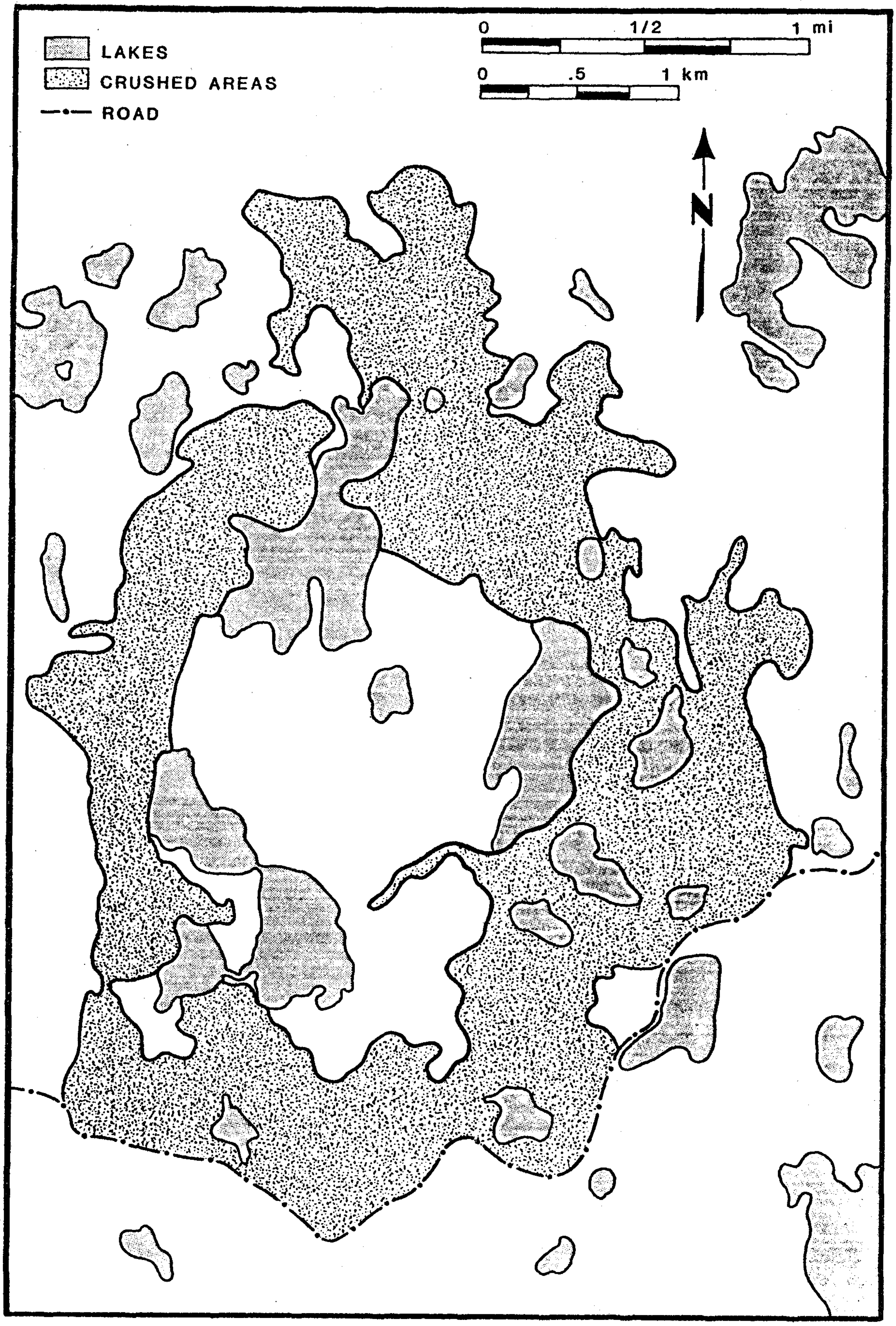

Fig. 3. Willow Lake crushed area.

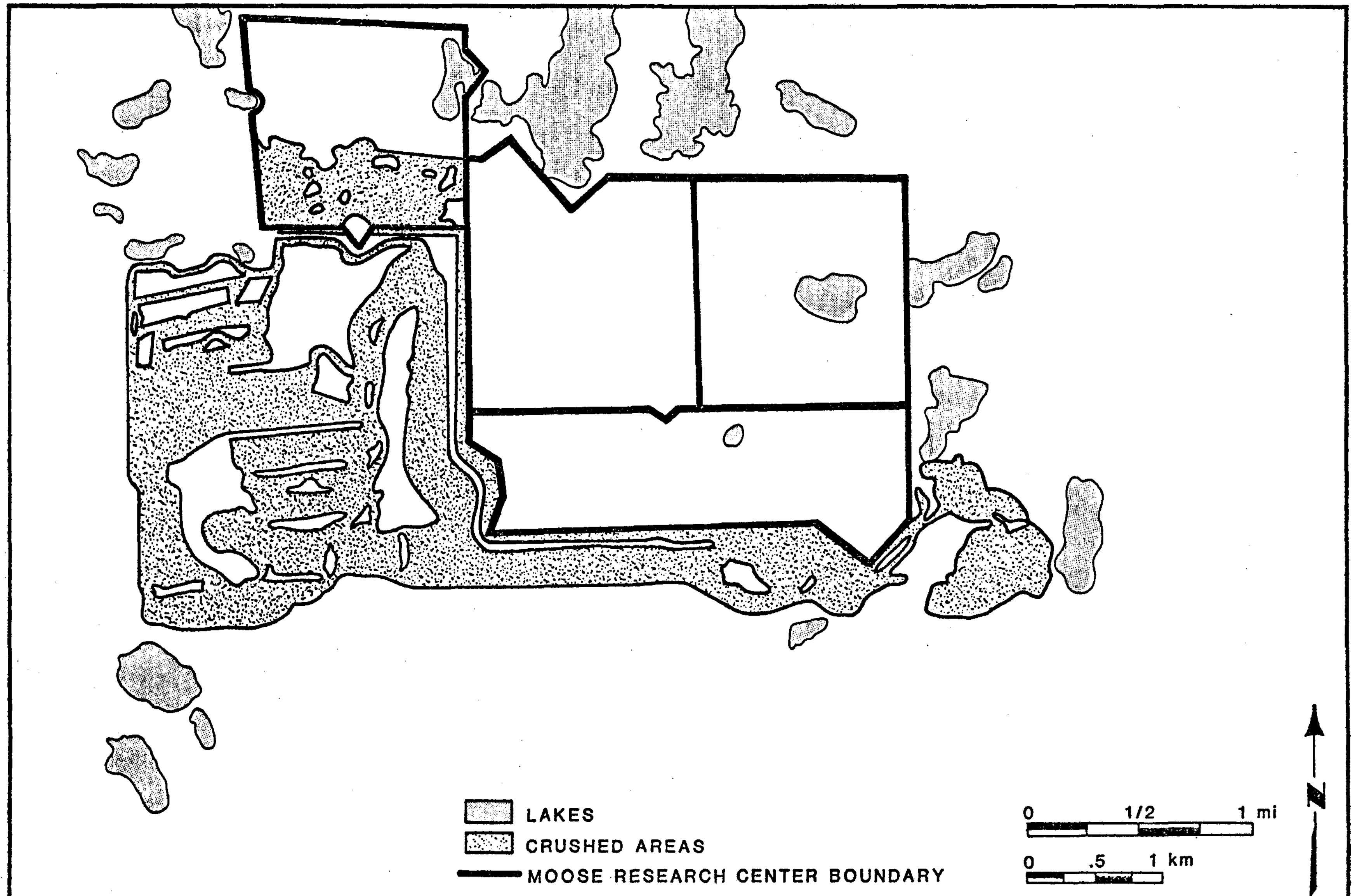

Fig. 4. Moose Research Center crushed area.

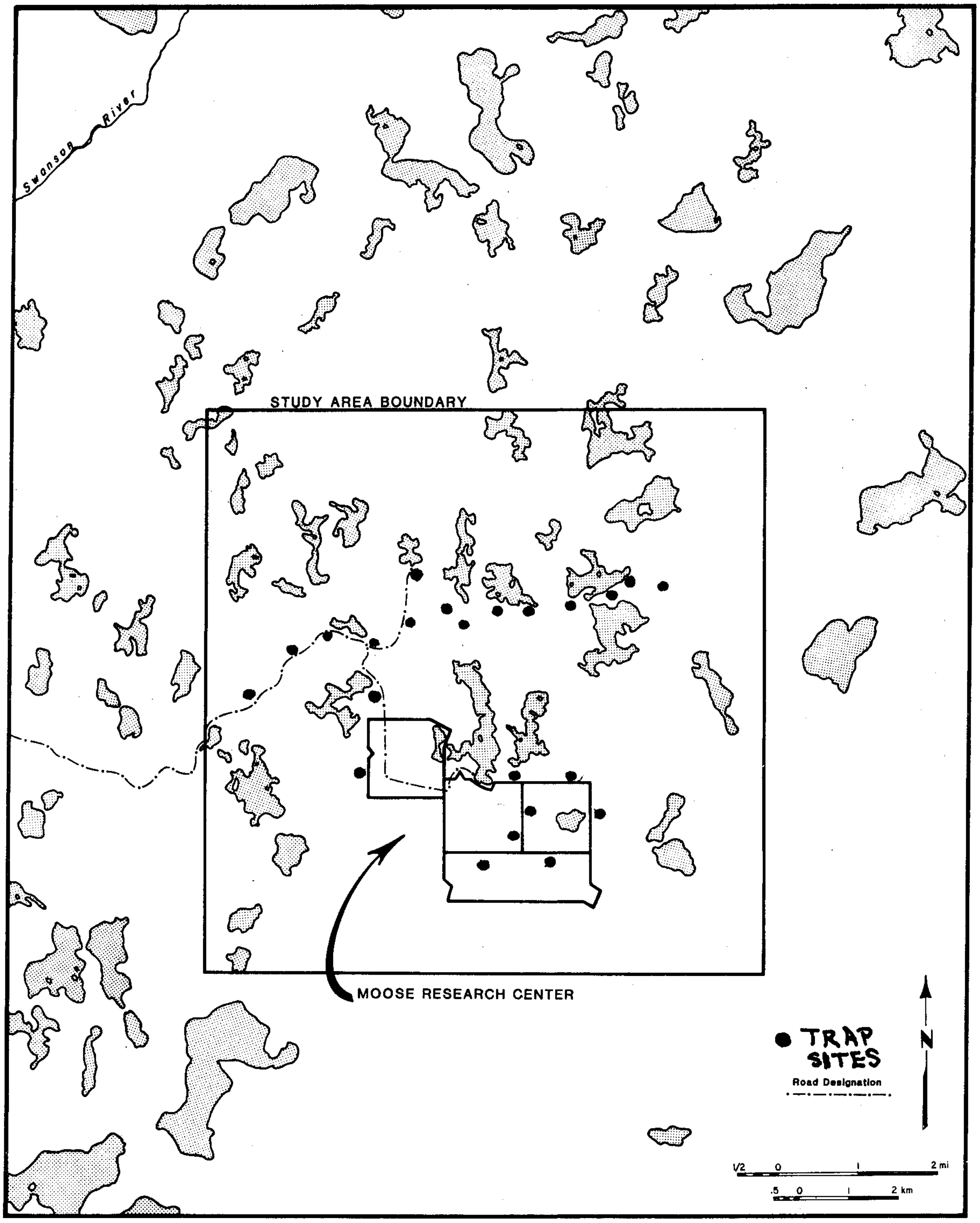

Fig. 5. Location of barrel traps used to capture black bears in the Moose Research Center Study Area, 1979.

Trapped or darted bears were immobilized with phencycline hydrochloride (Sernylan, Bio-Ceutic Laboratories, Inc., St. Joseph, MO) alone, or as a mixture with promizine hydrochlorine (Sparine, Wyeth Laboratories). Bears in traps were administered the drug intramuscularly by means of a hypodermic syringe mounted on the end of a 1 m wood stick. Dosages were calculated from the estimated weight of each bear and administered according to recommendations of Seal et al. (1970). Cubs were handled without being drugged.

The following morphometric data were collected: (1) total body length (tip of nose to tip of tail), (2) neck circumference at base of skull, (3) heart girth (circumference of chest posterior to shoulders) (4) hindfoot width (widest point across pad) and length (from tip of pad on the longest toe to the end of pad at the heel), (5) skull width (widest point on zygomatic arches) and length (junction of gums and upper incisors to the posterior end of sagittal crest), and (6) length and the maximum anterior-posterior, and labial-lingual thickness of the left upper and lower canines. In addition, baculum and testicle length and vulva and teat length were recorded for males and females, respectively. All animals were weighed with a spring scale, hair samples were plucked from the area between the shoulder blades, and a blood sample was drawn from the femoral vein or artery. A copy of our field form appears in Appendix A.

Newly captured females and adult males were marked with numbered, yellow, plastic ear tags, tattooed on both sides of the upper lip and fitted with a radio transmitter (Telonics Inc., Mesa, AZ). Because of their transient nature, juvenile males were marked with large white ear tags and not radio-collared unless they were born in the study area. The white ear tags enabled us to identify these bears from the air as juvenile males handled and marked within the study area.

Age of individual animals was determined by counting cementum annuli in decalcified, stained sections of the first upper premolar (Goodwin and Ball 1979).

Bear movements were monitored biweekly using a Super Cub from 19 April until 1 August and weekly from then until 28 October when all bears were in their winter dens. When possible, animals were visually located and the vegetation type and activities noted. Unmarked bears were also noted and recorded in a similar manner.

Home range, that area (polygon) formed by connecting the outside points of an individual's location (Mohr 1947), was determined for all radio-collared bears in 1978 and 1979. Home range boundaries were drawn subjectively to conform to the shapes of clusters, and certain points were omitted if they appeared unrealistic in light of boundaries produced from available telemetry and observational data (Rogers 1977). Clear-cut decisions to include, or exclude, locations were not always easy to make and in cases where we were unsure, the points were included in calculations of home range size. Individual data points, whether or not used in home range calculations, have been included to enable the reader to compare the subjectively drawn boundaries to the total area within the polygon defined as home range.

Actual area of the polygons was calculated by counting "squares" included within the home range boundary. Telemetry locations were plotted on 1 inch to the mile maps. Graph paper divided into 400 squares/in^2 was used as a grid to determine total area. Each square, therefore, was equal to 0.65 ha. When less than one-half of a square occupied the home range area, it was not counted, while partial squares greater than one-half were considered an entire square. It was assumed that squares containing less than, or greater than, one-half an area would equalize each other. We realize this method is subject to some error, but felt it was more accurate than a planimeter.

RESULTS

Capture and Handling

Trapping operations were initiated on 1 May 1979, but were discontinued on 17 May because of lack of success resulting from the presence of a large brown bear in the study area. This bear, over a 10-day period, damaged several traps and destroyed one. Because of his large size, he could not enter the traps so he turned them over until the bait fell out or the door closed and the bait became inaccessible. We unbaited all traps and waited until he left the area. Trapping activities were resumed on 1 June and continued through 29 June. During this period we captured 24 bears during 439 trap-days. Trapping success was 18.3 days per bear caught. This was considerably higher than our snaring success during 1978 when we caught 1 bear per 53 trap-days (Franzmann and Schwartz 1978). This high success was a result of several things. First, the barrel traps were much more effective in catching bears than Aldrich foot snares. With the exception of the brown bear, we had fewer misses (8 misses/24 catches) than with snares (6 misses/3 catches). Second, our traps were more uniformly distributed throughout the study area, thereby increasing the chance for a bear to encounter a trap (Fig. 5).

Of the 24 bear captures, 14 were different individuals and 10 were recaptures. Six of the 14 bears had been radio-collared the previous year. The eight remaining bears (Table 1) were classified as juvenile males (B26, B27, B28, B29), one adult male (B25) and three females (B24, B30, B31).

Table 1. Capture and marking information for 13 newly captured black bears within the Moose Research Center Study area, Kenai Peninsula, Alaska, 1979.

Bear and Tattoo No.	Sex	Capture Date	Capture Location	Transmitter Frequency	Ear Tag No. Right	Ear Tag No. Left
B20	F	2 May 1979	Melody Lake	164.260	311	312
B21 1/	F	14 May 1979	Pen 1	165.045	314	274
B23 1/	F	14 May 1979	Pen 1	165.055	313	250
B24	F	7 June 1979	Buteo Lake	165.065	319	320
B25	M	8 June 1979	South Buteo L.	165.095	317	318
B26	M	12 June 1979	1/2 mi. east Arrow Lake	None	1	2
B27	M	16 June 1979	Täkukak Lake	None	3	4
B28	M	20 June 1979	E. Pen 3	None	6	5
B29	M	21 June 1979	N. Pen 3	None	8	7
B30	F	25 June 1979	W. Arrow Lake	165.105	325	324
B31	F	28 June 1979	1/2 mi. east Arrow Lake	165.115	323	322
B32 2/	M	9 Oct. 1979	Pen 3	165.070	303	305
B34	M	9 Oct. 1979	Buteo Lake	None	10	9

1/ 1978 cub of B1
2/ 1979 cub of B13

Table 2. Immobilization results for 28 black bear captures in the Moose Research Center study area Kenai Peninsula, Alaska during 1979. The drug used was phencycline hydrochloride (Sernylan) alone or in combination with promazine hydrochloride (Sparine) as indicated.

Bear No.	Wt. (kg)	Date	Immobilization Time (min.)	Drug and Dosage (mg/kg) Sernylan	Sparine	Method of Capture	Comments
B2	-	27 June	3	1.4	0.3	Barrel Trap	Convulsed twice
B9	118.0	19 June	14	1.3	0.2	Barrel Trap	Dosage adequate, no convulsions
B9A[1]	115.8	25 June	21	1.3	0.4	Barrel Trap	Minimal effect, still taxic
			19	0.4	-	Barrel Trap	Good dosage
B12	59.1	15 June	10	1.4	0.3	Barrel Trap	Convulsed twice, sow with 2 cubs, very thin, wet when weighed
B13	48.6	5 June	5	1.8	0.4	Barrel Trap	Good dosage
B13A	49.9	14 June	6	1.8	0.4	Barrel Trap	Good dosage
B13B	79.4	3 Oct. 1979	18	1.1	-	Barrel Trap	Minimal effect, still taxic
			9	0.2	-		Good dosage
B14	61.3	1 June	16	1.3	0.8	Barrel Trap	Animal calm, but taxic
			5	0.3	-		Good dosage
B14A	59.0	14 June		1.7	0.3	Barrel Trap	Down time not recorded
B14B	61.3	25 June	9	1.6	0.3	Barrel Trap	Good dosage, wet when weighed
B15	62.2	17 March	19	1.0	1.3	Drugged in den	Dosage adequate
B15A	54.5	8 June	6	1.8	0.4	Barrel Trap	Dosage adequate

Table 2. Continued.

Bear No.	Wt. (kg)	Date	Immobilization Time (min.)	Drug and Dosage (mg/kg) Sernylan	Drug and Dosage (mg/kg) Sparine	Method of Capture	Comments
B15B	55.4	14 June	5	1.8	0.4	Barrel Trap	Good dosage; up and moving 3 hr. 13 min. later
B20	61.3	2 May	17	0.8	1.3	Helicopter	No visible effect
			9	0.5	-		Minimal dosage, animal still taxic
				0.2	-		Supplemental on ground. Dosage appeared adequate; no convulsions,
B21	20.4	14 May	7	1.9	1.0	Helicopter	Dosage adequate
B23	20.4	14 May	14	1.9	1.0	Helicopter	No visible effect, internal charge of dart malfunctioned; no injection
			4	1.9	1.0		Dosage adequate
B24	61.3	6 June	18	1.1	0.6	Barrel Trap	Almost down
			16	0.3	-		Good dosage
B25	84.0	8 June	10	1.2	0.2	Barrel Trap	Minimal dosage, but adequate
B26	70.4	12 June	9	1.4	0.3	Barrel Trap	Good dosage
B26A	71.3	26 June	2	1.4	0.3	Barrel Trap	Good dosage
B27	52.2	16 June	10	1.5	0.4	Barrel Trap	Good dosage
B28	43.1	20 June	5	1.2	0.5	Barrel Trap	Good dosage
B29	50.8	21 June	15	1.0	0.4	Barrel Trap	Minimal dosage, still taxic
				0.4			Dosage adequate, down time not recorded

Table 2. Continued.

Bear No.	Wt. (kg)	Date	Immobilization Time (min.)	Drug and Dosage (mg/kg)		Method of Capture	Comments
				Sernylan	Sparine		
B30	59.0	25 June	4	1.4	0.3	Barrel Trap	Good dosage
B30A	77.2	9 Oct.	5	1.4	-	Barrel Trap	Convulsed one time
B31	54.5	28 June	10	1.5	0.4	Barrel Trap	No effect
			18	0.4			No Effect
			13	0.4			Minimal dosage
B32	34.0	9 Oct.	5	1.2	-	Barrel Trap	Good dosage
B34	74.9	9 Oct.	9	1.2	-	Barrel Trap	Good dosage

1/ An A or B indicates a 1st or 2nd capture.

2/ Weight not taken because of convulsions. Estimation based on previous weight.

Table 3. Age and morphometric data for 19 black bears captured 28 times at the Moose Research Center Study Area, Kenai Peninsula, Alaska, 1979. Measurements are in centimeters.

Bear No.	Weight (kg)	Age (years)	Total Length	Circumference Chest	Circumference Neck	Hind Foot Length	Hind Foot Width	Skull Length	Skull Width	Left Canine[1/] Upper L	Upper A-P	Upper L-L	Lower L	Lower A-P	Lower L-L
B9	118	5	186	105.5	-	20.9	11.0	29.0	19.2	3.2	2.0	1.2	2.6	1.8	1.3
B9A	115.8	5	-	-	-	-	-	-	-	-	-	-	-	-	-
B12	59.1	4	162.5	76	44	18.5	9.5	26.5	15.0	2.5	1.4	1.0	2.3	1.4	1.2
B12 Cub	5.4	0.3	76	36	21.8	9.0	5.6	10.5	9.3	-	-	-	-	-	-
B13	48.6	4	158	80.5	-	17.0	8.4	21.7	15.1	2.5	1.1	0.8	2.3	1.0	0.8
B13A	49.9	4	-	-	-	-	-	-	-	-	-	-	-	-	-
B13B	79.4	4	162	104	-	18	8.5	24.8	15.1	2.4	1.5	1.0	2.2	1.5	1.1
B14	61.3	3	160	83	48.5	19.5	10.8	24.0	15.2	2.3	1.5	1.0	1.9	1.4	0.9
B14A	59.0	3	-	-	-	-	-	-	-	-	-	-	-	-	-
B14B	61.3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
B15	62.2	3	132	-	-	-	-	25.6	14.8	-	-	-	-	-	-
B15A	54.5	3	142	78	42.6	19.0	9.4	24.9	14.7	2.1	1.4	1.3	2.0	1.2	0.9
B15B	55.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
B20	61.3	7 or 8	165	85.5	48.0	17	8.5	27.0	16.0	2.6	-	-	2.0	-	-
B21	20.4	1	106.5	59	30	16	7	19	11	1.0	-	-	1.0	-	-
B23	20.4	1	104.0	64	31	17	7	18	11	1.0	-	-	1.0	-	-
B24	61.3	10	144.3	83.8	46	18	9	25.2	16.2	2.7	1.5	1.0	2.1	15.	0.9
B25	84.0	5	177	96	62	18.4	12.0	28	18	3.2	1.9	1.4	2.8	1.7	1.2
B26	70.4	3	172	80	52.7	20.4	9.3	27.8	16.2	3.0	1.6	1.3	2.8	1.7	1.2
B26A	71.3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
B27	52.2	2	146	78.5	45	19.0	9.5	25.1	14.8	2.8	1.5	1.1	2.8	1.6	1.2
B28	43.1	2	147	80.0	43.2	16.0	8.6	23.5	13.7	2.7	1.5	1.0	2.7	1.7	1.5
B29	50.8	2	145	86.5	46.5	17.2	10.0	24.3	14.5	2.9	1.5	1.2	2.7	1.5	1.2
B30	59.0	4	152	90.0	49.5	18.7	9.0	26.3	15.6	2.5	1.4	1.1	2.3	1.4	1.1
B30A	77.2	4	156	103	59.0	17.4	9.5	25.4	15.0	2.5	1.8	1.0	2.4	1.5	1.1
B31	54.5	4	153	84	46.5	18.0	9.3	23.7	14.5	2.3	1.4	0.9	2.1	1.6	1.2
B32	34.0	0.5	126	77	41.0	12.5	7.6	21.0	12.2	-	-	-	-	-	-
B34	74.9	-	149	95	-	18.0	9.5	24.5	13.2	2.6	1.4	1.1	2.6	1.8	1.2

1/ L = total length, A-P = maximum anterior-posterior thickness, and L-L = maximum labial-lingual thickness for the canine specified.

We also trapped the study area during late fall (25 Sept.-14 Oct.) and caught four bears in 255 trap-days for a catch rate of 63.8 trap-days per bear captured. This success rate was higher than that experienced during fall 1977 (Franzmann and Schwartz 1978) and reflects the improvement in trapping techniques. Of the four bears captured (Table 1) two were previously radio-collared (B13, B30) and two were not (B32, B34).

Results of immobilization attempts on 28 black bears indicate that 20 animals received adequate dosage levels after one injection while eight others required additional drugs (Table 2). No bears were given fatal dosages. Because sparine was used in combination with sernylan in 1979, our results were not comparable with those of 1978. However, it was apparent that less sernylan was required to immobilize bears when used in conjunction with sparine, and the incidence of convulsions was greatly reduced. Only two bears convulsed during 1979, both were adult females with cubs which were in very poor condition at the time of drugging. We experienced some variation in dosage levels required to immobilize individuals (Table 2), but in general, dosages of 1.4 to 1.8 mg/kg of sernylan in combination with 0.3 to 1.3 mg/kg sparine, respectively, appeared adequate. Dosages of 1.0 to 1.7 mg/kg of sernylan in combination with 0.2 to 0.8 mg/kg of sparine, respectively, were not adequate to induce immobilization.

Morphometric, Blood, and Hair Data

No attempt was made to assess the morphometric data collected during this report period. Data collected during this period (Table 3) and from 1977-1978 (Franzmann and Schwartz 1978) are being recorded on a computer input form for future analyses.

Linear regression analysis of chest circumference (x) to total body weight (y) for all bears except cubs showed significant ($P>0.01$, $n=39$) correlation (Fig. 6). Variations in chest circumference accounted for 47.3 percent of the variation associated with body weight. No other comparisons are available at this time.

Blood chemistry, protein electrophoresis and hematological data (Tables 4 and 5) analyses are complete on all samples collected through summer 1979. Results for the fall blood samples collected in 1979 are not available. Blood data have been entered on the computer file system and will be assessed soon. Hair samples have not been analyzed.

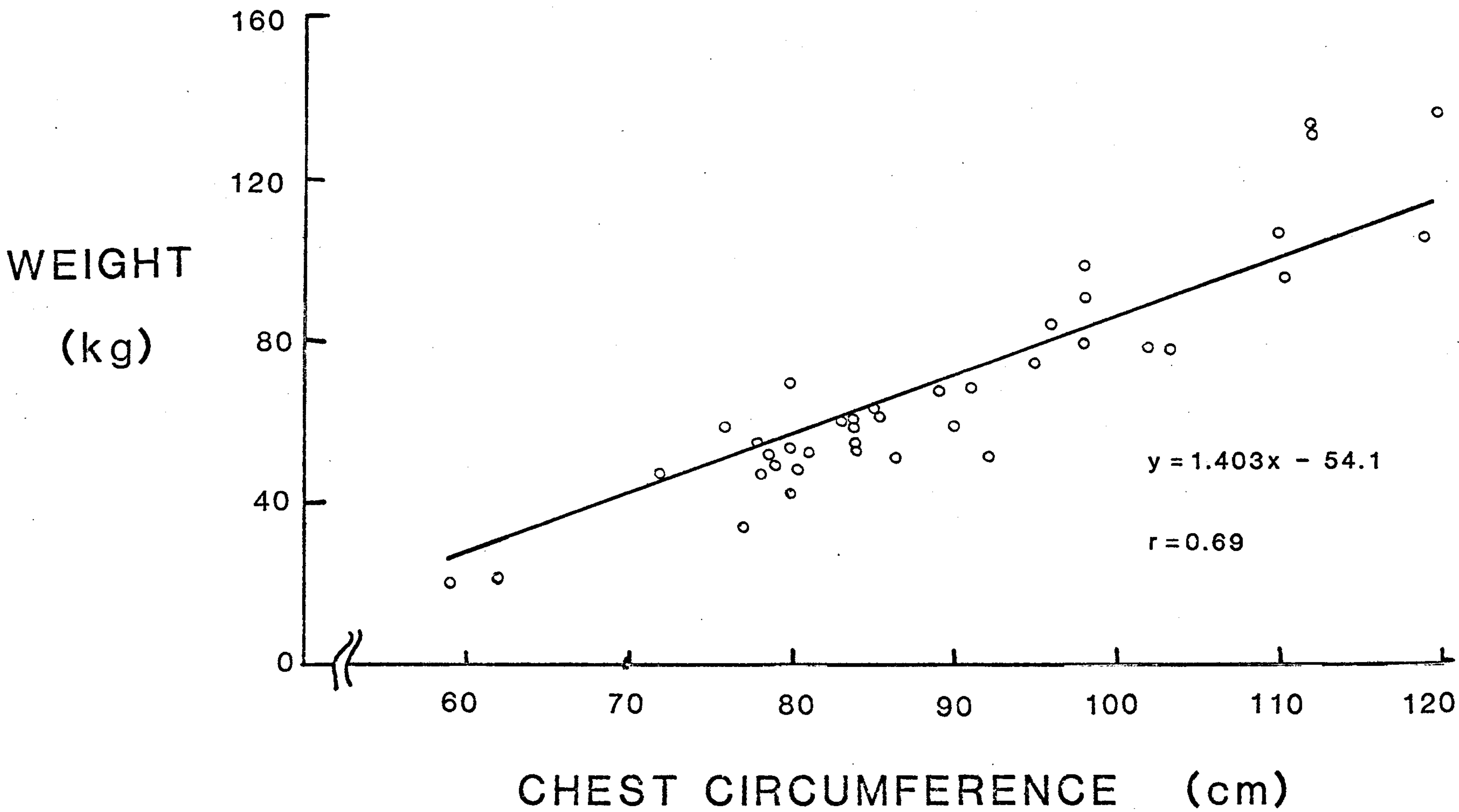

Fig. 6. Relationship between chest circumference and body weight in black bears from the Kenai Peninsula, Alaska.

Table 4. Black bear blood chemical data collected from August 1976 to July 1979 on the Kenai Peninsula, Alaska.

Bear Number	Date	Age (mo.)	Sex	Glucose mg/dl	Chol. mg/dl	Tri-Glyceride mg/dl	LDH U/L	SCOT U/L	SGPT U/L	Alk Phos. U/L	Phos. mg/dl	Ca mg/dl	Calp Ratio	Na mEq/L	K mEq/L	Cl mEq/L	CO_2 mEq/L	BUN mg/dl	Creat. mg/dl	Bili mg/dl	Uric Acid mg/dl
B-1	10/08/77	42	F	100	310	215	998	950		35	4.0	9.6	2.40	143	4	102	20	5	1.1	0.0	
B-1A	5/31/78	51	F	66	202		601	251		58	7.5	9.3	1.24					5		0.2	4.5
B-2	10/15/77	32	F	71	225	128	995	555		14	7.3	8.2	1.12	146	5	103	17	7	1.1	0.2	
B-2A	6/09/78	40	F	98	235		601	131		98	6.6	10.1	1.53					10		0.1	2.1
B-2B	6/27/79	52	F	96	310	283	467	39	31	20	3.7	8.4	2.27	142	5	107	14	11	0.8	0.1	1.3
B-3	4/28/78	38	M	150	215	163	601	216		110	6.0	8.2	1.37	145	4	100	24	12	1.0	0.1	1.8
B-5	5/02/78	50	M	100	192	267	536	184		40	6.6	9.0	1.36	139	4	94	17	43	1.3	0.1	2.8
B-6	5/02/78	50	M	109	269		601	218		45	8.1	10.4	1.28					35		0.1	2.0
B-7	5/09/78	96	F	60	264		564	111		23	6.5	8.9	1.37					16		0.1	2.5
B-8	5/16/78	120	M	158	230		601	251		29	3.8	8.7	2.29					3		0.1	1.4
B-9	5/17/78	51	M	95	178		558	144		59	5.4	8.7	1.61					9		0.1	3.6
B-9A	6/19/79	64	M	52	286	368	658	84	41	33	4.8	8.9	1.89	139	5	100	15	16	1.0	0.1	1.6
B-9B	6/25/79	64	M	88	253	347	548	52	33	38	4.5	9.4	2.09	140	5	105	16	15	1.3	0.1	1.1
B-10	5/17/78	108	M	113	220		601	251		95	7.5	10.1	1.35					38		0.1	2.3
B-12	5/19/78	40	F	94	174		601	67		90	6.8	9.8	1.44					6		0.1	2.3
B-12A	6/15/79	52	F	76	316	271	970	112	76	39	5.0	8.5	1.70	138	6	99	13	13	1.1	0.1	2.4
B-13	5/19/78	40	F	67	243		601	162		78	6.9	9.9	1.43					11		0.1	3.0
B-13A	6/13/79	52	F	76	270	205	621	81	44	23	4.2	8.6	2.05	147	4	110	12	5	1.0	0.1	1.6
B-13B	6/14/79	52	F	47	360	322	771	88	33	23	3.9	9.3	2.38	144	4	105	15	7	0.9	0.1	2.0
B-14	5/25/78	28	F	93	203		601	200		83	7.7	9.3	1.21					27		0.1	2.6
B-14A	6/01/79	40	F	33	250	266	828	105	27	62	5.6	9.6	1.71	142	5	98	12	11	1.2	0.1	2.4
B-14B	6/14/79	40	F	51	280	322	845	89	48	52	4.6	9.4	2.04	140	5	100	15	13	0.9	0.1	2.0
B-14C	6/25/79	40	F	181	274	221	618	56	36	52	5.2	8.9	1.71	142	4	102	17	19	1.2	0.1	1.5
B-15	5/30/78	28	F	119	212		601	161		94	7.3	10.5	1.44					15		0.1	2.0
B-15A	3/17/79	37	F	117	246	215	366	24	6	18	2.7	10.0	3.70	141	4	99	15	4	2.1	0.1	0.7
B-15B	6/08/79	40	F	61	281	465	776	101	43	43	4.6	9.4	2.05	139	4	102	12	11	0.9	0.1	1.7
B-15C	6/14/79	40	F	35	278	279	988	139	40	37	6.0	9.8	1.63	140	5	101	8	9	1.1	0.1	2.0
B-16	6/02/78	84	M	55	229		601	251		17	7.0	9.3	1.33					8		0.1	4.6
B-17	6/05/78	108	M	110	152		601	251		61	5.1	9.4	1.84					8		0.1	2.0

Table 4. Continued.

Bear Number	Date	Age (mo.)	Sex	Glucose mg/dl	Chol. mg/dl	Tri-Glyceride mg/dl	LDH U/L	SCOT U/L	SGPT U/L	Alk Phos. U/L	Phos. mg/dl	Ca mg/dl	Calp Ratio	Na mEq/L	K mEq/L	Cl mEq/L	CO_2 mEq/L	BUN mg/dl	Creat. mg/dl	Bili mg/dl	Uric Acid mg/dl
B-18	6/13/78	60	F	52	265		561	284		64	5.7	9.6	1.68					14		0.1	3.0
B-19	6/13/78	17	M	53	321		601	158		80	6.9	9.2	1.33					5		0.2	3.1
B-20	5/02/79	122	F	82	149	96	611	91	25	26	2.2	8.1	3.23	142	5	103	17	11	1.8	0.1	1.8
B-21	5/14/79	14	F	77	217	160	823	119	29	93	6.6	8.9	1.35	138	4	101	14	5	0.9	0.1	2.1
B-23	5/14/79	14	F	53	266	173	803	130	32	116	5.5	8.7	1.58	139	4	100	11	1	0.9	0.1	2.2
B-24	6/07/79	123	F	74	238	250	997	143	50	48	4.1	9.0	2.19	140	5	101	16	7	1.2	0.1	1.7
B-25	6/08/79	75	M	92	387	480	946	179	63	37	5.2	9.3	1.78	140	4	104	13	18	0.9	0.1	2.0
B-26	6/12/79	52	M	84	298	292	672	77	49	35	4.6	9.4	2.05	143	4	106	14	17	1.2	0.1	1.3
B-26A	6/26/79	52	M	88	269	316	584	81	59	51	4.9	9.5	1.91	139	5	103	18	12	0.8	0.1	1.2
B-27	6/16/79	40	M	105	322	302	778	121	105	52	5.2	9.8	1.89	139	4	101	17	12	0.7	0.1	1.6
B-28	6/19/79	40	M	91	260	309	855	78	43	62	5.8	9.3	1.60	140	5	102	17	10	0.8	0.1	1.3
B-29	6/21/79	40	M	122	322	339	913	93	38	108	5.8	8.8	1.52	137	5	104	13	16	0.6	0.1	1.8
B-30	6/25/79	52	F	203	304	194	675	54	51	50	5.0	8.2	1.64	141	5	102	19	16	0.8	0.1	1.5
B-31	6/28/79	52	F	94	298	443	818	99	76	68	5.3	10.2	1.92	141	4	102	18	29	0.8	0.1	1.6
15024	8/13/76		M	91	257	164	998	137	26	32	5.0	9.8	1.96	138	5	101	11	1	1.0	0.1	1.6
15018	8/18/76		M	93	323	144	998	243	83	53	6.7	9.5	1.42	145	5	108	14	13	0.6	0.0	1.5
15028	8/27/76		F	138	339	162	998	271	103	60	5.6	9.1	1.63	150	4	111	17	9	0.7	0.1	1.0
125	5/29/78	51	F	60	180		611	266		33	2.6	9.5	3.65					9		0.1	1.8
180	6/03/78	16	M	92	216		580	266		80	5.0	9.7	1.94					7		0.1	1.5
196	6/05/78	16	F	59	259		611	266		180	7.6	9.8	1.29					16		0.1	2.1
223	10/12/78		F	82	283	209	501	501	241	41	3.9	8.4	2.15	144	3	111	13	6	1.1	0.1	1.3

Table 5. Black bear blood protein, electrophoresis and hematologic data collected from August 1976 to July 1979 on the Kenai Peninsula, Alaska.

Bear Number	Date	Age (mo.)	Sex	Total Protein %/dl	Albumin %/dl	Globulin %/dl	Alpha 1 %/dl	Alpha 2 %/dl	Beta %/dl	Gamma %/dl	A/G Ratio	Hb %/dl	PCV %
B-1	10/08/77	42	F	8.4	4.0	4.4	0.8	1.0	1.1	1.6	0.90	19.9	75
B-1A	5/03/78	51	F	7.3	3.6	3.7	0.5	0.9	0.6	1.8	1.00	17.0	46
B-2	10/15/77	32	F	7.0	4.6	2.4	0.7	0.5	1.0	0.3	1.80		
B-2A	6/09/79	40	F	6.6	3.9	2.7	0.7	0.7	0.7	0.7	1.50	18.5	48
B-2B	6/27/79	52	F	6.1	3.9	2.2	0.6	0.3	1.1	0.2	1.70	17.8	42
B-3	4/28/78	38	F	6.7	4.2	2.5	0.6	0.2	1.5	0.3	1.60		
B-5	5/02/78	50	M	7.1	4.0	3.1	0.6	0.5	1.3	0.7	1.30		
B-6	5/02/78	50	M	7.5	4.4	3.1	0.6	0.8	1.0	0.8	1.40	17.0	39
B-7	5/16/78	96	F	7.8	4.8	3.0	0.5	0.5	1.2	0.9	1.60	17.0	39
B-8	5/16/78	120	M	8.2	3.4	4.8	0.4	0.8	1.4	2.2	0.70	12.5	40
B-9	5/17/78	51	M	7.5	4.0	3.5	0.6	0.5	1.2	1.2	1.20	18.0	48
B-9A	6/19/79	64	M	8.3	3.8	4.5	0.5	0.9	1.8	1.3	0.80	16.6	45
B-9B	6/25/79	64	M	7.9	3.5	4.4	0.5	0.6	2.1	1.2	0.80	13.0	39
B-10	5/17/78	51	M	8.4	4.3	4.1	0.6	0.7	1.4	1.4	1.00	17.0	46
B-12	5/19/78	64	M	6.4	3.9	2.5	0.6	0.4	1.3	0.2	1.60	19.0	46
B-12A	6/15/79	52	F	7.3	3.8	3.5	0.7	0.6	1.6	0.6	1.10	18.0	60
B-13	5/19/78	40	F	6.4	4.3	2.1	0.6	0.3	1.0	0.2	2.00	19.0	48
B-13A	6/13/79	52	F	6.5	3.8	2.7	0.6	0.4	1.0	0.7	1.40	17.9	45
B-13B	6/14/79	52	F	6.7	3.9	2.8	0.6	0.5	1.2	0.5	1.40	18.3	46
B-14	5/25/78	28	F	5.7	3.6	2.1	0.6	0.2	0.6	0.7	1.80	18.5	46
B-14A	6/01/79	40	F	6.3	4.5	1.8	0.4	0.3	0.9	0.2	2.50	19.0	54
B-14B	6/14/79	40	F	6.6	3.5	3.1	0.6	0.4	1.4	0.7	1.20	19.1	48
B-14C	6/25/79	40	F	6.5	3.6	2.9	0.5	0.6	1.5	0.2	1.30	16.0	44
B-15	5/30/78	28	F	7.0	3.9	3.1	0.7	0.8	0.8	0.8	1.30	18.0	45
B-15A	3/17/79	37	F	8.3	4.7	3.6	0.7	0.4	2.2	0.3	1.30	18.0	46
B-15B	6/08/79	40	F	6.9	3.9	3.0	0.6	0.4	1.8	0.2	1.30	15.8	47
B-15C	6/14/79	40	F	7.2	4.1	3.1	0.6	0.5	1.6	0.4	1.30	18.0	48
B-16	6/02/78	84	M	7.7	4.8	2.0	0.0	1.6	0.4	1.0	1.60	17.0	48
B-17	6/05/78	108	M	7.9	4.4	3.5	0.4	0.6	1.3	1.3	1.30	19.5	47
B-18	6/13/78	60	F	7.8	4.4	3.4	0.4	0.8	1.1	1.1	1.30	19.5	58
B-19	6/13/78	17	M	7.3	4.8	2.5	0.5	0.7	0.7	0.7	2.00	19.5	54
B-20	5/02/79	122	F	6.2	3.7	2.5	0.4	0.3	0.7	1.1	1.40	17.0	40
B-21	5/14/79	14	F	5.2	3.0	2.2	0.7	0.8	1.2	0.5	1.40	16.0	41
B-23	5/14/79	14	F	5.4	3.4	2.0	0.6	0.3	0.7	0.4	1.70	17.5	43
B-24	6/07/79	123	F	6.8	4.0	2.8	0.5	0.3	1.3	0.7	1.40	16.5	43

Table 5. Continued.

Bear Number	Date	Age (mo.)	Sex	Total Protein %/dl	Albumin %/dl	Globulin %/dl	Alpha 1 %/dl	Alpha 2 %/dl	Beta %/dl	Gamma %/dl	A/G Ratio	Hb %/dl	PCV %
B-25	6/08/79	75	M	7.8	3.4	4.4	0.6	1.4	1.9	0.5	0.80	16.4	48
B-26	6/12/79	52	M	7.5	3.7	3.8	0.5	0.6	2.1	0.6	1.00	16.7	43
B-26A	6/26/79	52	M	7.1	3.7	3.4	0.5	0.5	1.6	0.8	1.00	16.0	44
B-27	6/16/79	40	M	7.1	3.6	3.5	0.7	0.5	1.3	0.9	1.10	16.0	48
B-28	6/19/79	40	M	6.4	4.4	2.0	0.5	0.2	0.9	0.4	2.20	17.8	41
B-29	6/21/79	40	M	6.4	3.4	3.0	0.5	0.4	1.4	0.7	1.20	15.8	43
B-30	6/25/79	52	F	6.9	3.8	3.1	0.4	0.6	1.2	0.9	1.30	20.0	53
B-31	6/28/79	52	F	6.8	4.1	2.7	0.5	0.5	1.0	0.7	1.50	18.4	46
15024	8/13/76		M	7.1	3.8	3.3	0.7	0.6	1.1	0.9	1.13	18.5	50
15018	8/18/76		M	7.4	3.8	3.6	0.9	0.9	1.2	0.7	2.06	19.0	48
15028	8/27/76		F	6.9	3.8	3.1	0.5	0.8	1.0	0.9	1.21	18.5	49
125	5/29/78	15	F	7.1	4.0	3.1	0.5	0.6	1.1	1.1	1.20	18.0	48
180	6/03/78	16	M	6.4	4.0	2.4	0.3	0.4	1.3	0.4	1.60	17.0	43
196	6/05/78	16	F	6.3	3.9	2.4	0.5	0.3	1.2	0.5	1.70	18.4	46
223	10/12/78		F	8.2	3.9	4.3	0.5	0.9	1.1	1.8	0.90		

Table 6. Aerial tracking data and current status of all radio-collared bears at the Moose Research Center Study Area, Kenai Peninsula, Alaska, 1978 and 1979.

Bear Number	Times Located 1978	1979	Last Observed	Current Status
B1	30	28	6 August 1979	Status unknown, transmitter failed
B2	28	36	28 October 1979	Active
B3	14	-	22 August 1978	Status unknown
B5	23	-	3 October 1978	Transmitter failed
B6	10	-	23 June 1978	Shot 1 September 1978
B8	29	-	1 May 1979	Dead
B9	2	33	28 October 1979	Active
B10	26	31	28 October 1979	Active
B12	29	37	28 October 1979	Active
B13	31	37	28 October 1979	Active
B14	30	37	28 October 1979	Active
B15	10	36	28 October 1979	Active
B16	18	31	6 September 1979	Status unknown, transmitter failed
B17	18	-	8 November 1978	Status unknown, transmitter failed
B18	21	35	28 October 1979	Active
B19	21	26	21 August 1979	Status unknown, lost radio contact in mountains
B20	-	33	28 October 1979	Active
B21	-	20	28 October 1979	Active
B23	-	19	28 October 1979	Active
B24	-	23	28 October 1979	Active
B25	-	23	28 October 1979	Active
B30	-	20	28 October 1979	Active
B31	-	17	28 October 1979	Active
B32	-	2	28 October 1979	Active

Current Status, Movement and Home Range

We are currently monitoring 16 black bears (Table 6). The transmitters on bears B1 and B16 probably failed during summer 1979. B1 was radio-tracked to her summer feeding area and then contact was lost (6 August). Likewise, B16 was located several times in his summer feeding area, but could not be located after 6 September 1979. We made several routine flights over the area normally occupied by these bears during the winter denning period, but failed to locate either animal. We have experienced some corrosion of the antenna lead wire with the Telonics radios originally used in 1978 and feel these transmitters probably failed for this reason. Hopefully we can re-radio these individuals in 1980. Likewise, the transmitters on bears B5 and B17 are probably not functioning. Contact with these animals was lost prior to the 1979 field season. A large bear wearing a radio collar was seen at Mystery Creek on 17 May 1979. This bear was probably B5 since this was the area he used in 1978. No signal was received from the transmitter. The signal from B17 was last heard on 8 November 1978. Its signal was weak at that time, and on a later flight in December no signal could be received.

As suspected, B6's radio collar slipped off sometime between 18 and 23 June 1978. He was shot by a sport hunter on 1 September 1978 near Forest Lake.

Bear B8 was found dead on 1 May 1979 in the area where he was suspected to have denned in 1978. Necropsy results revealed that the bear probably died during late October 1978 and never denned. Heavy snowfall in October covered the carcass, and the animal was presumed in a den when in fact it was dead. Although the cause of death was not determined, the animal was suffering with a severe lower gastrointestional tract infection. External signs indicated severe diarrhea; all the hair around the anus and rump was gone and the skin was inflamed and raw. Internal examination revealed discoloration of the intestinal tract, mesentric fat and peritoneum. The liver was gray in color and contained several whitish colored cysts. The respiratory and circulatory systems appeared normal. This individual probably was afflicted with this problem when first captured on 16 May 1978. At that time, he had a large open wound on his rump and lacked hair cover around the rump and anal area. The wound on the rump was healed prior to his death and appeared normal at necropsy.

During the 1978 field season, 16 radio-collared black bears were relocated 340 times, while 19 radio-collared black bears were relocated 524 times during the 1979 field season. An additional 83 and 124 uncollared black bears were sighted in 1978 and 1979, respectively.

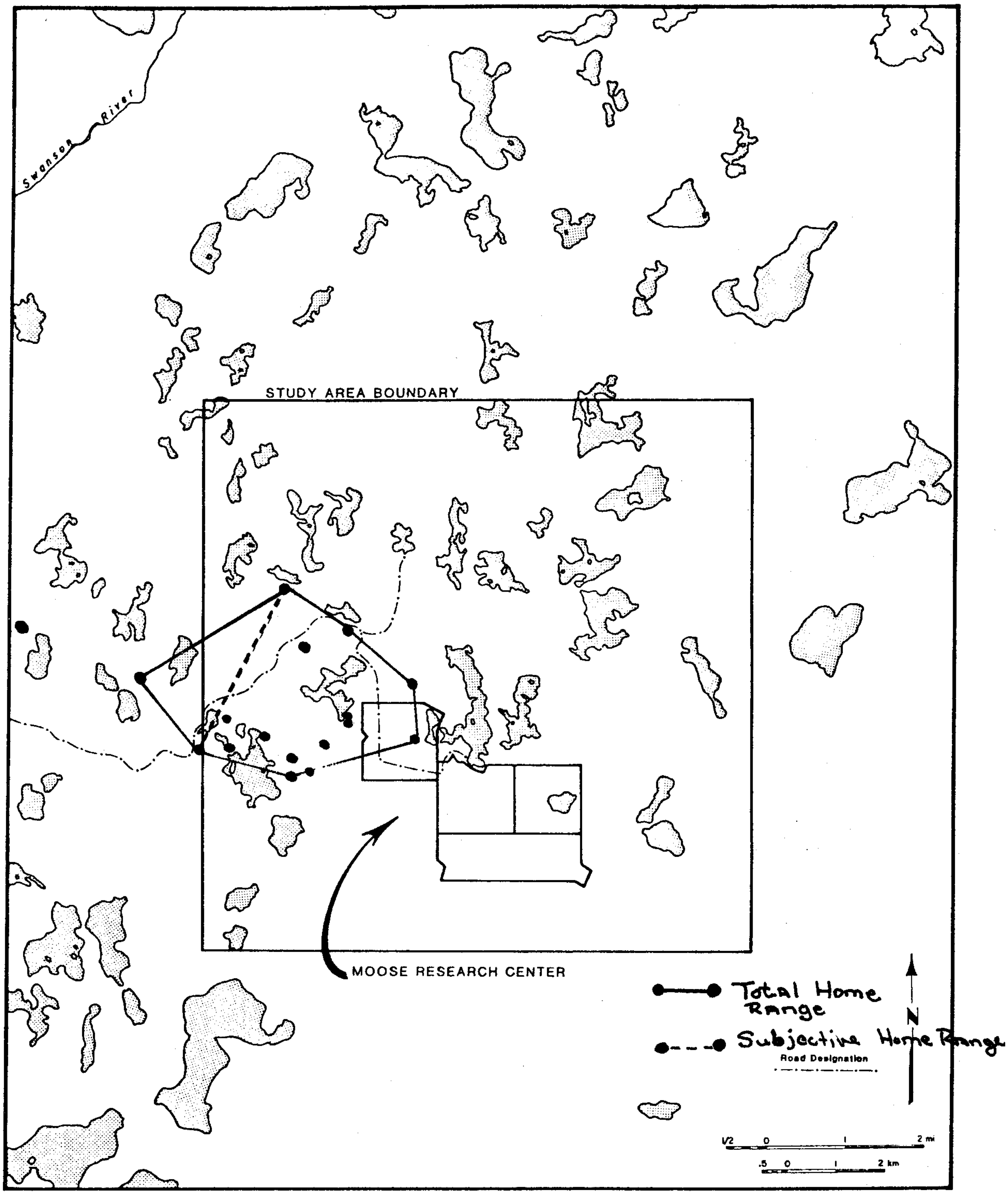

Fig. 7. Home range and movements of adult female B1 and her 2 cubs in 1978.

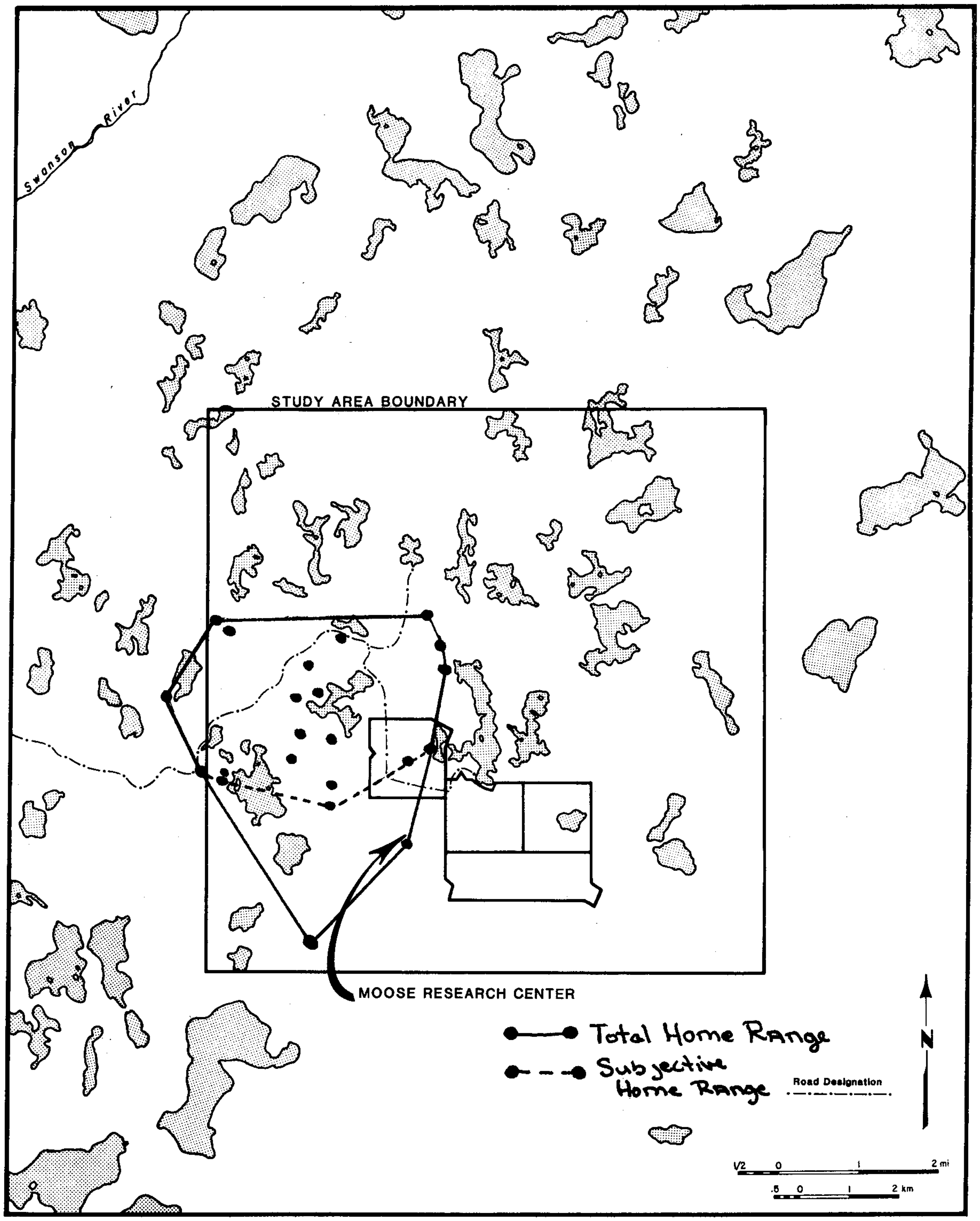

Fig. 8. Home range and movements of adult female B1 and her 2 yearlings in 1979.

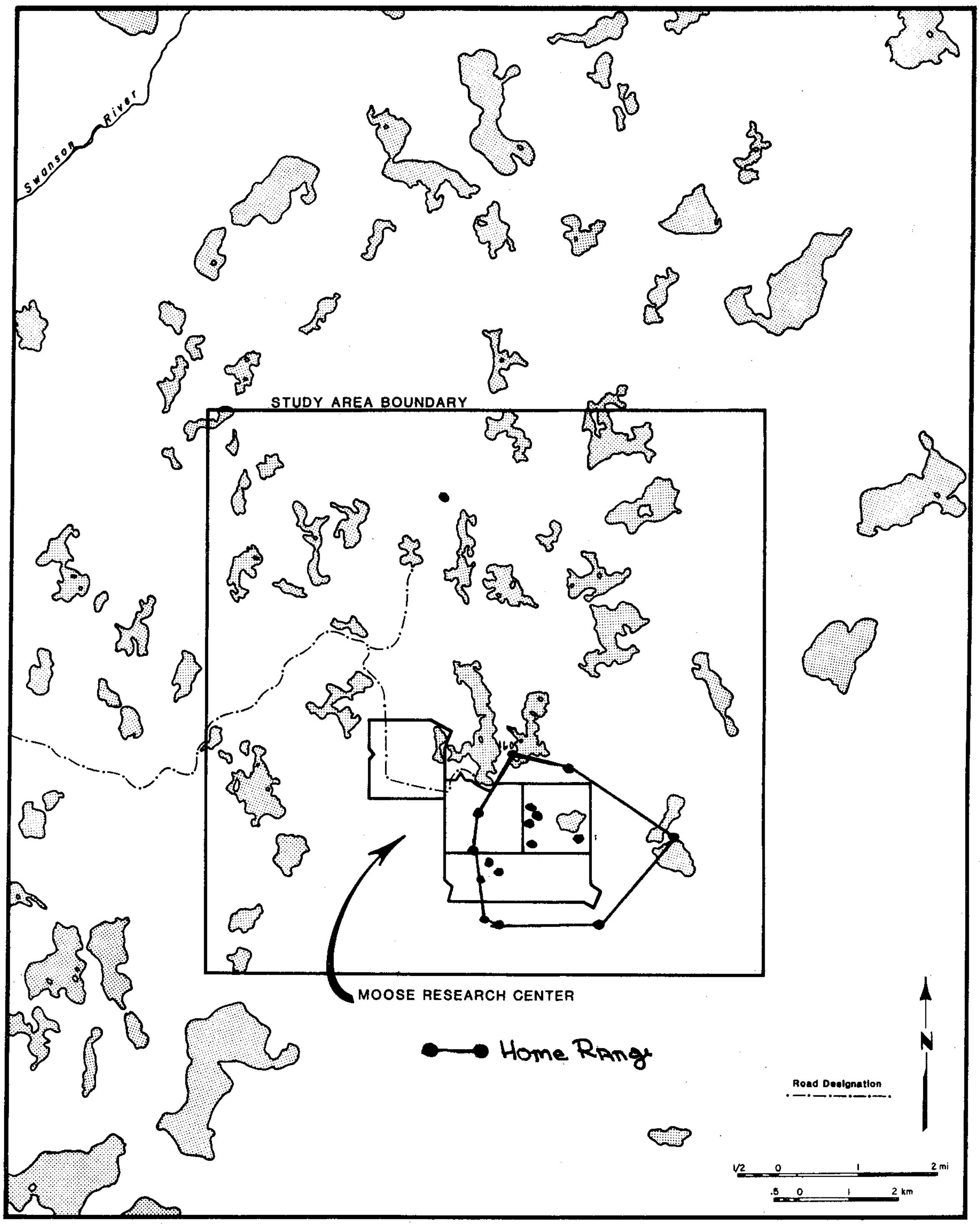

Fig. 9. Home range and movements of juvenile female B2 in 1978.

Table 7. Home range size and reproductive status for 17 female black bears in the Moose Research Center Study Area, 1978 and 1979.

Bear Number	Year	Age	Reproductive Status	Total[1/] Home Range Size (ha)	Actual[1/] Home Range Size (ha)
B1	1978	4	2 cubs	1470	1130
B1	1979	5	2 yearlings	2659	1718
B2	1978	3	open	1057	943
B2	1979	4	2 cubs	189	189
B12	1978	3	open	3420	3071
B12	1979	4	2 cubs	1158	995
B13	1978	3	open	1879	1879
B13	1979	4	1 cub	2165	1390
B14	1978	2	open	2547	2547
B14	1979	3	open	2587	2587
B15	1979	3	open	3127	3127
B24[2/]	1979	10	open (yearlings)	1863	1863
B30	1979	4	open	432	432
B31	1979	4	open	1146	1146
B18	1978	3	open	3761	3761
B18	1979	4	2 cubs	766	766
B20	1979	7 or 8	2 yearlings	4708	4708

1/ Total area contained within a polygon formed by connecting the peripheral points; actual area excludes areas of non-use within the total area. For a detailed explanation see text.

2/ Captured 7 June 1979, in heat and had apparently just chased away her yearling(s).

Analysis of the home range data for female bears (age >1 yr.) (Figs. 7-9) indicated that the average home range was 2055±1242 ha (Table 7). As expected, the subjective home range (see Methods section) was smaller (1897±1242 ha), but not significantly different (P>0.05) from the total home range. Areas excluded from the total home range were, the Willow Lake crushed area and the south MRC crushed areas. Both were rehabilated with LeTorneau tree crushers to improve moose browse. Movements of radio-collared bears indicated lack of use of these crushed areas and for this reason we felt they were not bear habitat. In several instances, bears used areas on all sides of crushed areas, but were never sighted within them. In these cases, our subjective home range sizes equaled the total home range size minus the number of hectares of crushed area contained within the home range polygon.

In addition to excluding crushed areas, we also excluded certain points which appeared unrealistic in relationship to clusters of points. For example, some bears upon emerging from their dens in the spring, made long movements into areas they did not use during the summer feeding season. Likewise, females in heat; moved out of the "core area" of their home range into areas not normally visited. These too were excluded. All location points are presented for interpretation.

When the female cohort was partitioned into age and reproductive status, home range sizes were different. Females accompanied by cubs (n=5) occupied a total home range of 1150±742 ha with a subjective home range of 894±454 ha (Figs. 7, 10, 12, 14). Female bears with small cubs restricted their movements to the immediate area near the den during the first 2-3 weeks after emergence from the den. Usually by mid-May movements were more extensive, but activities were generally associated with mature forests or were within the immediate vicinity of large trees within the 1947 burn regrowth vegetation. Females with small cubs were very difficult to see from the air, and considerable circling was required before the female could be seen. On many occasions the bear could be found only because a few large trees were present in the area and invariably the family was at the base of a tree. During this period most of the activity observed was the sow nursing the cubs or the family unit resting together. By mid-June, our ability to see females with cubs improved as their movements and use of habitat without large trees increased. Cub activity also increased and cubs were frequently observed feeding on insects exposed by the sow when she tore up rotten logs. By late summer all females with cubs traveled to summer feeding areas. Distances traveled and locations are presented in a later section.

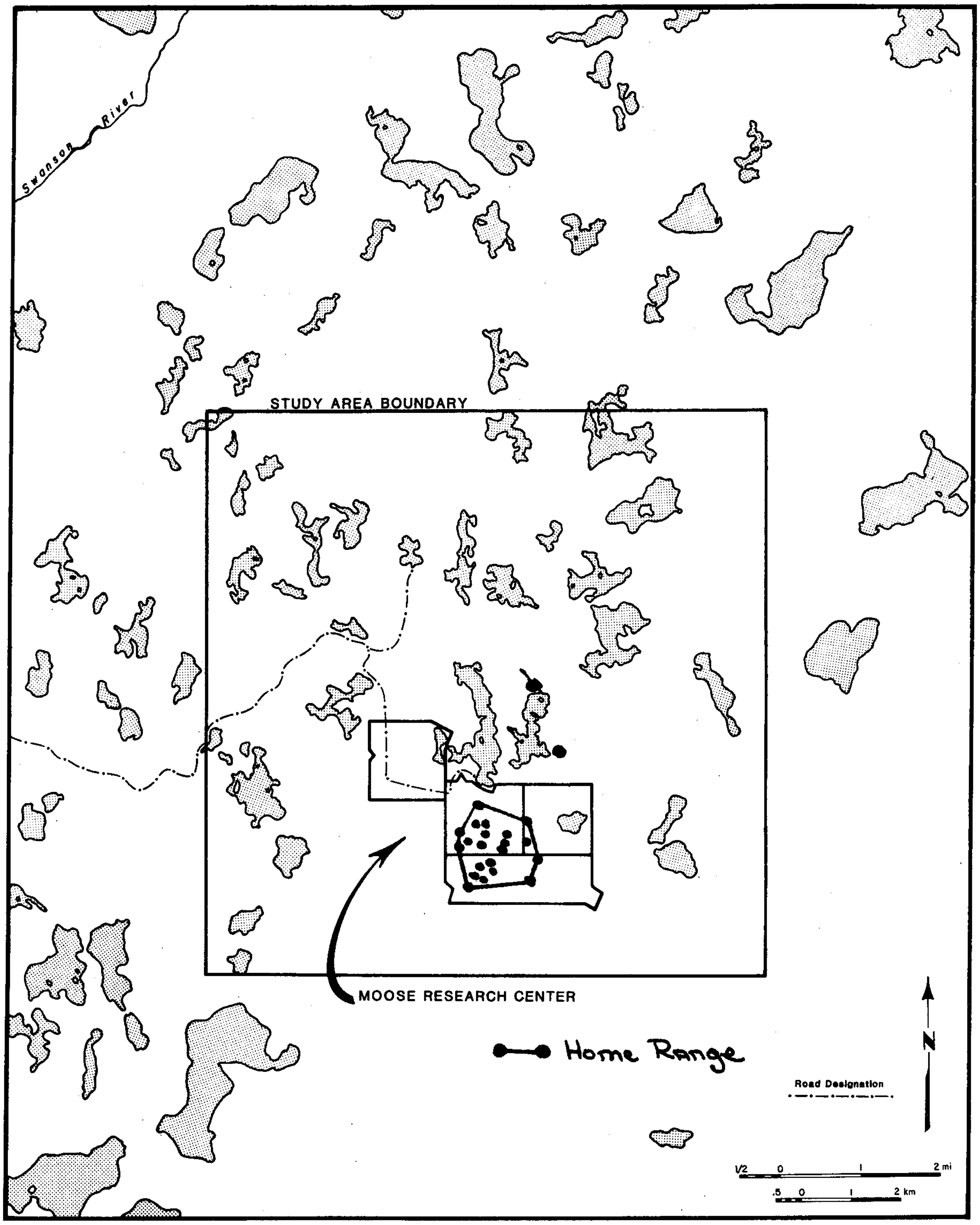

Fig. 10. Home range and movements of adult female B2 and her 2 cubs in 1979.

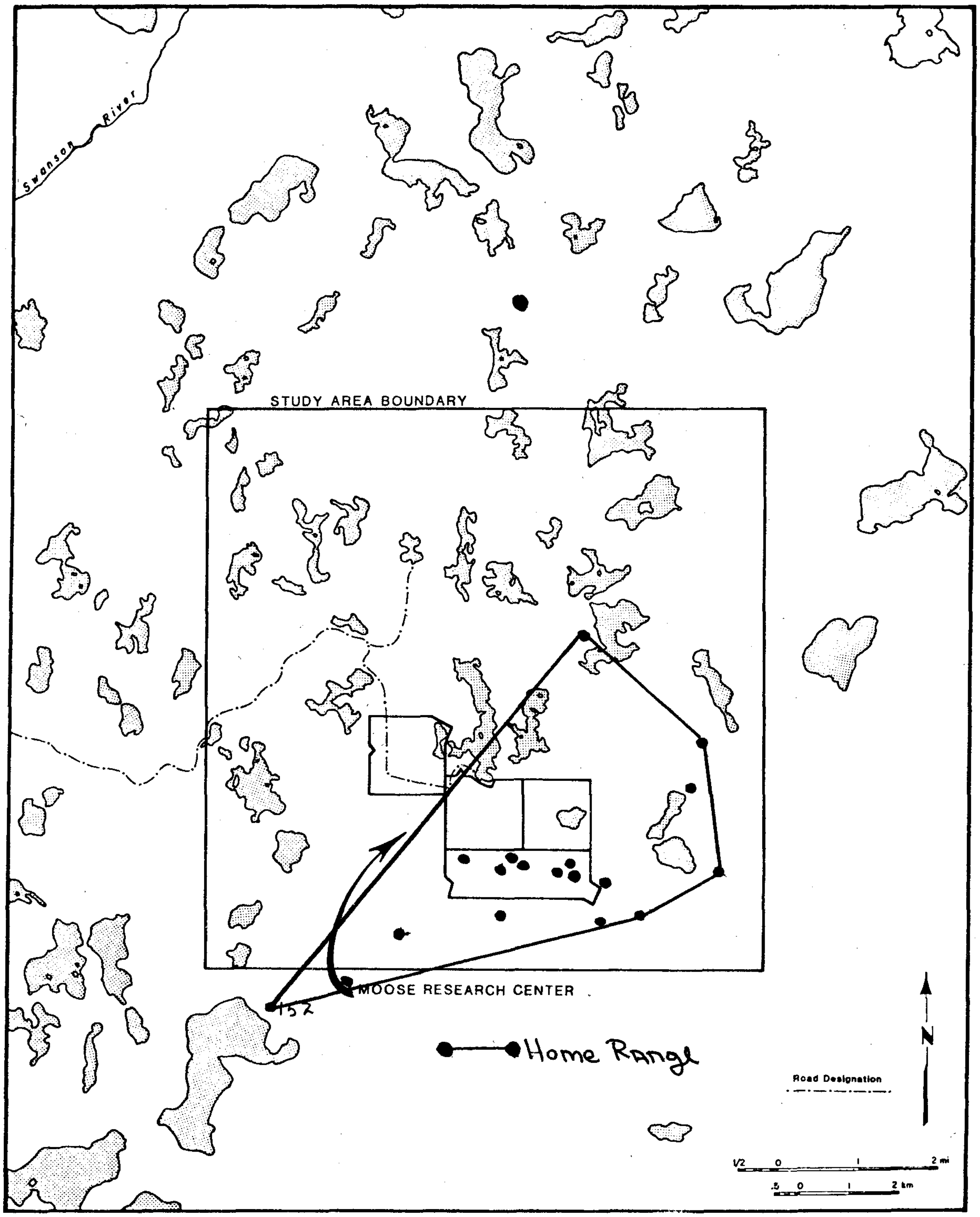

Fig. 12. Home range and movements of juvenile female B12 during 1978.

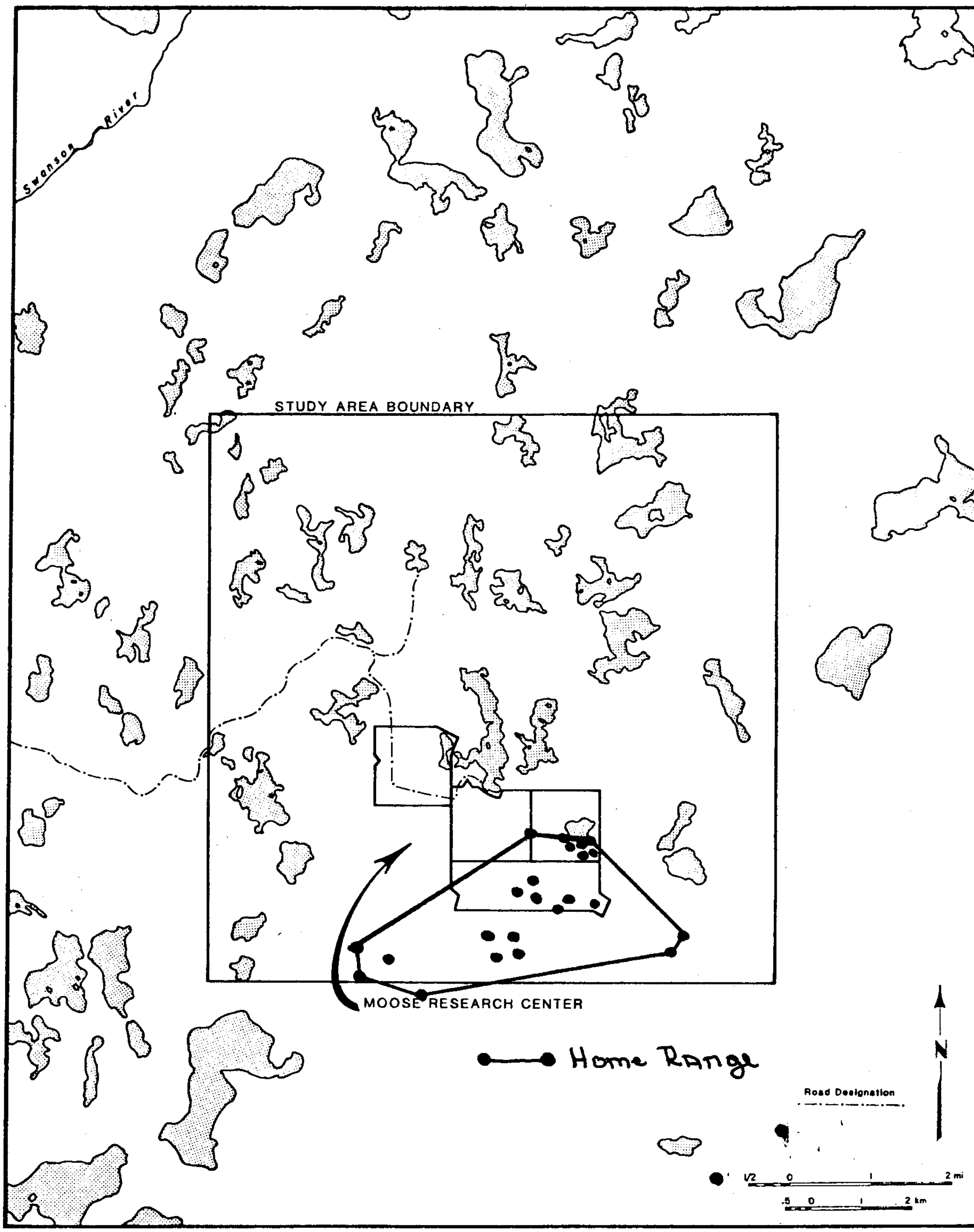

Fig. 12. Home range and movements of adult female B12 and her 2 cubs in 1979.

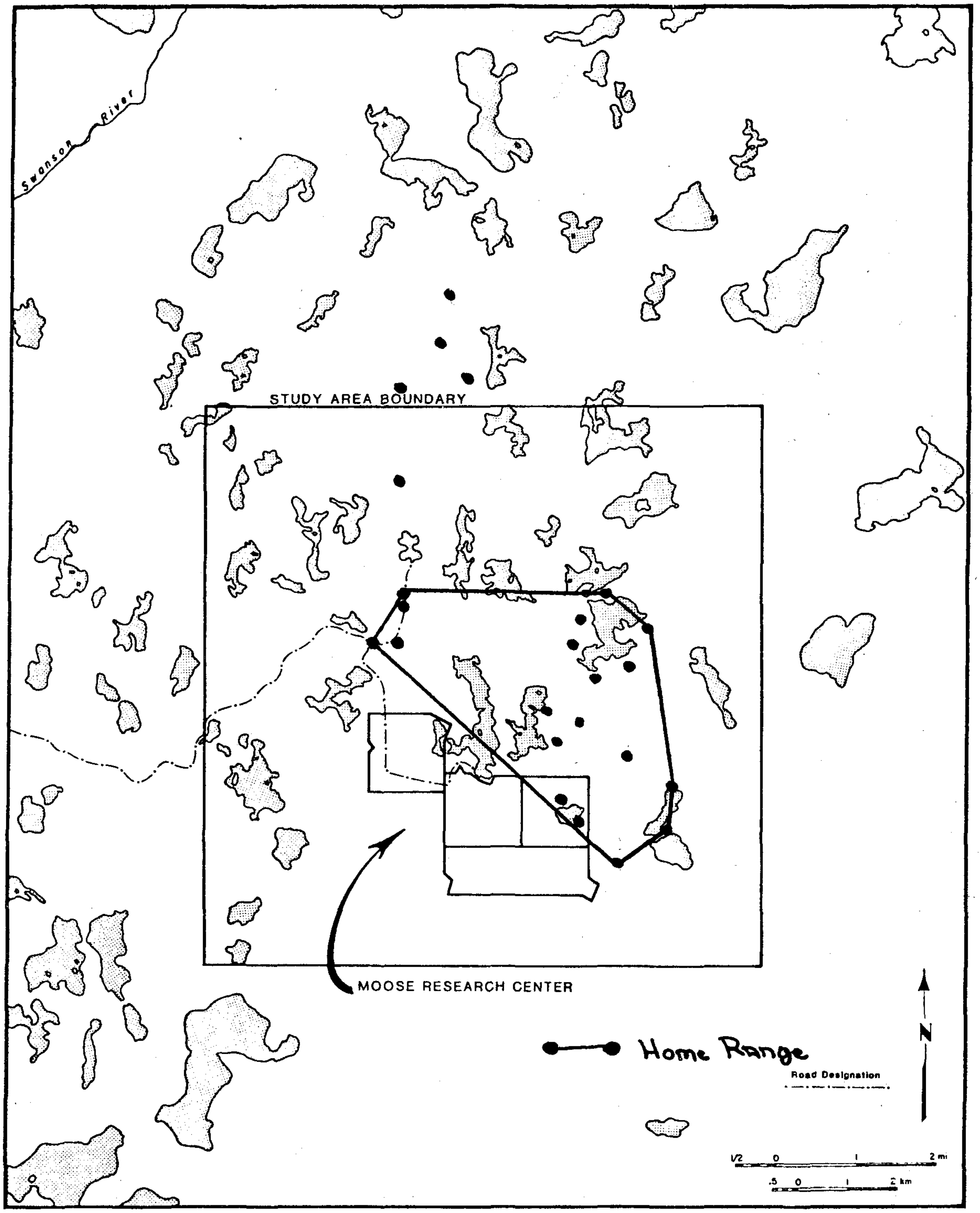

Fig. 13. Home range and movements of juvenile female B13 in 1978.

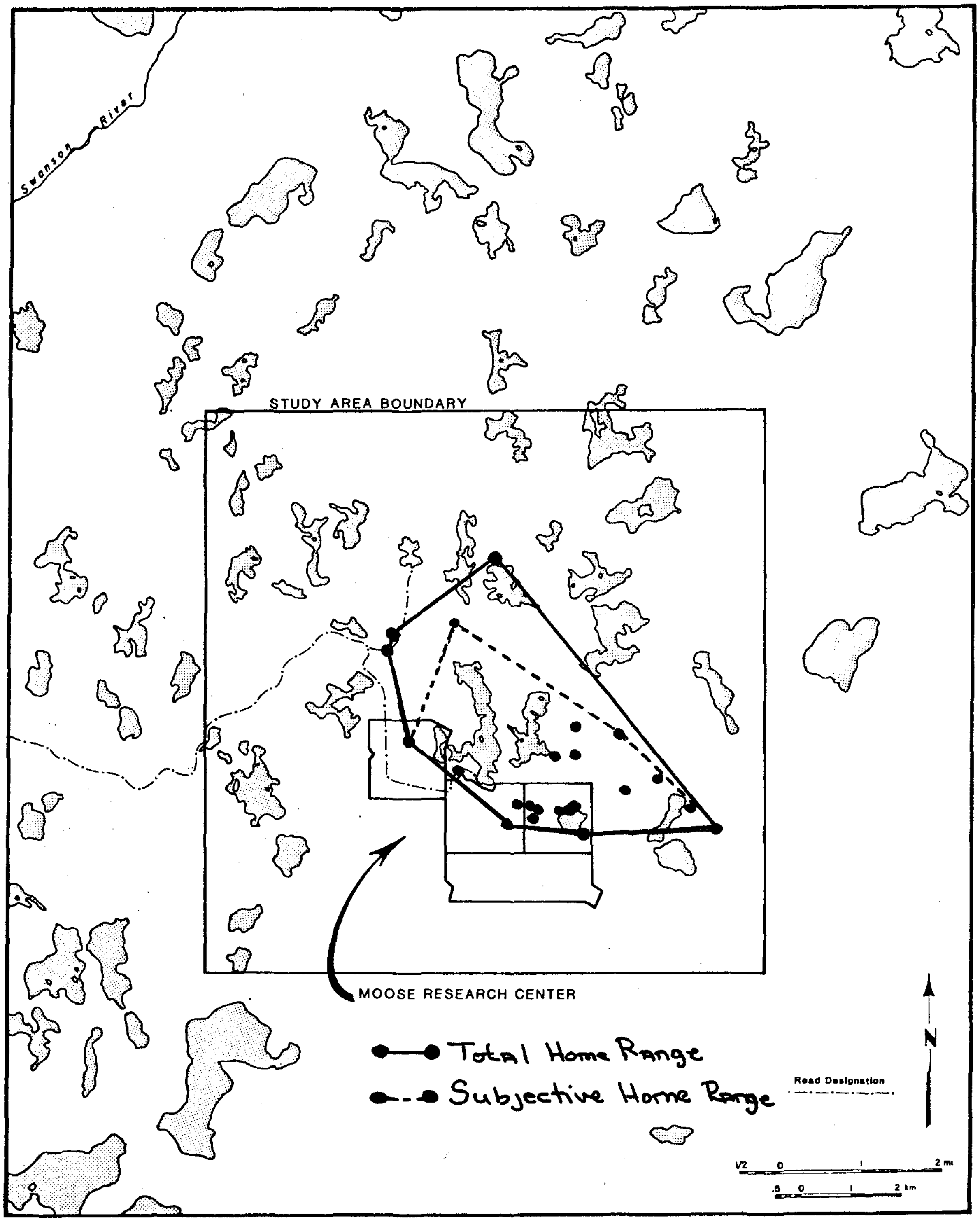

Fig. 14. Home range and movements of adult female B13 and her cub in 1979.

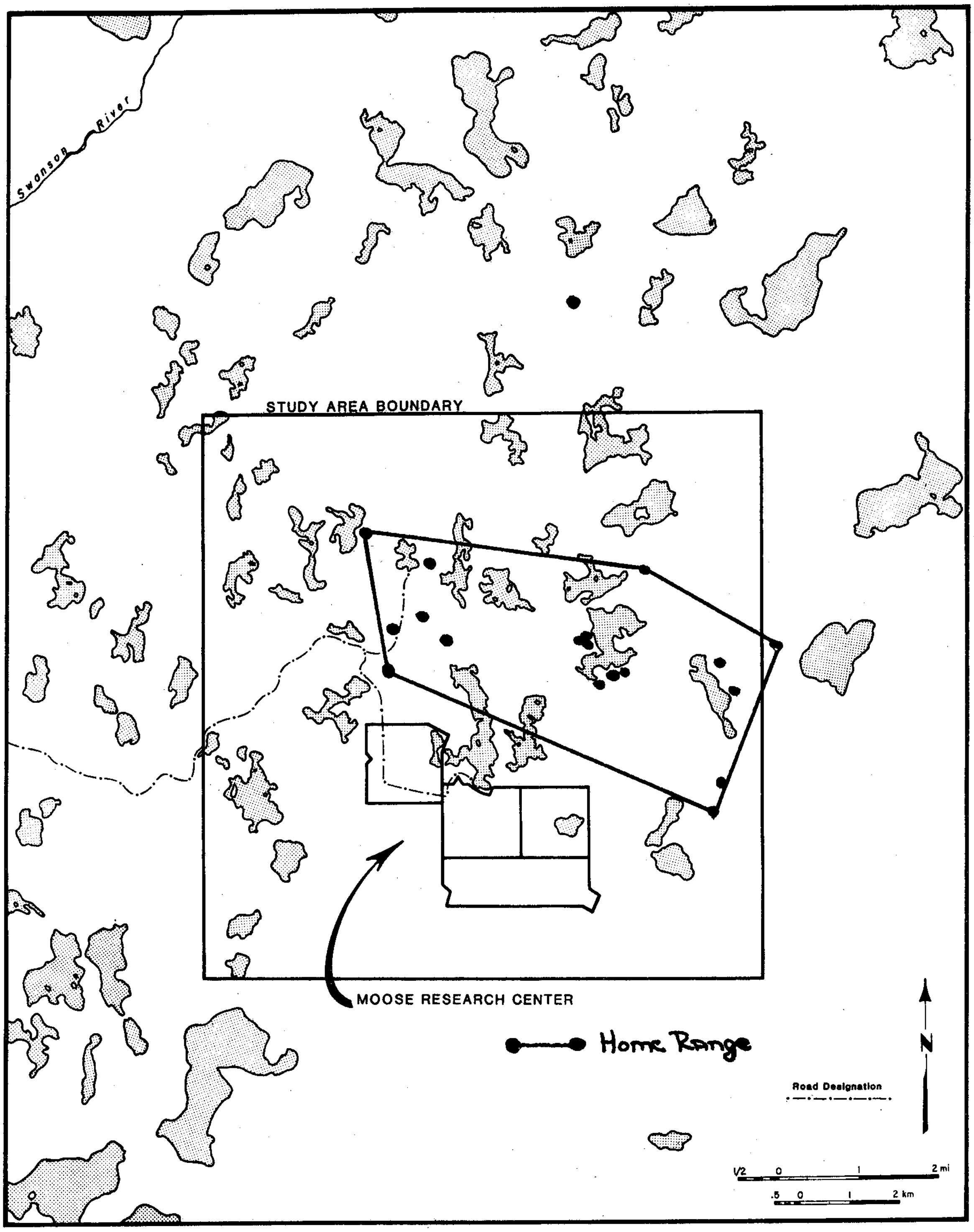

Fig. 15. Home range and movements of juvenile female B14 in 1978.

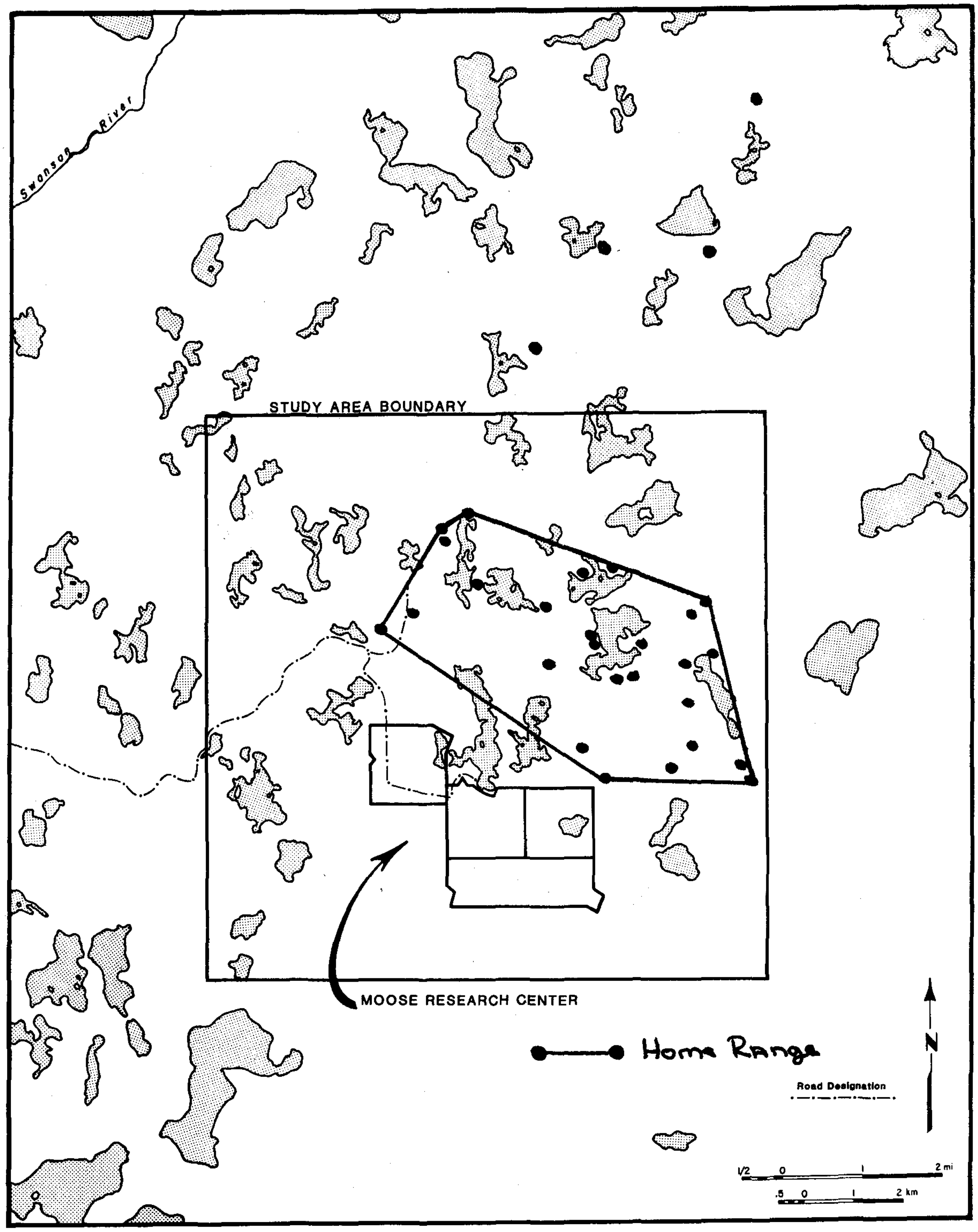

Fig. 16. Home range and movements of juvenile female B14 in 1979.

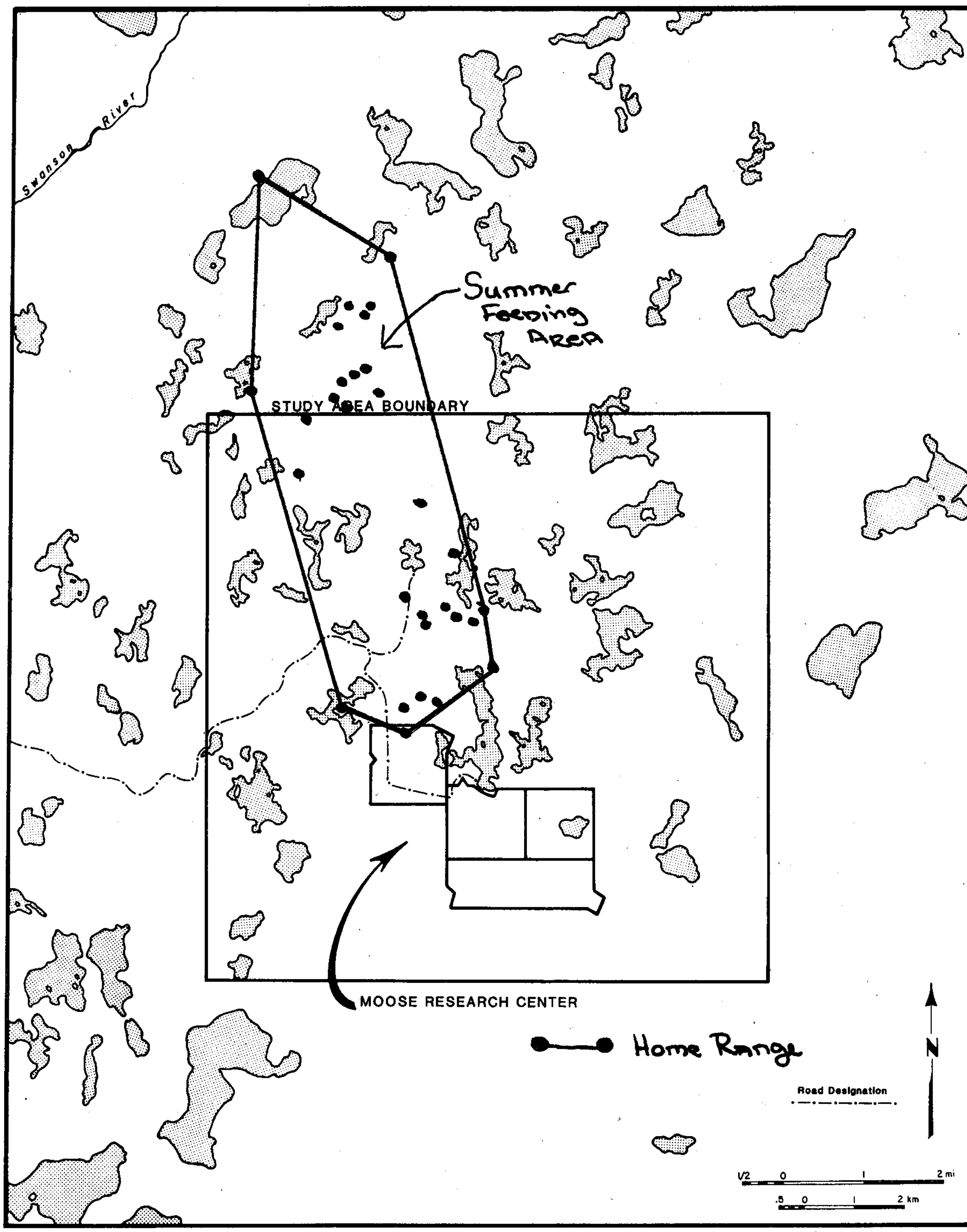

Fig. 17. Home range, movements and summer feeding area of juvenile female B15, 1979.

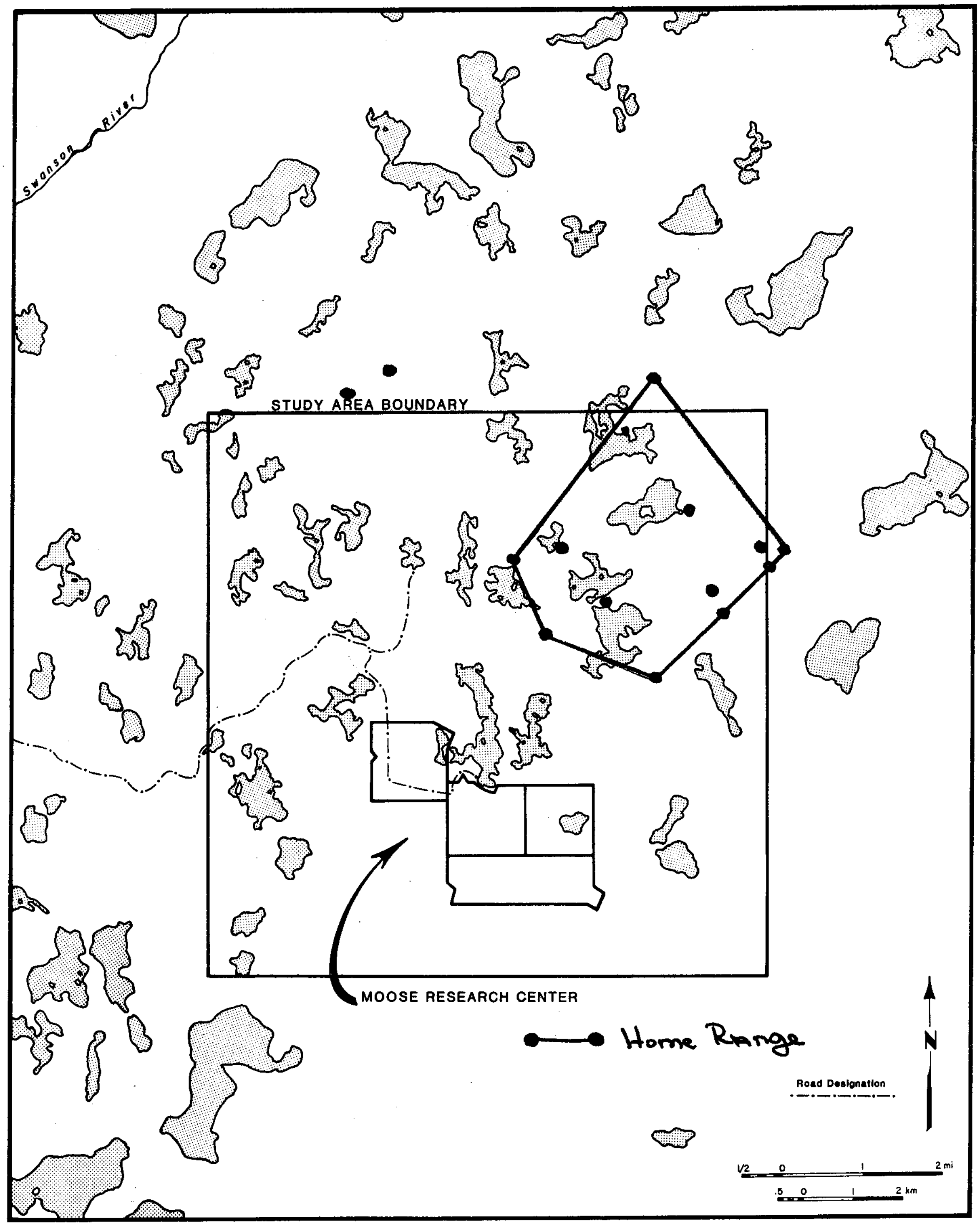

Fig. 18. Home range and movements of adult female B24 in 1979.

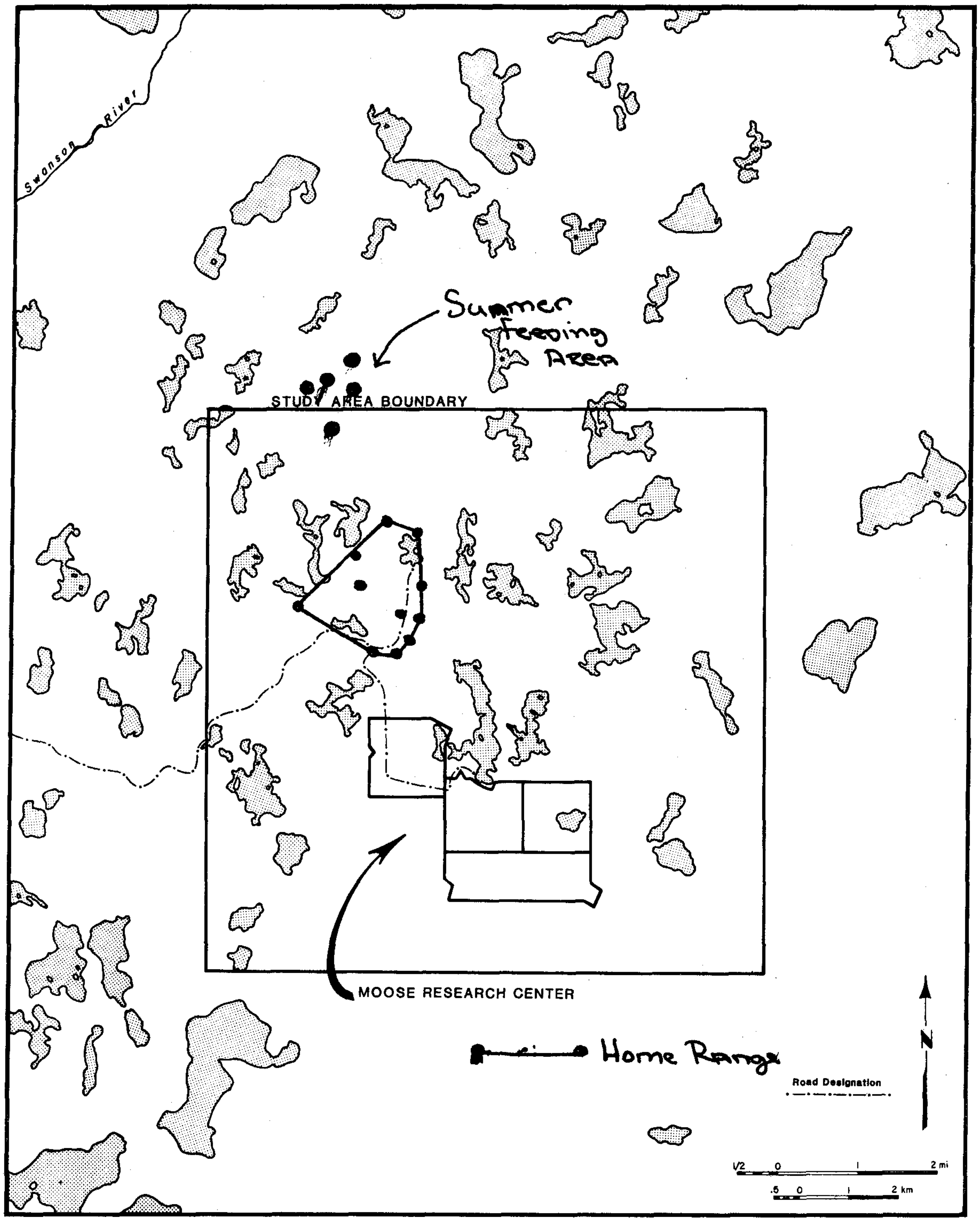

Fig. 19. Home range, movements and summer feeding area for juvenile female B30 in 1979.

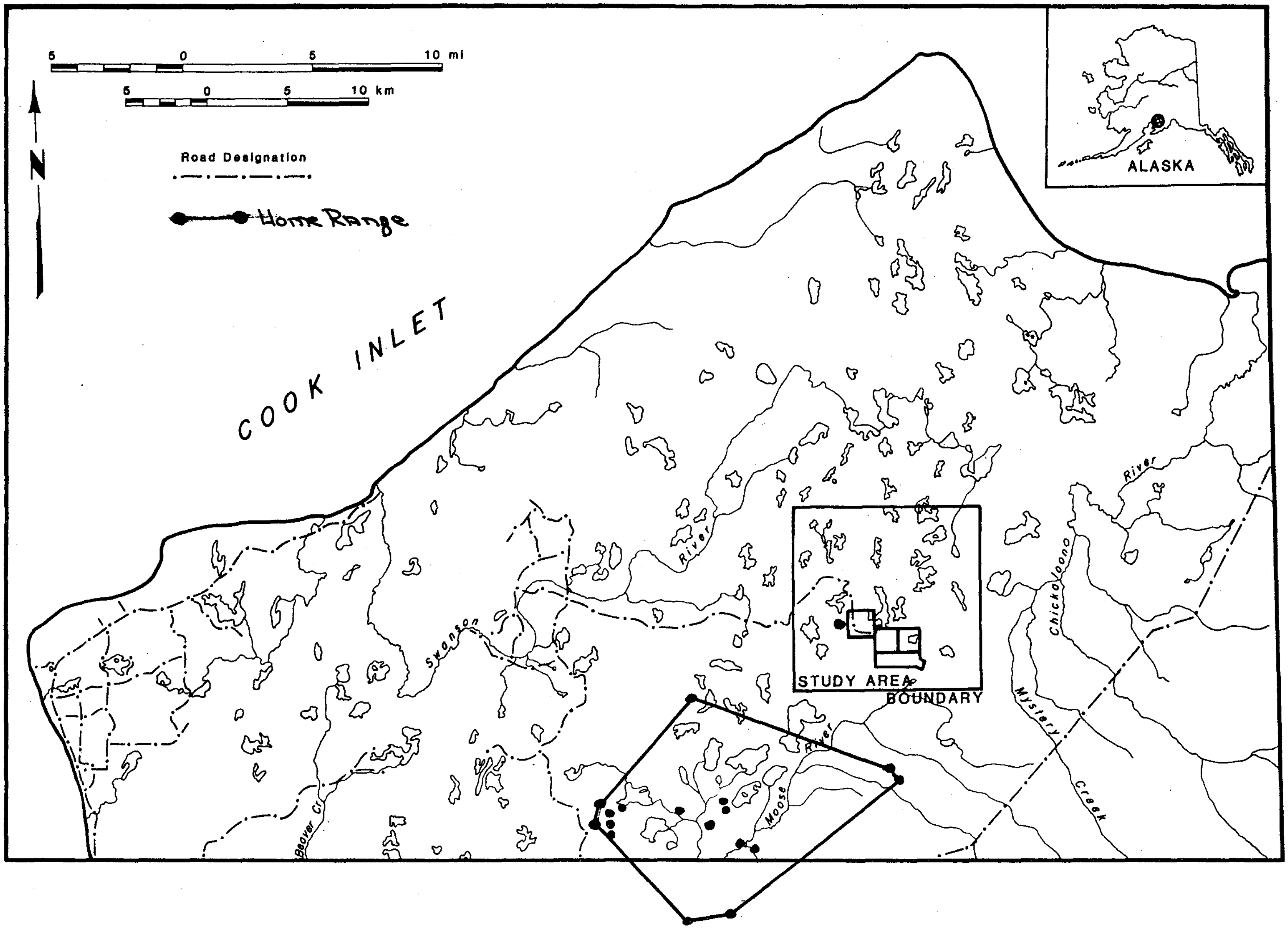

Fig. 20. Home range and movements of a 3-year-old male (B3) in 1978.

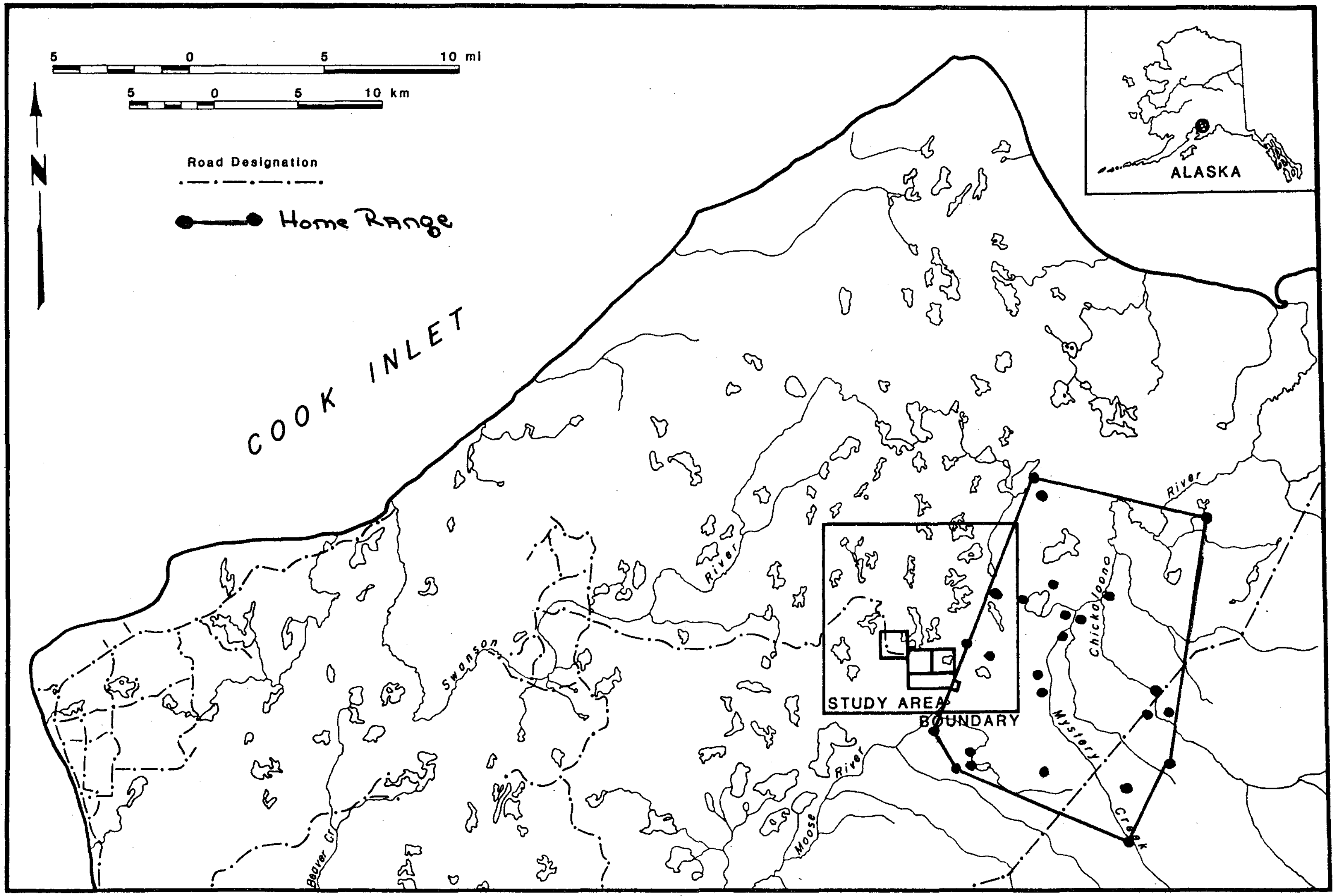

Fig. 21. Home range and movements of a 4-year-old male black bear (B5) in 1978.

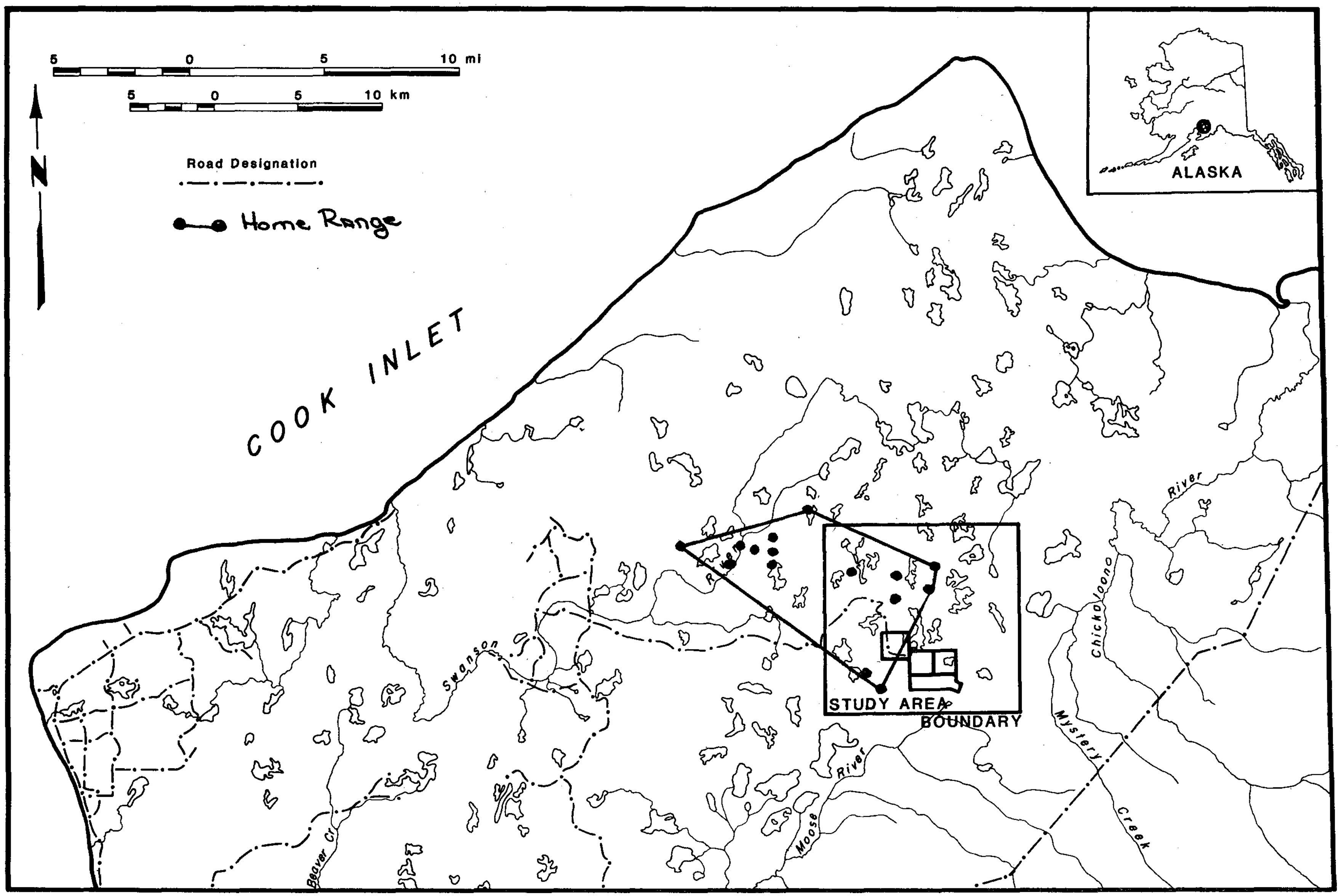

Fig. 22. Home range and movements of a 10-year-old male black bear (B8) in 1978.

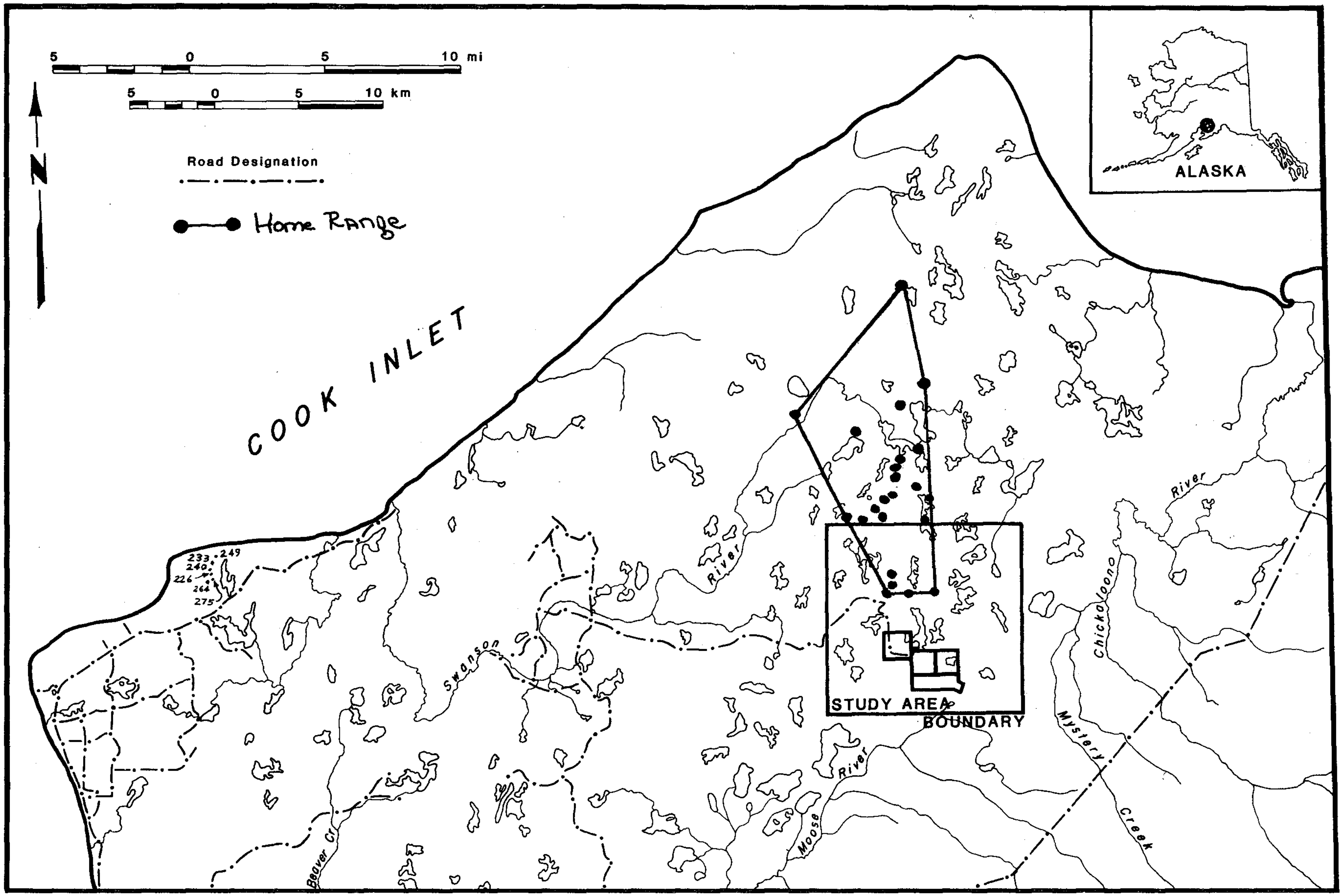

Fig. 23. Home range and movements of a 5-year-old black bear (B9) in 1979.

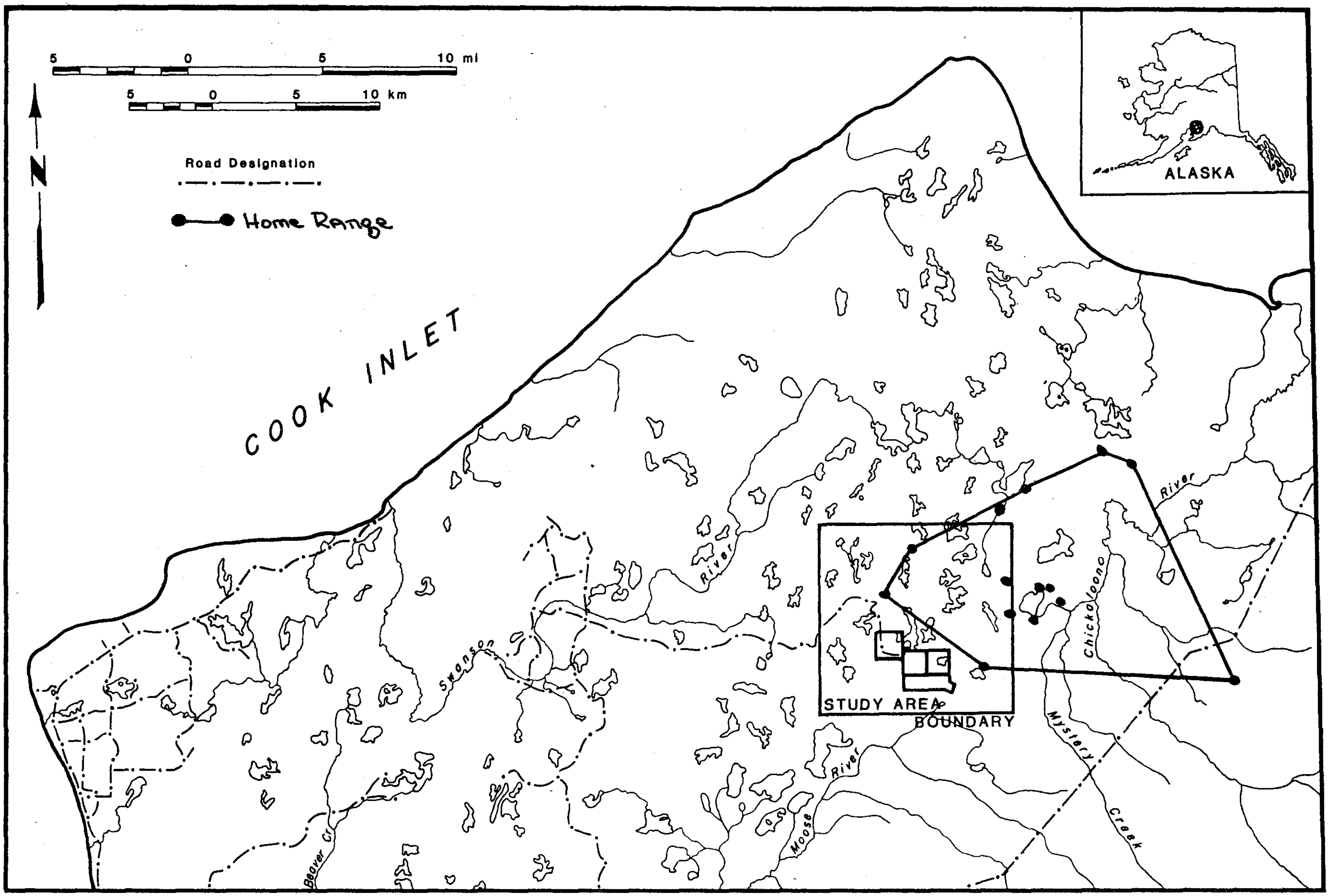

Fig. 24. Home range and movements of a 9-year-old male black bear (B10) in 1978.

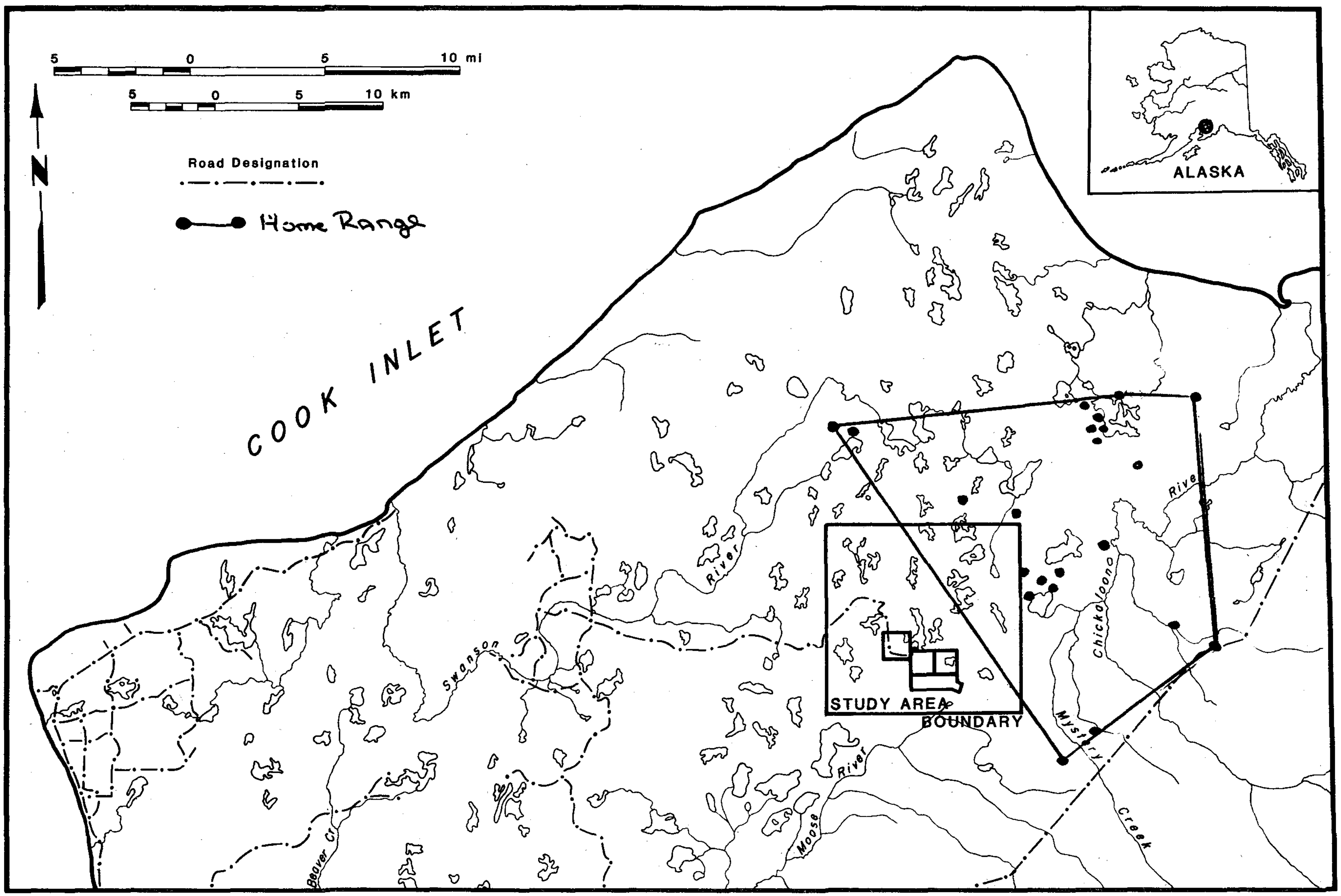

Fig. 25. Home range and movements of a 10-year-old male black bear (B10) in 1979.

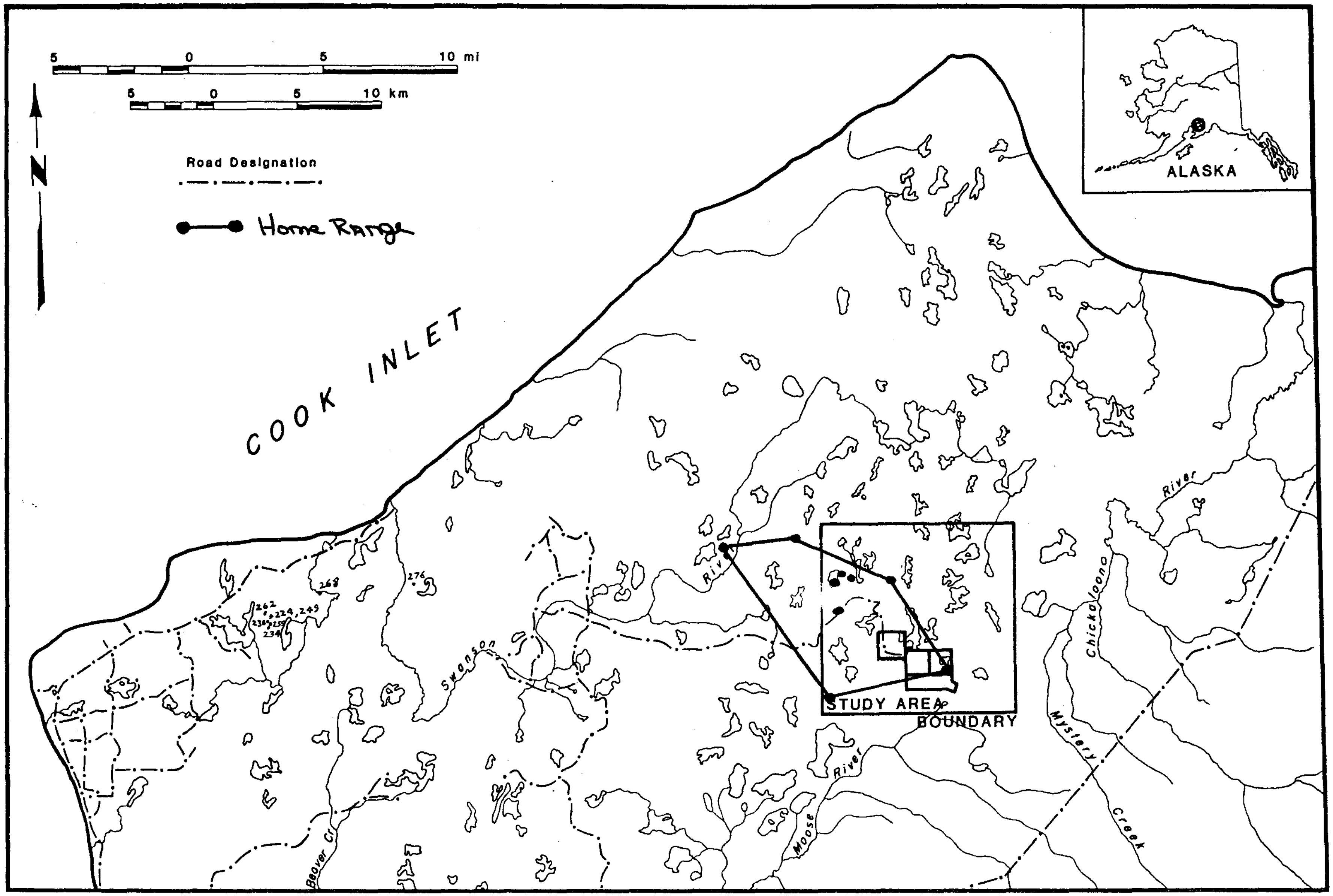

Fig. 26. Home range and movements of a 7-year-old male black bear (B16) in 1978.

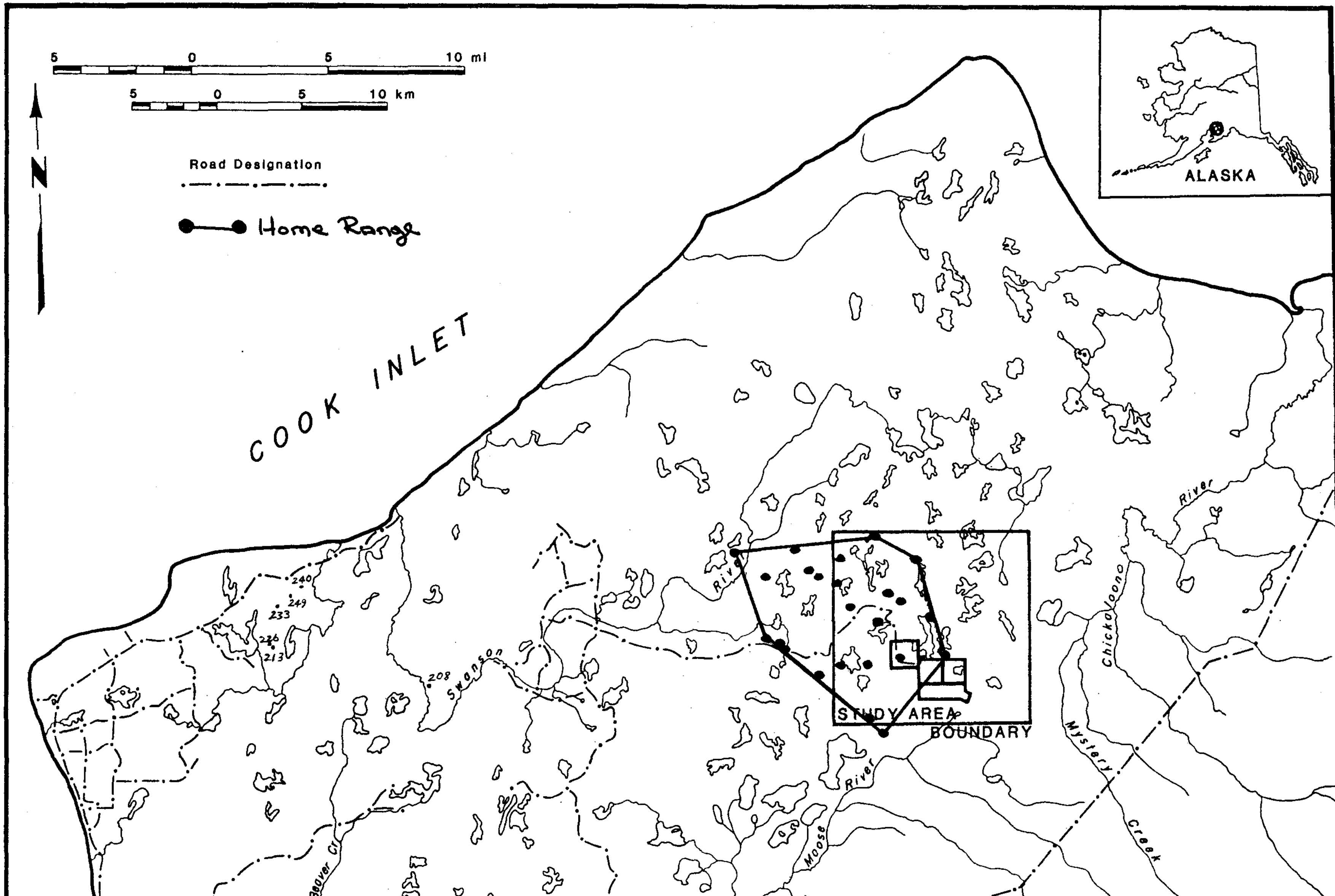

Fig. 27. Home range and movements of an 8-year-old male black bear (B16) in 1979.

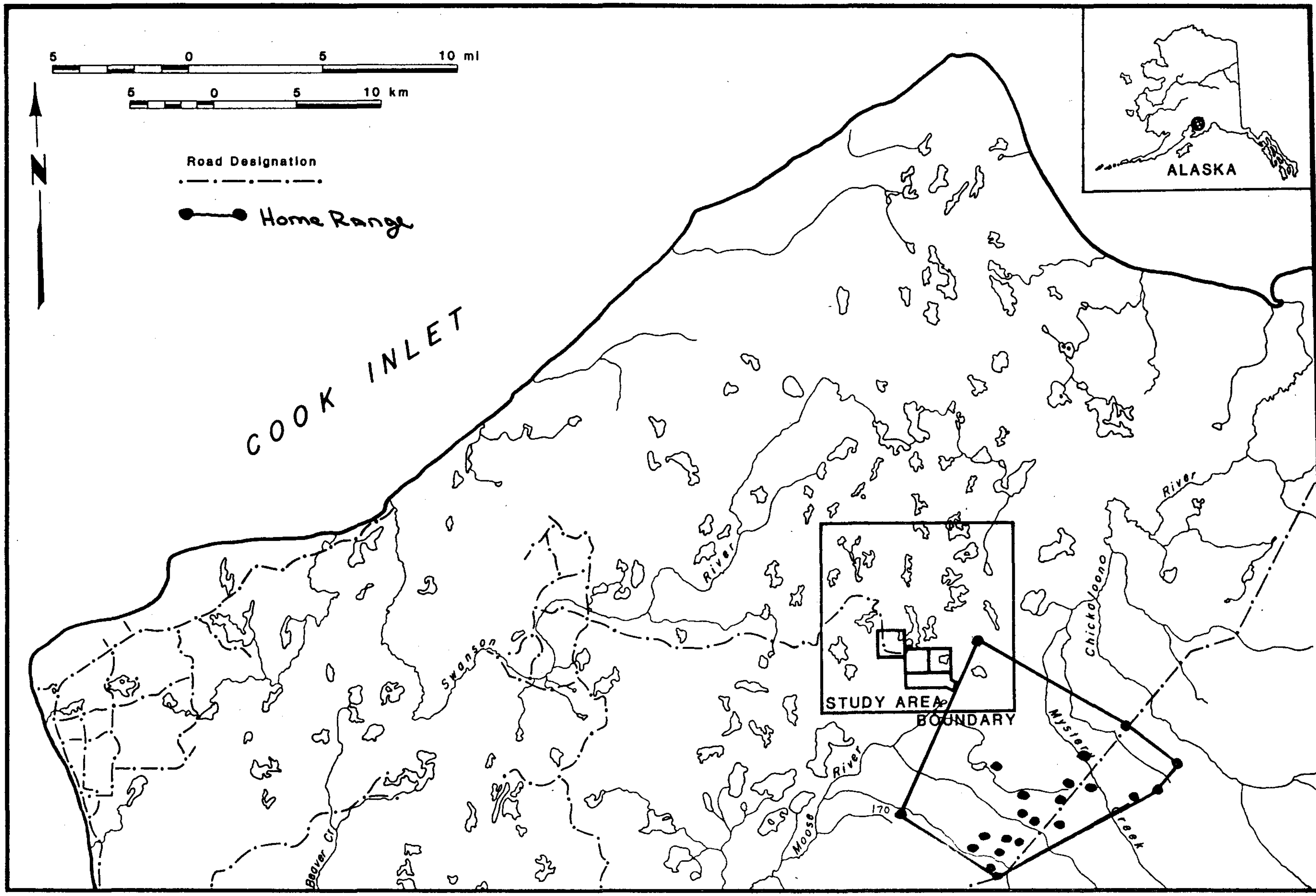

Fig. 28. Home range and movements of a 3-year-old male black bear (B19) in 1979.

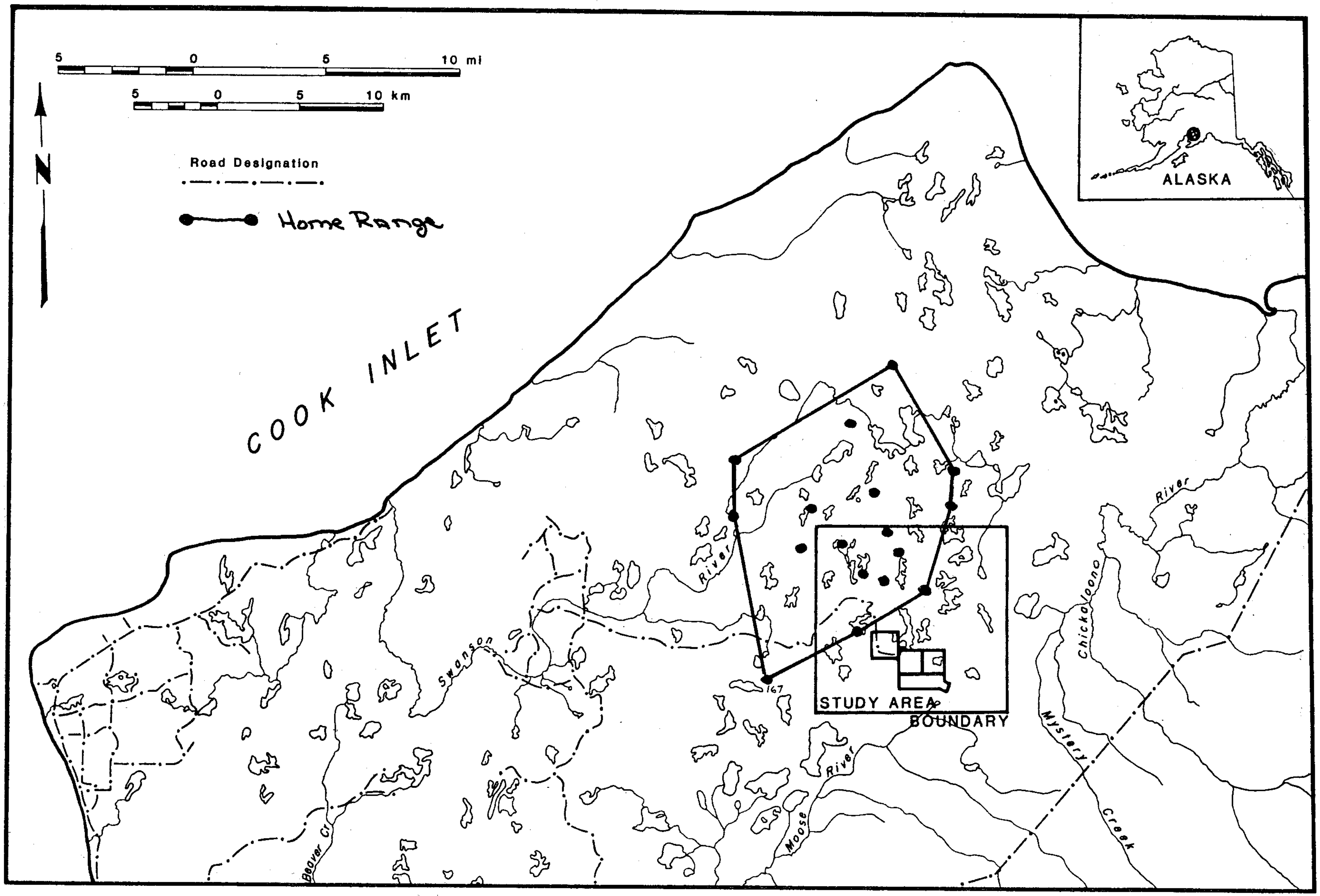

Fig. 29. Home range and movements of a 5-year-old male black bear (B25) in 1979.

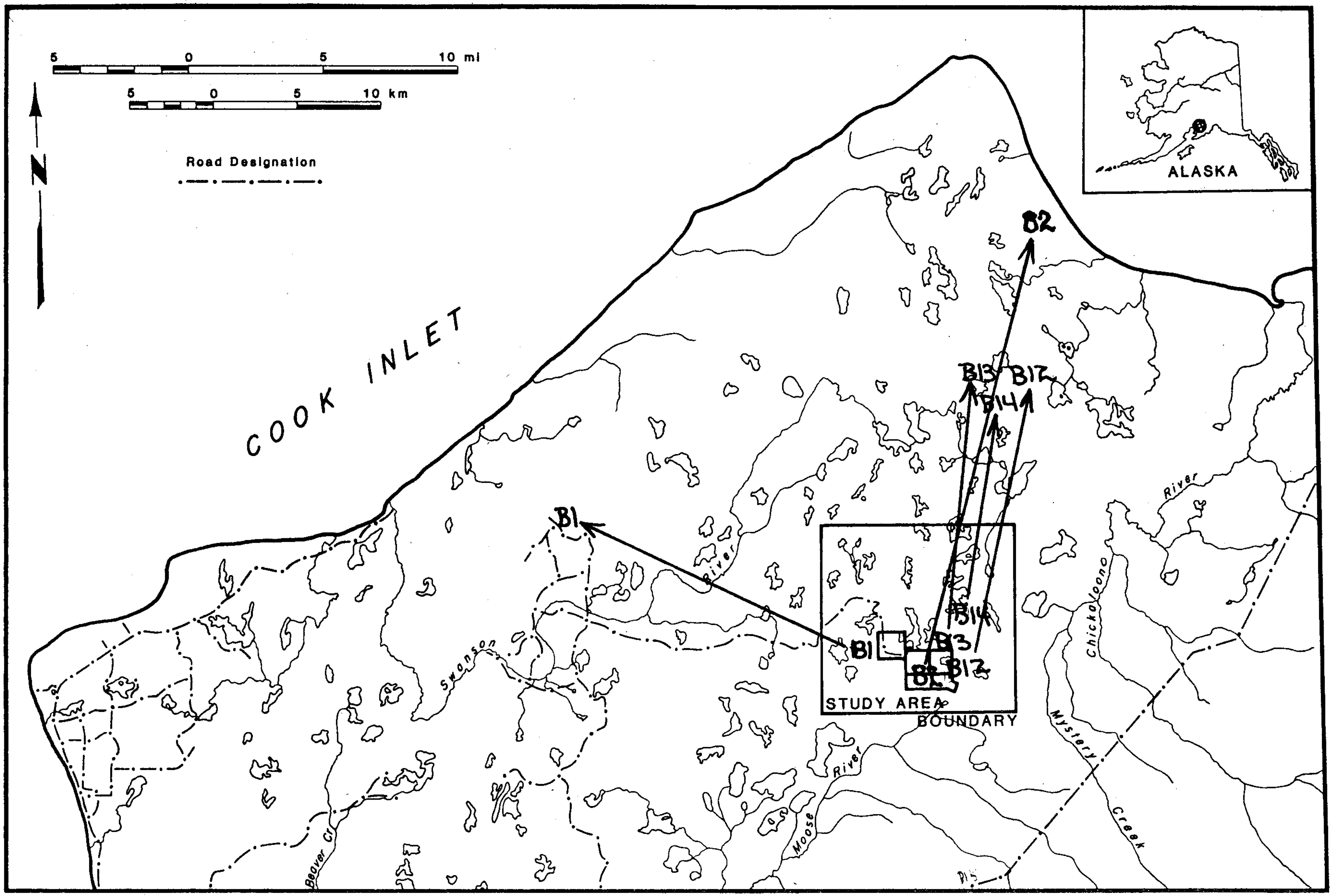

Fig. 30. Direction of movement and general location of summer feeding areas for resident female black bears in 1978.

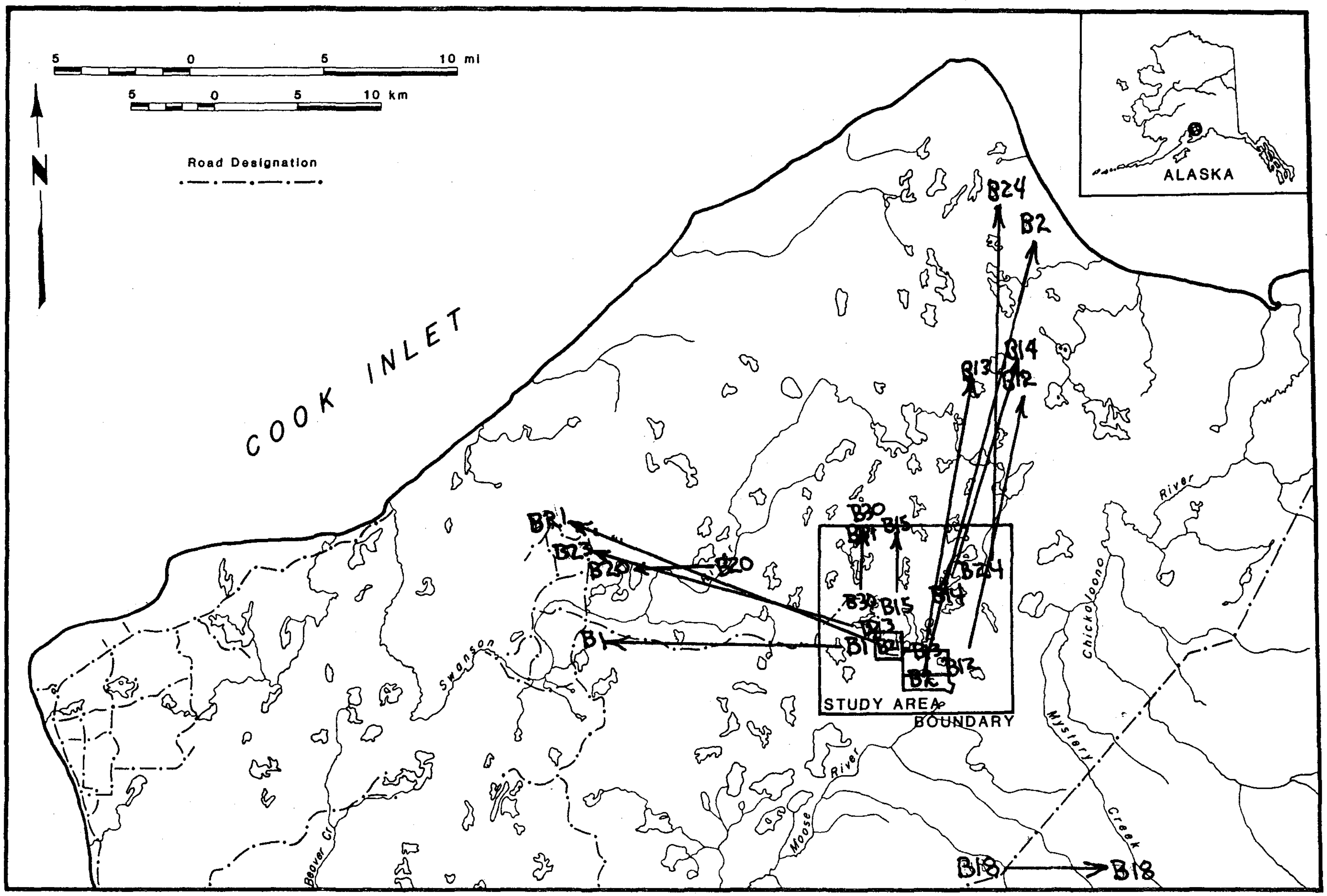

Fig. 31. Direction of movement and general location of summer feeding areas for resident female black bears in 1979.

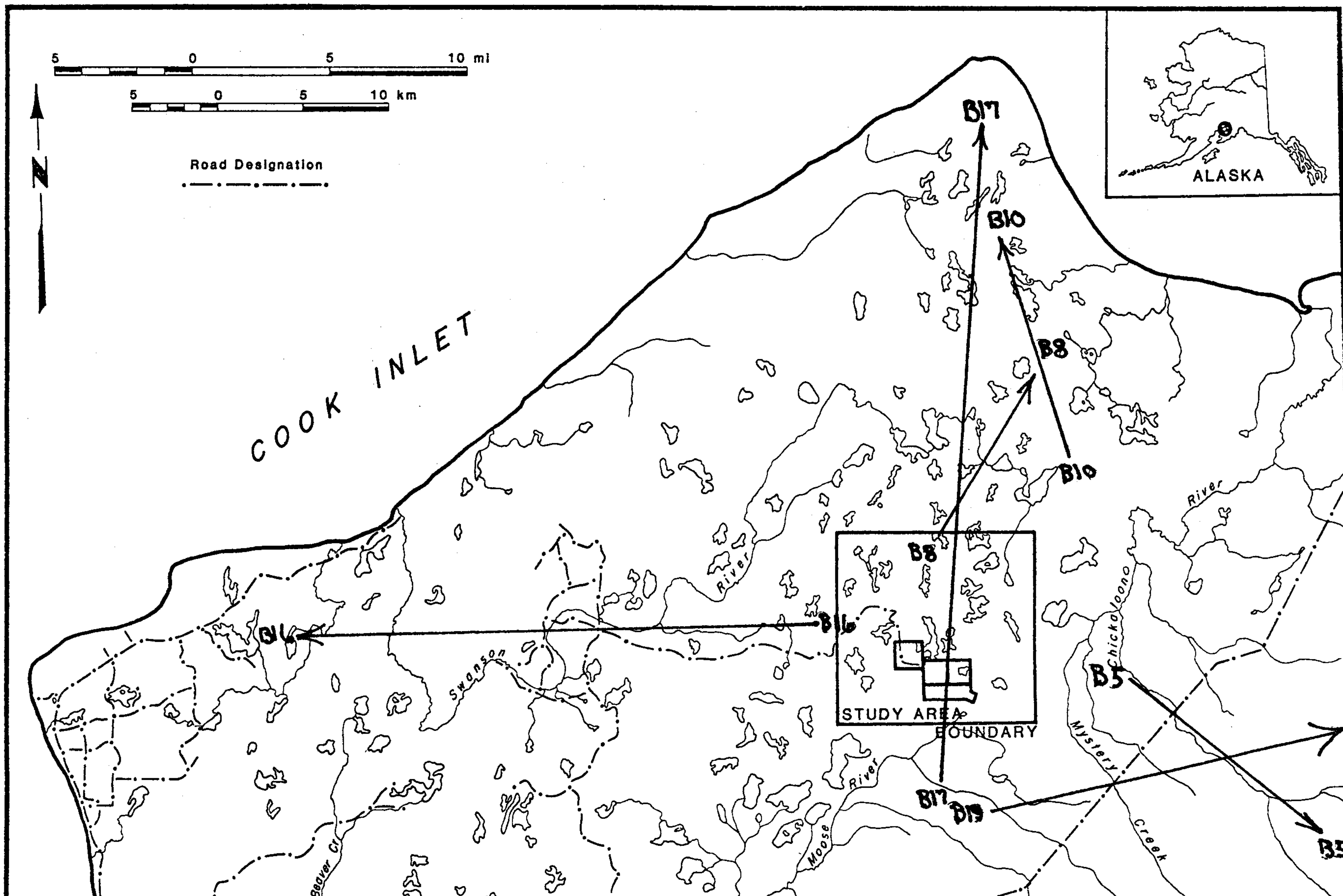

Fig. 32. Direction of movement and general location of summer feeding areas for resident male black bears in 1978.

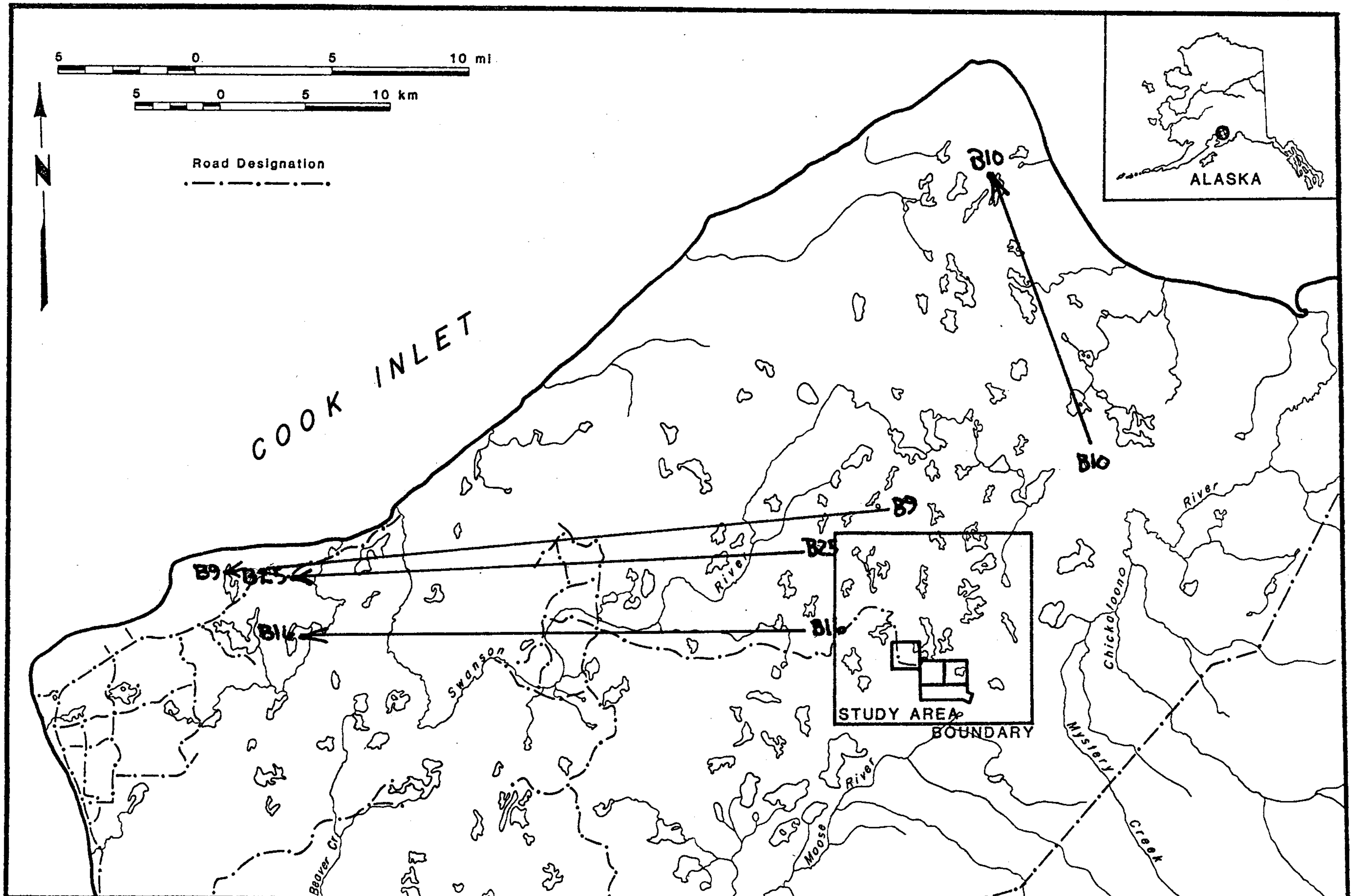

Fig. 33. Direction of movement and general location of summer feeding areas for resident male black bears in 1979.

Females with yearlings (n=3) occupied the largest area with total and subjective home ranges of 3077±1468 ha and 2763±1686 ha, respectively (Fig. 8). Movements after emergence from the den were generally greater than those for sows with small cubs, but were still centered around the den area. Two yearling females (B21, B23), radio-collared in the study area, remained with their sow (B1) until at least 19 June. They were not with her on 25 June when she was accompanied by a resident male. Their (B21, B23) movements and home ranges were within the area occupied by B1. They also moved to their late summer feeding area in late July. It is interesting to note that they followed the same route used with the sow the previous year as cubs. They even went to the same area.

Immature females (age 2-3 years) (n=9) occupied an average total home range of 2217±1156 ha with a subjective home range of 2166±1131 ha (Figs. 9, 11, 13, 15, 16, 17, 19). Early spring activity was centered around the winter den and their movements were generally similar to those of females with yearlings.

Average home range size (Table 8) for adult male black bears was significantly (<0.05) larger than that for females (127.4±50.6 km^2). Because males covered such a large area and the distances between location points were great, subjective and total home ranges are the same (Figs. 20-29). Like females, males did not defend a specific territory, and considerable overlap of home ranges occurred.

During both years of study all resident bears left the study area during late summer (Aug.-Oct.) and traveled some distance to "summer feeding areas." These areas were generally located to the north or west of the MRC (Figs. 30-33). Females traveled shorter distances than males, but all bears selected vegetation types that were mature to over mature forest with a thick understory of devils club (*Oplopanax horridus*) and other berry producing plants. Bears that were radio-tracked in 1978 and 1979 appeared to use the same "route" between their home ranges and summer feed areas and, in general, used the same areas each year.

Timing of their return from summer feeding areas to the study area appeared contingent on the production and abundance of lowbush cranberries (Vaccinium vitis-idaea) within the study area in the fall. Prior to trapping in 1977, a bumper crop year for cranberries, bear sign was very common around the MRC in September. In 1978, a poor year for cranberries, radio-collared bears did not return to the study area until mid-October, just prior to denning. Bear sign around the MRC was lacking in fall 1978. In 1979, a year of average berry production, radio-collared bears returned to the study area in early September and fed on cranberries until denning in late October.

Table 8. Home range size and age of 10 male black bears in the Moose Research Center study area, 1978 and 1979.

Bear number	Year	Age	Home range size (km^2)
B3	1978	3	141.7
B5	1978	4	227.8
B8	1978	10	76.3
B9	1979	5	86.5
B10	1978	9	171.1
B10	1979	10	114.9
B16	1978	7	69.5
B16	1979	8	88.8
B19	1979	3	130.3
B25	1979	5	116.7

Because centers of activity have not been calculated for home range and summer feeding areas, exact linear distances between the two have not been calculated for this report. A computer program (Schoen 1979) is being modified to calculate this and other variables.

Bear Movements in Moose River Flats and LeTorneau Crushed Areas

Bear movement data from 1978 and 1979 indicated bears residing in the MRC study area did not make long distance moves out of their home range area into the Moose River flats calving area. It was originally suspected that black bears may exhibit this form of behavior because of the high incidence of moose calf predation (Franzmann and Schwartz 1979) by black bears. It appears that only bears which typically use the calving flats as part of their home range are present there in the spring. Radio-collared male B10, whose home range extended over a large part of the calving flats (Figs. 24 and 25), visited the area several times during spring 1978 and 1979. B10 was originally radio-collared on the Moose River flats. Male B5, which was radio-collared west of the calving flats (Fig. 21), also visited the calving flats frequently during spring 1978. Female B18, first radio-collared during spring 1978 as a 3-year-old, was frequently seen in the open bog areas around Bear Lake, which is part of the moose calving area. In 1979 she had 2 new calves and did not visit this open water, but remained in the upland forest south of the Bear Lake area.

Our bear movements data indicated that black bears avoided those areas rehabilitated for moose with LeTorneau tree crushers. Of the 23 black bears radio-collared in 1978 and 1979, 15 had home ranges which included or bordered one or more of the crushed areas (Figs. 34 and 35). However, observations of these bears indicated lack of utilization and/or avoidance of crushed areas. During the 1978 and 1979 field seasons, these 15 bears were relocated a total of 574 times. During this period, collared bears were seen in crushed areas only eight times. In six of these eight observations, the radio-collared bears were in uncrushed stands of forest within rehabilitated areas. All eight sightings were either of one sow (B1) and her two cubs (B21, B23) or B21 as a yearling the following year. The area utilized by B1 was the uncrushed forest in the center of the Willow Lake area "doughnut." She went to this area once each year when traveling from her traditional home range to her summer feeding area. Her yearling B21 also went to the "doughnut" when returning from her summer feeding area in 1979. Her movements, home range, and summer feeding area were included in the area used by her mother (B1). As a yearling B21 also utilized strips of uncrushed regrowth spruce in the MRC crushed area shortly after separation from B1 in 1979. Observations of this bear from a Piper PA-18

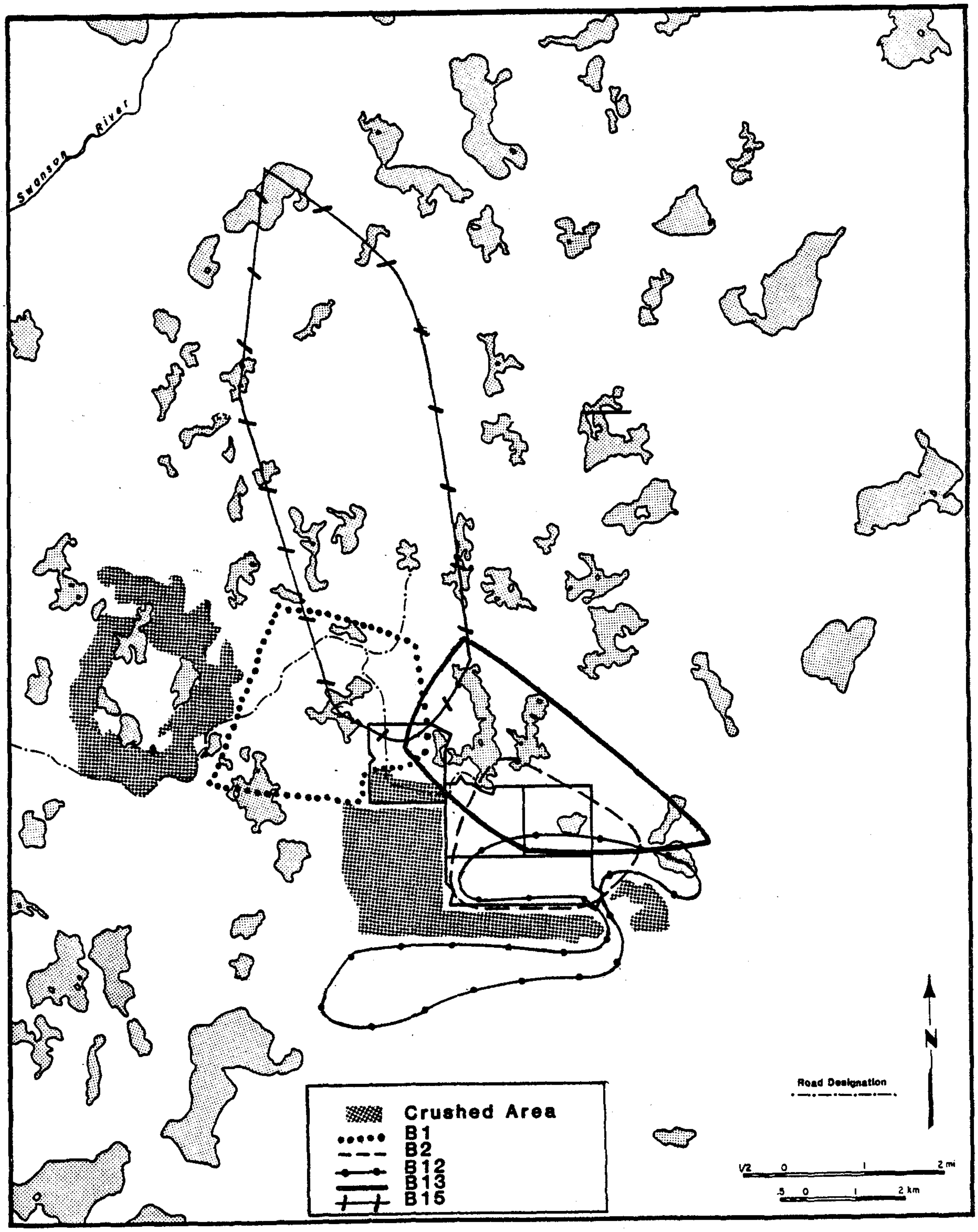

Fig. 34. Movements and home range location of female black bears in relation to LeTorneau tree crushed areas, Kenai Peninsula, Alaska.

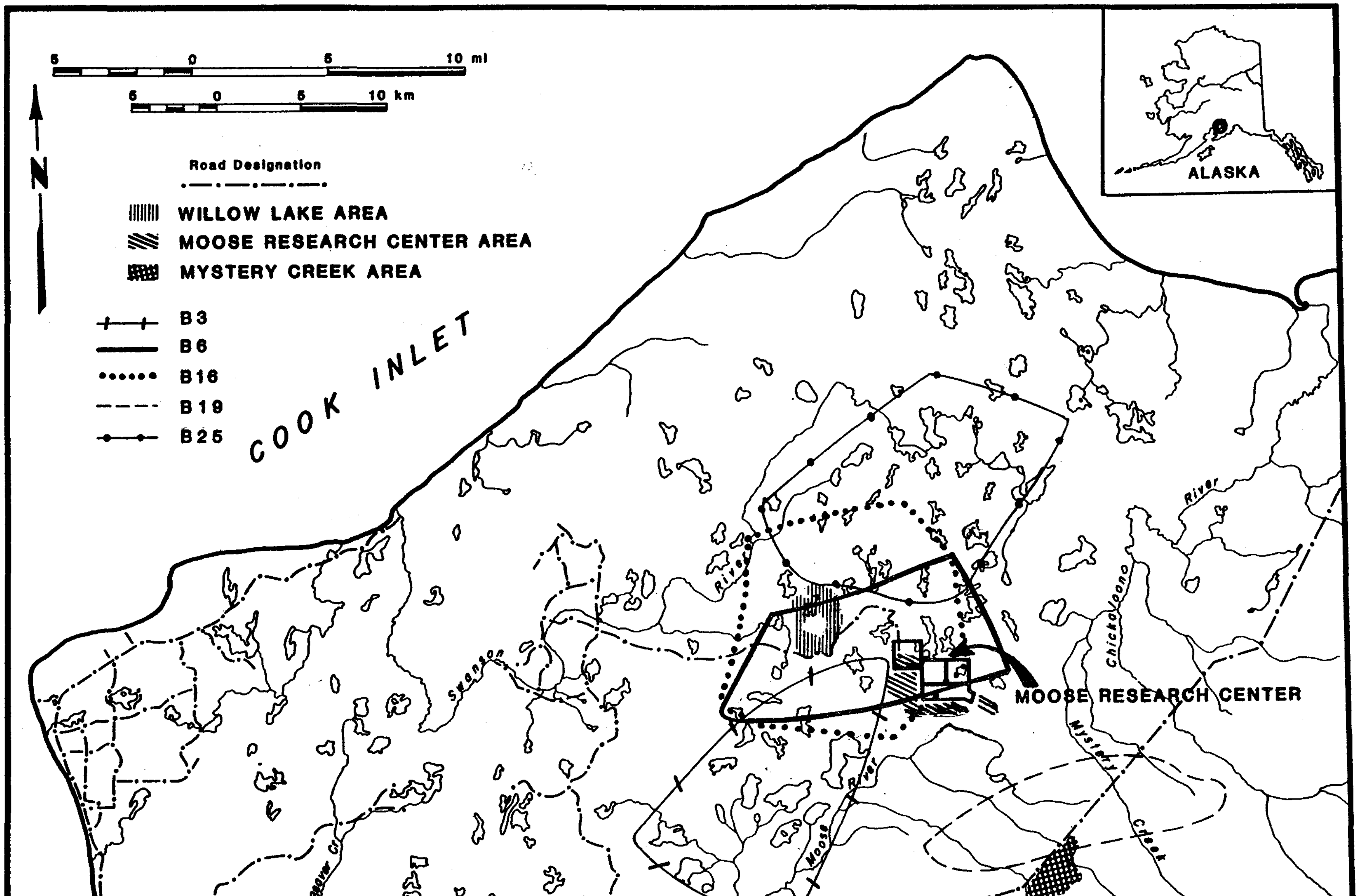

Fig. 35. Movements and home range locations of male black bears in relation to LeTorneau tree crushed areas, Kenai Peninsula, Alaska.

Super Cub indicated she was uneasy when traveling in the crushed area and ran between the uncrushed strips. Once in the forest, she resumed a "normal" foraging movement pattern, walking and searching for insects, tearing apart rotten logs and feeding on available vegetation.

Another female which was intensively studied (B12) used areas both to the north and south of the MRC crushed area, but was never seen in a crushed area during 2 years of study. Her movements indicated that she probably used a strip of uncrushed spruce to travel through the crushed area. Likewise, home ranges of females B2 and B13 bordered the MRC crushed areas. These bears were never seen in or on the opposite side of the rehabilitated area indicating that the crushed vegetation may have created a "natural" geographic boundary.

Movements of adult males B5, B6, B8, B16, and B25 and juvenile male B3 also bordered or encircled the MRC and/or Willow Lake crushed areas (Fig. 35). These individuals were never seen in a crushed area.

Although the Mystery Creek rehabilitation area was not in the study area proper, three radio-collared bears utilized the uncrushed forest around this area. Female B18, and males B19 and B17, like other bears studied, avoided the crushed area.

In addition, 128 sightings of uncollared black bears were made during routine tracking flights over the study area. Only one of these used by her mother (B1). As a yearling B21 also utilized strips of uncrushed regrowth spruce in the MRC crushed area shortly after separation from B1 in 1979. Observations of this bear from a Piper PA-18
Super Cub indicated she was uneasy when traveling in the crushed area and ran between the uncrushed strips. Once in the forest, she resumed a "normal" foraging movement pattern, walking and searching for insects, tearing apart rotten logs and feeding on available vegetation.

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Although the Mystery Creek rehabilitation area was not in the study area proper, three radio-collared bears utilized the uncrushed forest around this area. Female B18, and males B19 and B17, like other bears studied, avoided the crushed area.

In addition, 128 sightings of uncollared black bears were made during routine tracking flights over the study area. Only one of these sightings was of a black bear in a crushed area, even though the sightability of black bears in a rehabilitated area was greater than in the forested areas. The black bear seen was in the Willow Lake crushed area and was observed for over 30 minutes while traveling across the area. The following excerpt from our field notes describes that event.

> 9 June 1978, medium-size black bear (150 lbs.) observed moving at a walk in an uncrushed strip southeast of Duckling Lake. Bear approached radio-collared calf 1855 which ran with cow out of uncrushed strip into crushed area. The black bear ran after them, but turned and fled when the cow moose turned and charged the bear. The bear then ran several hundred meters across the rehabilitated area and entered another uncrushed strip of regrowth spruce. The bear walked 50 or so meters in this strip where it encountered a cow moose with a calf. The cow and calf fled at a run (calf in front of cow) from the uncrushed strip and ran 300 meters before stopping. The bear pursued them for 1015 meters and then returned to the uncrushed strip and resumed its travel in an ENE direction until it came to the end of the uncrushed strip. The bear then ran for 100 meters until it again came to a patch of uncrushed forest where it slowed to a walk and began tearing apart a log. After feeding, the bear walked to the edge of the uncrushed forest and ran the remaining distance of 100 meters to the edge of the crushed area. Once in the forest, it resumed its walking pace down to a small lake where it took a long drink and then swam across the lake.

Shortly after this we lost sight of the bear in dense birch regrowth. Throughout this extended observation, the bear appeared to be "uncomfortable" when not in the forested strips. We do not feel this was a result of our presence in the aircraft overhead because the bear displayed "normal" behavior traits when it was in the uncrushed strips.

A copy of a manuscript presented and submitted for publication at the 5th International Conference on Bear Research and Management, discussing bears, LeTorneau tree crushing and moose calf mortality appears as Appendix II.

Population Density, Age Structure, and Reproductive Success

Although density estimates are only tentative at this time, it appears that there was approximately one bear per 430.5 ha (1.6 mi^2) within the study area. This density estimate was obtained by counting all: (1) resident radio-collared females and their cubs, (2) resident radio-collared juvenile females (ages 1 to 3 years), (3) four juvenile males (bears trapped within the study area), (4) three adult males, and (5) two unmarked adult females with 3.5 hypothetical cubs/yearlings.

Telemetry data indicated that five adult females used the MRC study area exclusively during 1979 (Figs. 36 and 37). In addition to these five, two unmarked adult females, each with two cubs, were sighted in the study area. Since these sightings could have been the same individual, they were considered as one female with two cubs for density calculations. Although the home range for this sow was unknown, she was sighted well within the study area at a time (June) when radio-collared females with new cubs were using the area around their winter den sites. An additional adult female with 1.5 cubs was also included in these estimates because home range data for female bears (Fig. 37) indicated that the southwest quarter of the study area was not used by the resident radio-collared females suggesting that another female should be present. The habitat in this area is similar to the rest of the study area.

Six radio-collared subadult females (age 1-3) were also present within the study area when density estimates were prepared. Female B15 was assigned a value of 0.67 rather than counted as 1.0 bears because 0.33 percent of her home range was outside of the MRC study area. In addition, 1.75 yearlings were assigned to B24, an adult female captured in June. At that time she was not accompanied by cubs or yearling, but was in estrus. Since she was an adult (7-8 yrs.) we assumed she produced cubs in 1977 and had separated from them as yearlings just prior to capture. The figure 1.75 was the mean number of cubs produced per female within the study area. Our estimates of cub survival to yearlings at this time were too poor to be credible so we assumed 100 percent survival.

Four juvenile males (ages 2-4 years) were also included in our estimates. These bears were captured within the study area in June, a period that Rogers (1977) used to estimate density because it occurred before dispersal of juvenile males.

Finally, we considered three adult males as being residents of the study area. Although these three adult males used areas outside the study area, they were counted as "entire" bears because we felt there were more large males using the study area than we had radio-collared.

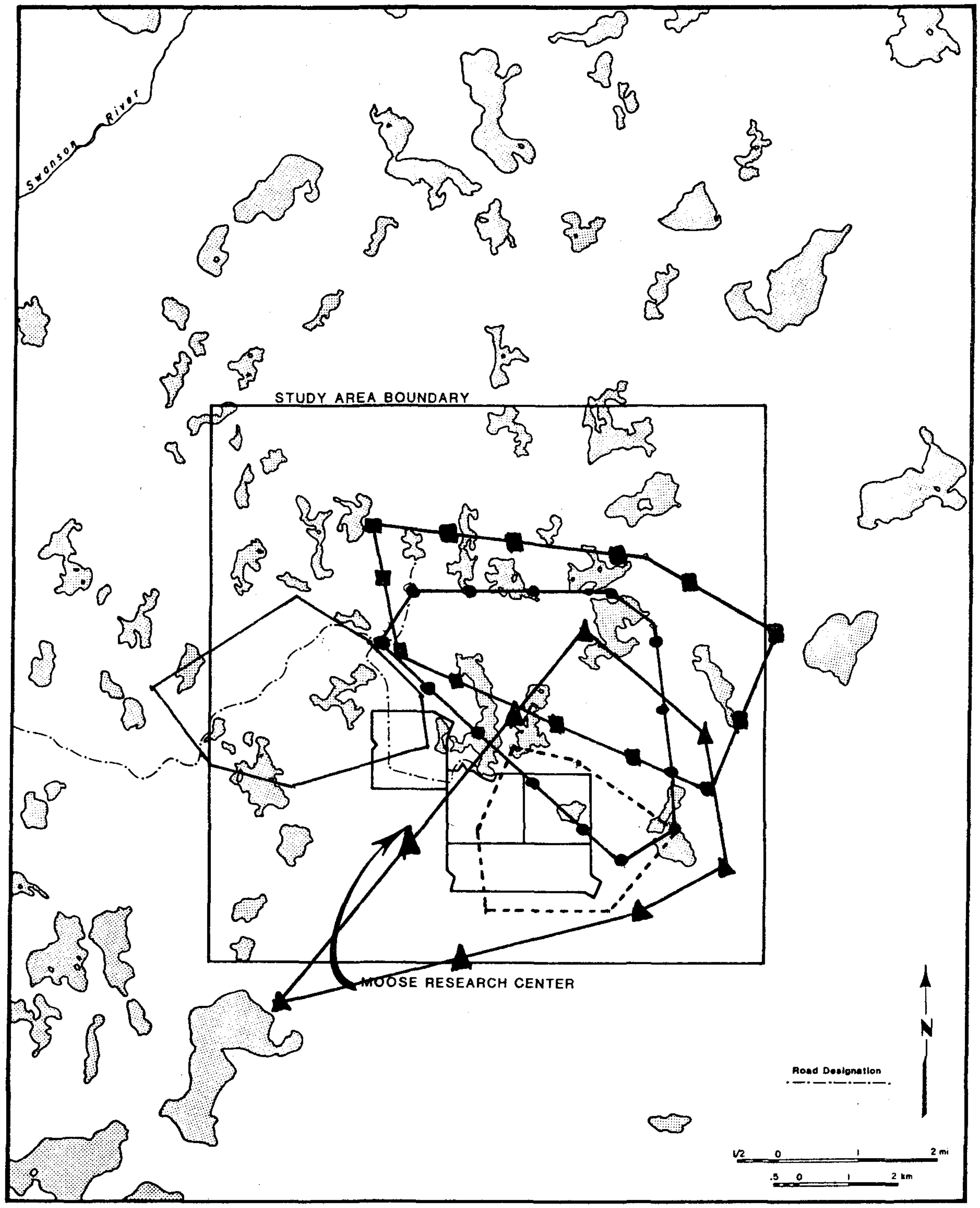

Fig. 36. Composite of home ranges for radio-collared female black bears at the MRC Study Area, Kenai Peninsula, Alaska, 1978.

B1 ——
B2 -----
B12 ▲—▲
B13 ●—●
B14 ■—■

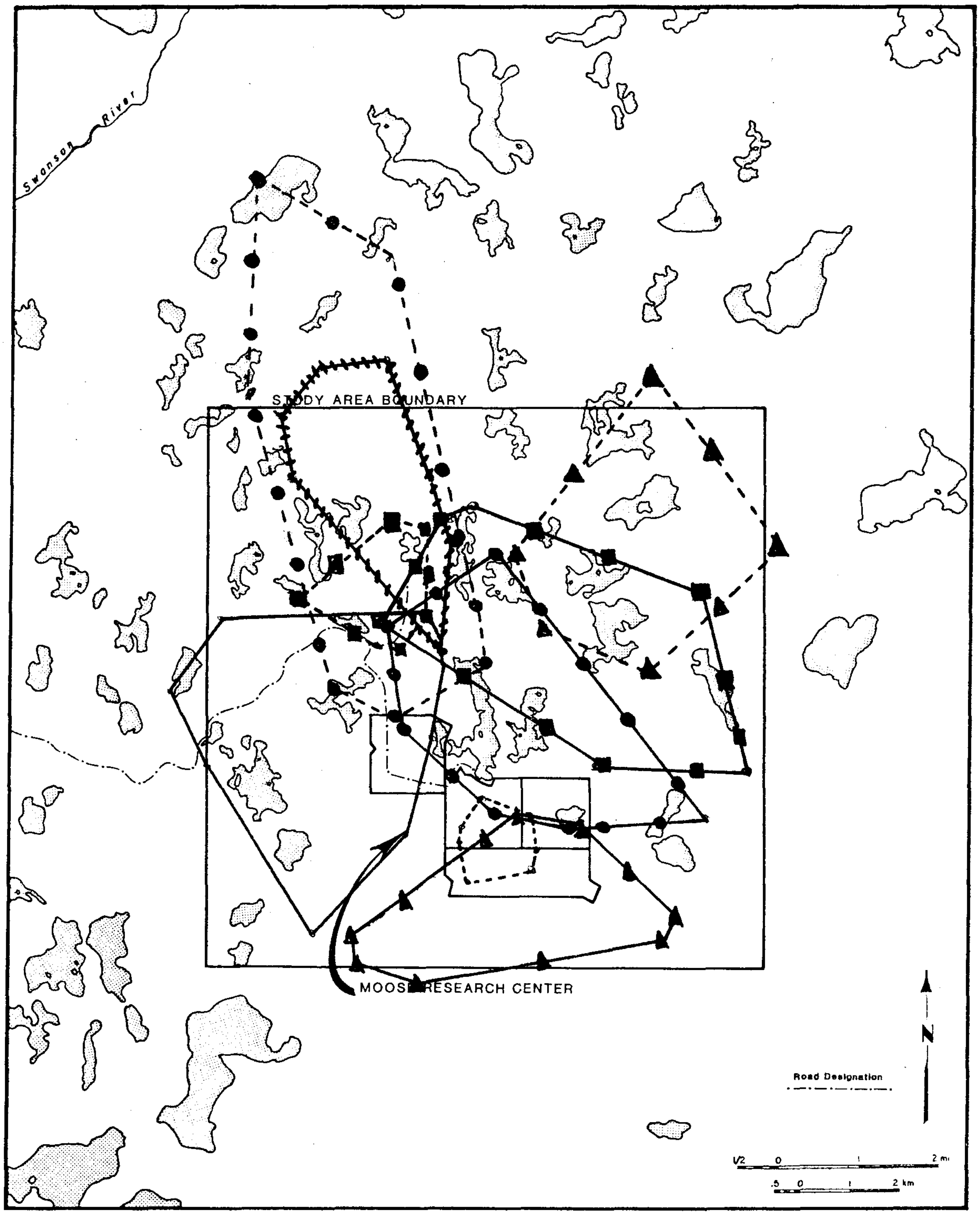

Fig. 37. Composite of home ranges for radio-collared female black bears at the MRC Study Area, Kenai Peninsula, Alaska, 1979.

B1 ——— B13 ●—●
B2 ------ B14 ■—■
B12 ▲—▲ B15 ●---●
B24 ▲---▲ B30 ■---■
B31 +++++

As indicated earlier, these figures and estimates should be considered preliminary in nature and are expected to change as our study progresses. Hopefully in 1980 we can capture and radio the remaining resident bears not radio-collared in 1978 and 1979. Density estimates were probably minimal since we made no attempt to account for those bears with home ranges located primarily outside the study area, but which used it part of the time.

Age and sex data (Table 3) are presented for resident bears of the MRC study area. Since these data are preliminary in nature and represent only a segment of the total study area population, no discussion of results is presented at this time.

Reproductive information from four marked sows indicated an average of 1.75 cubs per female surviving at the time of den emergence. All of these cubs (7) survived the summer and entered dens in the fall. Two of these cubs (B21, B23) born to B1 in 1978 also survived the summer season in 1979 and denned. Although our sample is still quite small it appeared that cub and yearling survival was quite high within the study area. Similar trends appeared for unmarked sows accompanied by cubs and yearlings.

Brown Bear Findings

During 1978 two adult male and two adult female brown bears were radio-collared. Movements of these bears were monitored until their radios failed. Results indicated that these bears made extensive movements, they were very difficult to keep track of and, consequently, few data were obtained.

We sighted few unmarked brown bears during routine flights both in 1978 (n=4) and 1979 (n=1), respectively. This compared with 66 and 67 sightings of black bears in 1978 and 1979, respectively. These data indicate that brown bears were more difficult to see, or were less abundant in and around the study area. We feel they represented low brown bear density because there were no apparent reasons why brown bears should have been less visible from the aircraft.

Brown bear movements indicated that the bears appeared to use the Kenai Peninsula lowlands during the early part of the year (post-denning to mid-June) to feed on winter-killed moose and new moose calves or adults that could be killed. Later in the year, brown bears moved southeast toward the Kenai Mountains along streams occupied by spawning salmon (*Oncorhynchus* sp.). However, since our data are so sparse we can only speculate on the significance of these moments.

Physiological and morphometric data for the four brown bears plus results of blood analyses (Table 9) are presented for use in comparative studies of brown bears collected in other areas. No assessment was attempted since the total sample size was so small.

Table 9. Physiologic and morphometric data from 4 Kenai Peninsula brown bears, collected during May and June 1978.

Parameter Measured		Bear Number Age and Sex			
		A-1 12 yr. M	A-2 7 yr. F	A-3 unk. M	A-4 3 yr. F
Glucose	mg/dl	83	89	111	174
Cholesterol	mg/dl	233	162	273	284
LDH	U/L	528	523	601	601
SGOT	U/L	103	193	251	251
Alkaline Phosphatase	U/L	28	80	45	75
Calcium	mg/dl	5.8	2.9	3.4	3.6
Phosphorus	mg/dl	9.1	8.7	8.8	8.9
Ca/P	ratio	1.57	3.00	2.59	2.47
BUN	mg/dl	30	20	41	19
Bilirubin	mg/dl	0.2	0.2	0.2	0.1
Uric Acid	mg/dl	2.5	3.4	3.2	2.4
Total Protein	g/dl	8.1	7.1	8.5	8.4
Albumin	g/dl	4.9	4.8	5.5	5.6
Globulin	g/dl	3.2	2.3	3.0	2.8
Alpha 1 globulin	g/dl	0.5	0.3	0.4	0.3
Alpha 2 globulin	g/dl	0.7	0.6	0.6	0.8
Beta globulin	g/dl	1.2	1.0	1.0	0.8
Gamma globulin	g/dl	0.9	0.5	1.0	0.9
A/G	ratio	1.50	2.00	1.90	2.00
Hemoglobin	g/dl	20.0	17.5	18.0	20.1
PCV	%	56	46	39	52
MCHC	%	35.7	38.0	46.2	38.7
Total length	cm	228	194	222	176
Hind foot	cm	27	22	30	24
Shoulder height	cm	130	118	140	111
Chest girth	cm		128	150	114
Neck circumference	cm	98	77	97	72
Skull length	cm	46.0	35.0	39.5	35.5
Skull width	cm	30.5	22.0	26.0	19.5
Upper canine length	cm	4.9	3.2	3.8	3.0
Lower canine length	cm	3.5	2.9	3.5	2.9
Hock to pad length	cm	27.0	22.0	30.0	24.0
Foot width	cm	17.0	16.0	19.0	15.0
Weight	kg	317.0	170.0	294.8	158.8

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Appendix I. 1979 field data form.

BEAR TAGGING DATA
MOOSE RESEARCH CENTER

Bear No. ______ Type ______ Date ______ Sex ______

Estimated Age ______ Cem. Age ______ Collectors ______

Location ______ Method of Take ______

Drug Data

Drug	Amount	Hit Time	Down Time	Comments

Measurements: Weight ______ T.L. ______ Ht. Sh. ______ HF ______ L ______ W
Nech ______

Girth ______ Head: Width ______ Length ______

Upper Canine R L Length ______ L-L ______ A-P ______

Lower Canine R L Length ______ L-L ______ A-P ______

Specimens Collected: Tooth Location ______ Blood vol. ______ PCV ______ HB ______

Hair ______ Feces ______ Milk ______ Urine ______

Productivity: Female with young: Yes ____ No ____ (If yes, age and no. of cubs) ______

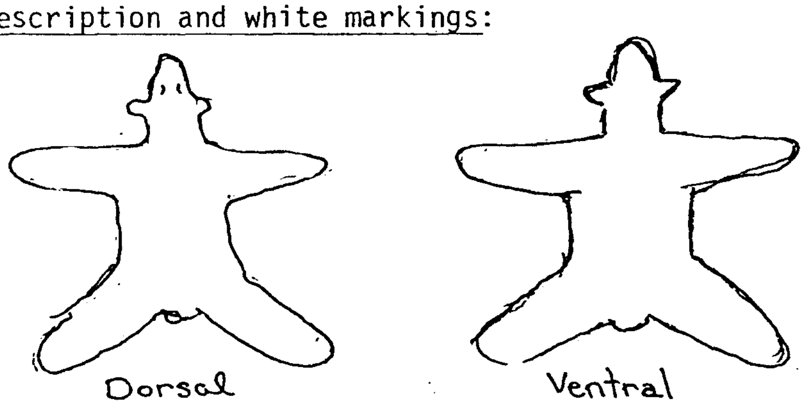
Mammae: Length ______ Width ______ Color ______ Vulva Length ______ Male: Testes Descended: Yes ___ No ___ Length ______ Baculum Length ______

Tagging Data: Ear tags: Left No. ______ Right No. ______ Color ______

Collar: Type ______ Color ______ Freq. ______ Setting ______

Tattoo: No. ______

Coat description and white markings:



Comments:

Appendix II. Paper presented at 6th International Conference on Bears, Their Biology and Management, February 13, 1980.

EFFECTS OF HABITAT MANIPULATION ON BLACK BEAR PREDATION OF MOOSE CALVES[1/]

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Abstract: Neonatal moose calf (*Alces alces*) mortality was evaluated on the Kenai Peninsula, Alaska during spring and early summer 1977 and 1978. Studies were conducted both inside and outside of a 461 ha browse rehabilitated area (Willow Lake) where standing vegetation was crushed with LeTourneau tree crushers. Uncrushed areas (control) were regrowth vegetation that was burned by forest fire in 1947. Moose calves were radio-collared with mortality sensor transmitters soon after birth. Black bear (*Ursus americanus*) predation accounted for 42 percent of the calf mortality in control areas while no calves were killed by black bears within the rehabilitated areas. Movements of 23 radio-collared black bears were also monitored during 1978 and 1979. Five of the 23 radio-collared black bears were associated with moose calf predation. Movements of radio-collared bears, whose home range bordered or included rehabilitated areas, indicated that black bears did not utilize and/or avoided rehabilitated areas. Results of our studies indicated that neonatal moose calf mortality was significantly reduced within browse rehabilitated areas.

1/ This work was supported in part by Federal Aid in Wildlife Restoration Project W-17-R.

Moose habitat enhancement efforts commonly stress abundance, production, and diversity of large woody shrubs. These factors are emphasized because browse is the only food available to moose in winter over much of their range and winter range is classically considered a limiting factor for moose populations.

Various types of browse rehabilitation programs to increase moose foods have been utilized on the Kenai National Moose Range (KNMR) since the 1950's. Starting in 1975, LeTourneau tree crushers (Oldemeyer 1977, Oldemeyer et.al. 1978) have been used to enhance moose browse, by mechanically crushing existing vegetation and stimulating browse regeneration. Although increased browse production was the primary objective of this program, additional benefits to the moose population by reducing black bear predation of moose calves may have resulted.

Neonatal mortality of moose calves recently has been identified as an important factor affecting population dynamics of moose on the Kenai Peninsula, Alaska (Franzmann et. al 1980, Chatelain 1950). Although three major species, timber wolves (*Canis lupus*), brown bear (*Ursus arctos*) and black bear, prey on moose, black bear's predation accounted for 34 percent of total calf mortality (58%) during two summers of study (Franzmann et al. 1980).

This report compares black bear predation rates of moose calves in areas crushed by LeTourneau tree crushers with rates in adjacent uncrushed areas. Movements of 14 radio-collared black bears whose home ranges were adjacent to or included rehabilitation areas are discussed in relation to the results of the moose calf mortality study.

This study was a cooperative effort between the Kenai Moose Research Center of the Alaska Department of Fish and Game, and the KNMR, U.S. Fish and Wildlife Service. V. Lofsted, L. Aumiller and D.C. Johnson, provided field assistance and K.B. Schneider and D.E. McKnight reviewed and improved the manuscript.

STUDY AREA AND METHODS

The Moose Research Center (MRC) study area is located on the KNMR in the northwestern Kenai Peninsula lowlands. Detailed descriptions of the study area were presented by Oldemeyer et al. (1977) and LeResche and Davis (1973). Three areas enhanced for moose with LeTourneau tree crushers were; (1) Willow Lake Rehabilitated area, (2) south MRC area, (3) Mystery Creek rehabilitated area. Control and crushed areas were located within the extensive 1947 Kenai, Alaska burn. A detailed description of the burn and the vegetation typed 25 years after the fire appear in LeResche et al. (1973).

Vegetation in Willow Lake area prior to crushing was mixed stands of white spruce (*Picea glauca*), aspen (*Populus tremuloides*), and paper birch (*Betula papyrifera*). Topography of the area was gently rolling to undulating with several small to medium (0.1-2.0 ha) lakes and bogs. During winter of 1974-75, 461 ha were crushed in the form of a "doughnut." The "doughnut-hole," which was not crushed, was approximately 182 ha in extent and was predominately 1947 burn regrowth (112 ha) and mature birch-aspen forest (70 ha).

Prior to crushing vegetation in the south MRC area was predominately black spruce (Picea mariana) and aspen regrowth with small stands of mature birch-aspen forest. Topography of the area ranged from relatively level in the broad lowlands to gently rolling in the uplands. During winter of 1975-76 approximately 584 ha were rehabilitated. The pattern of crushing in this area consisted of alternating crushed and uncrushed strips interspersed with uncrushed mature forests.

The Mystery Creek area was dominated by black spruce and aspen regrowth prior to crushing. It is a drier site than the other crushed areas and is relatively level. During the winters of 1976-77 and 1977-78 945 and 910 ha respectively, were crushed. The pattern of crushing was in large blocks separated by narrow strips of uncrushed regrowth or mature forest.

Procedures used to study moose calf mortality were those described by Franzmann et al. (1980) and Franzmann and Schwartz (1979). Ballard et al. (1980) presented techniques utilized to determine causes of moose calf mortality. Briefly, calves were fitted with radio collars which transmitted a pulse of 60 beats/minute as long as the calf moved. When movement ceased for 1 hour or more, the pulse rate trippled (fast or mortality mode). Upon detecting a fast mode, we located the calf and determined the cause of death.

During 1977, 15 radio-collared calves remained bonded with their cows. All of these were captured in regrowth of the 1947 burn. In 1978, we expanded our study and radio-collared calves in the 1947 burn and in the Willow Lake crushed area. Of 32 calves which remained bonded with their cows in 1978, 8 were radio-collared within the crushed area and 24 were in regrowth vegetation outside of the rehabilitation area.

While radio-collaring calves in 1978, we also radio-collared all black (n=16) and brown bears (Ursus arctos) (n=4) we found within the study area (Franzmann and Schwartz 1978). Movements and home range of individual bears were deliniated and activities and utilization of crushed areas noted. Details of methods were listed in Schwartz and Franzmann (1980).

RESULTS AND DISCUSSION

In 1977, 9 of the 15 bonded calves (67%) were killed by predators prior to 13 July. Of these 9, 6 (40%) were killed by black bears (Table 1). During a similar period in 1978, 14 or 32 bonded calves (44%) were killed by predators by 30 July. Black bears killed 10 (31%) of the 14 calves. When 1978 data were partitioned into moose utilizing crushed versus uncrushed areas, different trends in mortality were evident. Of 8 calves collared at the Willow Lake crushed area, none was killed by black bears while 10 of 24 (42%) were killed by black bears outside the rehabilitation area (Table 1). When the calves collared at Willow Lake were factored out, mortality rates between 1977 and 1978 were identical. Although our sample of calves collared at Willow Lake was not large (n=8), we feel the differences in mortality rates of moose calves reflected differences in predation rates between the two areas. These findings were further supported by observations of radio-collared black bears.

Table 1. Comparison between predation rates of moose calves radio-collared in a 1947 burn and an area rehabilitated by LeTourneau tree crushers (Willow Lake).

	1947 Burn (uncrushed)		Willow Lake (crushed)
Year	1977	1978	1978
	Number (%)		
Black bear	6[1] (40.0)	10 (41.7)	0
Brown bear	1 (6.7)	2 (8.3)	0
Wolf	1 (6.7)	2 (8.3)	0
Unknown predator	1 (6.7)	0	0
Total calves Radio-collared	15	24	8

1 Six of 15 radio-collared calves (40%) were killed by black bears.

Of the 23 black bears radio-collared in 1978 and 1979, 15 had home ranges which included or bordered one or more of the crushed areas However, observations of these bears indicated lack of utilization and/or avoidance of crushed areas. During the 1978 and 1979 field seasons, these 15 bears were located a total of 574 times. During this period, collared bears were seen in crushed areas only 8 times. In 6 of these 8 observations, the radio-collared bears were in uncrushed stands of forest within rehabilitated areas. All 8 sightings were either of one sow (B1) and her 2 cubs (B21, B23) or B21 as a yearling the following year. The area utilized by B1 was the uncrushed forest in the center of the Willow Lake area (doughnut-hole). She went to this area once each year when traveling from her traditional home range to her summer feeding area (Schwartz and Franzmann 1980). Her yearling B21 also went to the "doughnut-hole" when returning from her summer feeding area in 1979. Her movements, home range, and summer feeding area were included in the area used by her mother (B1). As a yearling, B21 also utilized strips of uncrushed regrowth spruce in the MRC crushed area shortly after separation from B1 in 1979. Observations of this bear from a PA-18 Super Cub indicated she was uneasy when traveling in the crushed area and ran between the uncrushed strips. Once in the forest, she resumed a "normal" foraging pattern of movement. That is, walking and searching for insects, tearing apart rotten logs and feeding on available vegetation.

Another female which was intensively studied (B12), used areas both to the north and south of the MRC crushed area, but was never sighted in a crushed area during 2 years of study. Her movements indicated that she probably used a strip of uncrushed spruce to travel through the crushed area. Likewise, home ranges of females B2, and B13 bordered the MRC crushed areas. These bears were never seen in or on the opposite side of the rehabilitated area indicating that the crushed vegetation may have created a "natural" geographic boundary.

Likewise, movements of adult males B5, B6, B8, B16, and B25 and juvenile male B3 also bordered or encircled the MRC and/or Willow Lake crushed areas. These individuals were never seen in a crushed area.

Although the Mystery Creek rehabilitation area was not in the study area proper, 3 radio-collared bears utilized the uncrushed forest around this area. Female B18, and males B19 and B17 like other bears studied avoided the crushed areas.

In addition, 128 sightings of uncollared black bears were made during routine tracking flights over the study area. Only one of these sightings was of a black bear in a crushed area, even though the sightability of black bears in a rehabilitated area was greater than in the forested areas. The black bear seen was in the Willow Lake crushed area and was observed for over 30 minutes while traveling across the area. The following excerpt from our field notes describes that event.

> 9 June 1978, medium size black bear (150 lbs.) observed moving at a walk in an uncrushed strip southeast of Duckling Lake. Bear approached radio-collared calf 1855 which ran with cow out of uncrushed strip into

crushed area. The black bear ran after them, but turned and fled when the cow moose turned and charged the bear. The bear then ran several hundred meters across the rehabilitated area and entered another uncrushed strip of regrowth spruce. The bear walked 50 or so meters in this strip where it encountered a cow moose with a calf. The cow and calf fled at a run (calf in front of cow) from the uncrushed strip and ran 300 meters before stopping. The bear pursued them for 10-15 meters and then returned to the uncrushed strip and resumed its travel in an ENE direction until it came to the end of the uncrushed strip. The bear then ran for 100 meters until it again came to a patch of uncrushed forest where it slowed to a walk and began tearing apart a log. After feeding, the bear walked to the edge of the uncrushed forest and ran the remaining distance of 100 meters to the edge of the crushed area. Once in the forest, it resumed its walking pace down to a small lake where it took a long drink and then swam across the lake.

We lost sight of the bear shortly after this in dense birch regrowth. Throughout this extended observation, the bear appeared to be "uncomfortable" when not in the forested strips. We do not feel this was a result of our presence in the aircraft overhead because the bear displayed "normal" behavior traits when it was in the uncrushed strips.

Mid-winter composition counts of moose conducted within the Willow Lake rehabilitated area indicated 28 calves/100 cows compared to 5 calves/100 cows in a nearby 1947 burn control count area (T. Bailey pers. comm.). These data are a mean for counts made in November and December 1978, and were made by intensively searching 2-mi^2 quadrats per area in November and 3-mi^2 quadrats per area in December. These data also indicated higher calf survival within the crushed habitats.

Our data suggest that moose calf predation is lower in crushed areas and that black bears either avoid or are "uneasy" when in crushed areas. Herrero (1972), in a review of the aspects of evolution and adaption of black bears, indicated that black bears were very reluctant to venture far from trees. Erickson (1965) noted that garbage dumps in Alaska, if located in open areas tended not to be visited by black bears, while those located close to or in forested areas were frequently utilized for feeding.

Throughout most of the area inhabited by black in Alaska, black and brown bears are sympatric. Relative densities of the two species vary, but on the Kenai Peninsula black bears are much more abundant (Schwartz and Franzmann 1980). Interspecific encounters between black bears and brown bears were observed twice during this study. In both cases, the black bear fled from the area when it detected the presence of the brown bear. Cahalane (1947) reported observations of brown bears treeing black bears. Grizzly bears were observed to prey on black bears in Montana (Jonkel 1962), although the converse situation has not been documented. Black bears also have been observed to leave dumps when grizzlies arrive (Finley and Finley 1940, Herrero 1972).

Reviews by Herrero (1972, 1978) indicated that the black bear evolved as a forest dwelling species and as such developed strategies suited to life in forested habitats. Black bears are excellent tree climbers and climb in response to potentially dangerous situations as a means of escape. Herrero felt that the significance of tree climbing in black bears was that it led to a position of relative safety. These "safety" trees were absent in crushed areas since all standing vegetation was mechanically destroyed. Black bears traveling in crushed areas would, therefore, be some distance from potential escape cover should a threatening situation occur. However, large male black bears do not use trees for this "safety-factor" yet they likewise did not utilize crushed areas. Also unexplained is why black bears frequently feed in alpine areas which are also devoid of trees.

Another major factor which proabably contributed to reduced mortality rates of moose calves in the crushed areas was the forage supply. Oldemeyer et al. (1978) found a greater quantity and diversity of woody species available to moose in the Willow Lake crushed area when compared to the 1947 burn. Cow moose utilizing the Willow Lake area, probably wintered in better condition and consequently produced more vigorus and healthy calves when compared to those in the 1947 burn. Thorne et al. (1976) found that survival of elk calves (Cervus elaphis) was directly related to the nutritional plane of the cow during gestation. Although studies were with captive animals not subject to predation, results demonstrated that calf mortality was related to weight loss of the cow during gestation, and calf weight at birth. Elk calves that weighed more than 16 kg at birth had a 90% chance of survival while those weighing less than 11.4 kg had less than a 50% chance of survival. Although crushed areas were not utilized as extensively as the forest by black bears, they were not bear-free. As noted earlier, black bears occasionally entered or crossed crushed habitats. Consequently, moose calves in crushed areas were subjected to predation attempts. Vigorous, healthy calves would be more likely able to out run or elude a black bear than a small unhealthy calf. Moose on a higher plane of nutrition would be expected to have higher calf survival.

It is logical that no single factor is solely responsible for the observed increase in moose calf survival within the crushed habitat. Changes induced by crushing the decadent over-story vegetation improved the habitat for moose by increasing the quantity of desirable browse species available and by increasing the diversity of woody browse. An additional benefit derived was the reduction of moose calf predation in those crushed areas due to the general avoidance of the areas by black bears. Whatever the determining factor benefitting moose may be, we concluded that LeTourneau tree crushing favored moose calf survival. Future application should consider crushing areas that may provide protective buffer to critical moose calving areas, as well as, for general improvement of moose habitat.

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