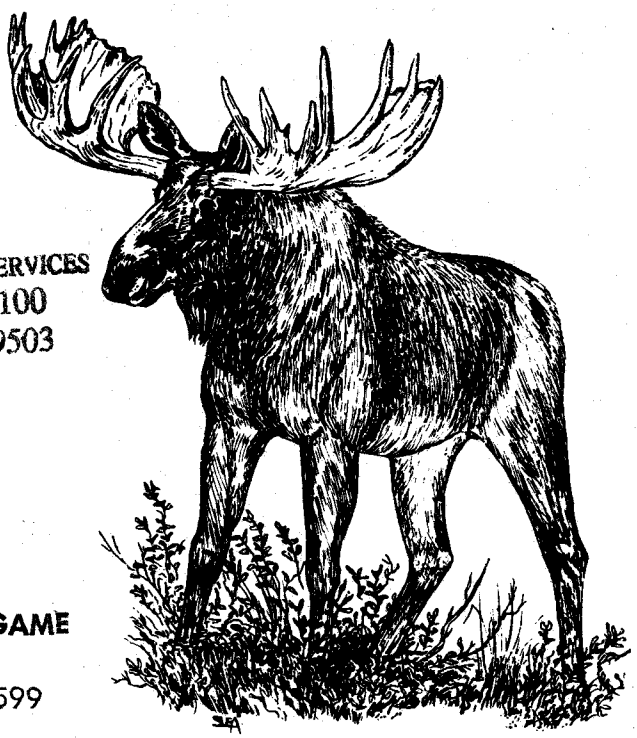
ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

UPPER SUSITNA VALLEY

MOOSE POPULATION STUDY



BY
Warren B. Ballard
and
Kenton P. Taylor

STATE OF ALASKA
Jay S. Hammond, Governor

DIVISION OF GAME
Ronald J. Somerville, Director
Donald E. McKnight, Research Chief

DEPARTMENT OF FISH AND GAME
Ronald O. Skoog, Commissioner

Final Report
Federal Aid in Wildlife Restoration
Projects W-17-9, W-17-10 and W-17-11, Job 1.20R
with Additional Support from the U.S. Corps of Engineers
(Through the U.S. Fish and Wildlife Service)
and the Alaska Power Authority

(Printed June 1980)

FINAL REPORT (RESEARCH)

State: Alaska

Cooperators: Warren B. Ballard, Kenton P. Taylor, Sterling H. Eide, Ted H. Spraker, and Albert Franzmann

Project Nos.: W-17-9, W-17-10 and W-17-11 Project Title: Big Game Investigations

Job No.: 1.20R Job Title: Upper Susitna Valley Moose Population Study

Period Covered: August 1, 1976 to June 30, 1979

SUMMARY

One hundred and nine adult cow moose were marked with individually identifiable collars (including 43 radio collars) in the upper Susitna River Basin during October 1976, March 1977, and August 1978. Physical measurements, blood and hair samples, and one incisor tooth for purposes of age determination, were taken from each moose. During spring tagging, 59 moose were rectally palpated to assess pregnancy and fifty-two (88%) were found to be pregnant.

Mean age of marked moose was approximately 7 years. Fifty-one percent of the moose sampled were between 5 and 11 years of age. Comparisons of selected blood parameters with those obtained from other Alaskan moose populations indicated that upper Susitna River moose were in relatively good condition.

During the reporting period 43 radio-collared moose were located 1190 times. Moose tagged in the eastern half of the study area exhibited extensive migratory movements while those in other areas were more sedentary. For sedentary moose, most movements were from higher elevations in summer to lower elevations in winter. Fall migration was initiated from late October to November and appeared to be somewhat correlated with the first heavy snowfall. Spring migration occurred gradually from mid-April through mid-July. Four populations of moose were identified. Home ranges and movements of individual moose were described.

Flights were made every 3 to 5 days in late spring and early summer 1977 and 1978 to monitor parturition and calf survival. Parturition was first observed on 24 May in 1977 and 1978 and on 18 May 1979. Parturition peaked between 29 May and 3 June during 1977 and 1978.

Numbers of calves produced by cows tagged in spring versus those tagged in fall were compared (between themselves and between years). Significant differences were found for those cows tagged in spring indicating that the use of succinylcholine chloride to immobilize moose in spring may cause decreased calf production.

The mortality patterns of calves of radio-collared adults were compared with those of radio-collared calves; and losses between the two groups were found to be similar, suggesting the causes of mortality were also similar. Neonatal moose calf survival appears to be limited by brown bear predation.

Some potential impacts of the Susitna Hydroelectric Project on moose were assessed and additional study needs were identified.

CONTENTS

BACKGROUND

Prior to statehood, management of Alaska's moose (*Alces alces*) involved little more than establishing liberal seasons, conducting sex and age composition counts, monitoring harvests and controlling predators when necessary. Within the past 2 decades, however, Alaska's human population has grown significantly (Yankee 1974) and moose populations have been declining. Consequently, management has become more intensive, requiring detailed knowledge of various population and habitat parameters which were not necessary when moose numbers were increasing between 1940 and 1960 (Bishop and Rausch 1974).

Between 1963 and 1974, over 88,000 moose were harvested in Alaska (ADF&G unpublished files). Of that number, 18 percent were from the Nelchina Basin (Game Management Unit [GMU] 13) in southcentral Alaska. Moose numbers began to decline in the Nelchina Basin after the winter of 1961-62 (Bishop and Rausch 1974). Deep snows were thought to have precipitated that decline and predation and hunting were thought to be preventing the population from recovering. McIlroy (1974) suggested that low bull:cow ratios had influenced conception rates while Bishop and Rausch (1974) considered habitat deficiencies to be at least partially responsible for these declines.

Because of its depressed moose population and the importance of Unit 13 to the statewide harvest, a series of interrelated studies were initiated in 1975 in an effort to identify problems and possible solutions

to aid in the population's recovery. These studies, initially focused on moose-wolf (*Canis lupus*) relationships, to test the hypothesis that wolf predation was responsible for low calf survival. A later study involved removing wolves from a portion of GMU 13, then measuring calf survival in subsequent years. In order to evaluate the effects of wolf removal on study moose herds, it was necessary to accomplish the following: identify discrete moose populations and calving areas, and determine pregnancy rates, age structure and physical condition of moose in these populations. During the early phases of this study renewed interest in developing hydroelectric power on the Susitna River prompted expansion of these moose studies to include a preliminary assessment of the potential impacts of Susitna River hydroelectric development on moose. Funding for this expanded study was provided through contracts with the U.S. Fish and Wildlife Service and the Alaska Power Authority. The proposed plan of development includes a two dam system with dams located at Devil Mountain and below Watana Creek on the Susitna River. An in-depth description of the project and a preliminary assessment of study results were provided by Ballard and Taylor (1978). This report presents our findings on moose movements and habitat use, calf production and survival, and the general health of the moose population in the upper Susitna Basin.

Study Areas

Moose movements and habitat use were studied in the upper Susitna River Basin upstream from Devil Mountain. Studies, in relation to hydroelectric development, focused on the immediate hillsides north of the river between Devil Mountain and the mouth of the Maclaren River. Portions of this area were also included in the much larger wolf removal study area which was bounded by the Alaska Mountain Range on the north; Maclaren River on the east; Maclaren and Susitna Rivers on the south; and the confluence of Deadman Creek with Susitna River northwest to the headwaters of Brushkana Creek, down Brushkana Creek to its confluence with the Nenana River and then up the Nenana River to the Alaska Range on the west. This area encompasses nearly 7,380 km^2, and elevations range from approximately 450 to over 2,800 m. Over 65 percent of the area is between 450 and 1,200 meters elevation. Vegetation, topography and general climate were thoroughly described by Skoog (1968) and correspond to his following range units: 2 - Monahan flats, 3 - Clearwater Mountains, 5 - Deadman Lake, 6 - Tangle Lakes, and 8 - upper Susitna bottomlands.

Along the banks of the Susitna River and its tributaries from the Maclaren River to Devil Creek the dominant vegetative cover is black spruce (*Picea mariana*), interspersed with muskeg bogs on the basin floor. Occasional stands of black cottonwood (*Populus trichocarpa*) are found on river islands. Understory vegetation in the lower elevations includes highbush cranberry (*Viburnum edule*), devil's club (*Echinopanax horridus*), blueberry (*Vaccinium* spp.), lowbush cranberry (*Vaccinium vitis-idaea*) and several representatives of the rose and grass families. Hardwoods such as aspen (*Populus tremuloides*) and birch (*Betula papyrifera*) are often found interspersed among the spruce, predominantly on south-facing slopes. White spruce (*Picea glauca*) replaces the smaller, stunted

black spruce on better drained soils. The understory vegetation above 300 m contains blueberry, lowbush cranberry, Labrador tea (*Ledum* spp.), fireweed (*Epilobium* spp.), crowberry (*Empetrum nigrum*), and several mosses and lichens. Alder (*Alnus* spp.) dominates the reaches just above timberline, particularly along the headwaters of streams. Willow (*Salix* spp.) is present throughout the study area, but occurs most frequently at timberline and on riparian sites. Alpine tundra extends above the alder-willow zone at about 1200 m. Old caribou (*Rangifer tarandus*) trails scar the tundra slopes of the mountain foothills throughout most of the area.

OBJECTIVES

To determine population identities and seasonal movement patterns of moose in the upper Susitna River Valley and determine potential impacts of Susitna River Hydroelectric power development on moose.

PROCEDURES

Adult female moose were captured with the aid of helicopter by darting with 3-cc aluminum darts fired from a CAP-CHUR gun with appropriate dosages of succinylcholine chloride (Franzmann et al. 1974). Helicopter capture methods were identical to those used previously on other Alaskan moose movement studies (Nielson and Shaw 1967). No attempt was made to capture bulls or yearling moose.

Captured cow moose were marked either with a radio collar, a colored, numbered visual collar, or both, permitting individual recognition from fixed-wing aircraft. One-half of the radio collars were color-coded with canvas tape wrapped around the machine belting. Visual collars were similar to those described by Franzmann et al. (1974). Radio collars were constructed of machine belting 1.3 cm thick by 5.4 cm wide. Collars had an inner adjustable circumference ranging from 101 cm to 111 cm. The belting surrounded the radio components which were encased in dental acrylic, theoretically making the unit waterproof. The entire unit weighed 1,133 grams. Radio frequencies were in the 150.000 MHz range. Radio collars were purchased from A.V.M. Instrument Company (810 Dennison Drive, Champaign, Illinois) and visual collars were obtained from Denver Tent and Awning Company (Denver, Colorado).

Each moose was also ear-tagged with a numbered, Monel metal tag. Most metal tags were accompanied by 5 cm x 13 cm piece of colored polyvinyl plastic. Tags were affixed to the base of the ear.

After collaring and tagging, if time and/or the animal's behavior permitted, additional data were collected. An attempt was made to extract a lower incisor tooth from each animal for determining its age using the methods described by Sergeant and Pimlott (1959).

Blood was extracted from the jugular vein into sterile evacuated containers. Upon return from the field, blood was centrifuged to separate sera which were placed into 5 ml plastic vials and immediately frozen. One-ml samples were later sent to Alaska Medical Laboratories, Anchorage, Alaska for blood chemistry analysis (Technical Autoanalyzer SMA-12) and protein eletrophoresis (Franzmann and Arneson 1973). Generally three or four 10-ml vials were filled 1/3 to 1/2 full. One vial contained heparin which provided whole blood for determination of percent hemoglobin (Hb) using an Hb-meter (American Optical Corporation, Buffalo, New York), and packed cell volume (PCV) was determined with a micro-hematocrit centrifuge (Readocrit-Clay-Adama Company, Parsippany, N.J.). Remaining sera were stored for possible future analyses.

Hair samples were plucked from the shoulder hump and will be analyzed as described by Franzmann et al. (1975) to aid in assessing physical condition. Physical measurements taken included total length, heart girth, and length of hind foot. An attempt was made to subjectively estimate the physical condition of each moose using the index criteria developed by Franzmann and Arneson (1973). During spring tagging, each moose was rectally palpated (Greer and Hawkins 1967) to determine pregnancy. Data from individual moose were placed on numbered tagging cards.

Radio signals were received with a 4-band, 48-channel portable receiver purchased from A.V.M. Instrument Co. Radio-collared moose were relocated from a Piper PA-18 Super Cub and STOL Cessna 180 fixed-wing aircraft. Tracking methods and equipment used were similar to those described by Mech (1974). Initially, radio-collared moose were tracked every 3-4 weeks. From mid-May through mid-July in 1977 and 1978, flights were conducted every 3-5 days to obtain data on parturition and subsequent calf survival. Thereafter, radio-collared moose were monitored every 6-8 weeks.

No special flights were made specifically to search for visual-collared cows. All observations of these animals were made incidental to other activities. When tagged moose were found, their locations were recorded on U.S.G.S. maps with a scale of 1:250,000. Numbers, sexes and ages of associates were also recorded. Public sightings of collared adults were also recorded. Beginning in March 1977, habitat descriptions at moose sightings were recorded based upon criteria developed during the first 6 months of study (Table 1). Personnel collecting moose data were familiarized with the system to insure that all observers classified habitat uniformly.

Home ranges of radio-collared moose were computed by constructing polygons of outermost relocations or sightings, and then tracing the area with a compensating polar planimeter. We subjectively classified observations into summer or winter range based upon the distribution of sightings. Generally, winter ranges consisted of observations obtained from November through April, while summer ranges consisted of observations

Table 1. Habitat classifications utilized to classify moose habitat usage from fixed-wing aircraft from March 1977 through March 1979 in the Nelchina and Susitna River Basins of southcentral Alaska.

Classification	Habitat Description
Tall Spruce	Usually white spruce (*Picea glauca*), with a height of more than 20 feet. Usually riparian.
Moderate spruce	Both black (*Picea mariana*) and white spruce, with heights ranging from approximately 10 to 25 feet. Probably the most common habitat type in the basin.
Short Spruce	Less than 10 feet in height. Usually approaching a subalpine situation or a very boggy wet area.
Riparian Willow	A number of willow (*Salix* sp.) species which may or may not include varying sparse densities of spruce or hardwoods.
Upland Willow and Brush	Predominantly a mixture of willow species and shrub birch (*Betula glandulosa*).
Cottonwood and Aspen	Cottonwood (*Populus trichocarpa*) or other hardwoods and some spruce usually found in riparian situations. Aspen often on hillsides in isolated clumps.
Marsh	No running water, open water in middle with edges consisting of sedges, grass, willow and birch.
Alder	Usually found at high elevations approaching subalpine tundra usually in continuous stands.

obtained from May through August. Observations considered to represent migratory locations were not included in calculations to determine home range size. Also not included, were observations obtained during September and October, because they did not fall within either polygon and were more than 8 km (5 mi) apart indicating that some animals were moving to specific areas for breeding purposes. Moose were classified as migratory only if their winter and summer home ranges did not overlap. Altitudinal movements of radio-collared moose were determined by utilizing the closest 61 m (200 ft) contour line on 1:250,000 scale maps.

During 1976-77, 105 adult cow moose were tagged within, or near, the Susitna River study area; 41 from 21 to 28 October 1976 and 64 from 18 to 23 March 1977. Forty of these moose were fitted with radio collars and the remainder were marked with visual collars. Twenty of the moose radio-collared during spring were also marked with visual collars. Five additional cow moose were captured and radio-collared between Deadman and Jay Creeks in August 1978.

RESULTS AND DISCUSSION

Summaries of tagging locations, moose numbers, physical measurements, age, and other statistics associated with tagging are presented in Appendices I and II. Considerable difficulty was experienced in sedating adult moose, and successful drug dosages in the fall season ranged from 27-31 mg ($\bar{X}$ = 28 mg), while those in the spring varied from 23-29 mg ($\bar{x}$ = 27 mg). During each tagging effort, several darted moose never responded to the drug and, consequently, were not collared. Dosages which would not sedate some moose, unexpectedly killed others--three in fall 1976 and five in spring 1977. The length of time necessary for a moose to respond to the drug was variable, ranging from 3 to 21 minutes. Similar problems with drugs have been reported in other Alaskan moose studies (Didrickson et al. 1977).

The average age of cow moose collared during this study was approximately 7 years; adult fall-captured cows averaged 81 months while spring-captured cows averaged 83 months.

Twenty-three percent of the moose sampled were 10 years old or older. VanBallenberghe (pers. comm.) reported that 49 percent of the tagged moose in the Gulkana, Gakona and Chistochina River areas were 10 years old or older. Bailey et al. (1978) reported that Kenai Peninsula females 10 years old or older constituted 28-34 percent of the moose sampled, and Didrickson and Taylor (1978) found that 9 of 24 (38%) cows tagged in the Peter's Hills area were 10 years old or older. We surmised from these comparisons, that moose populations in this study area have a relatively younger age structure than other Alaskan populations studied thus far. In Sweden, Markgren (1969) concluded that moose from 6-11 years of age produced more twin calves than moose in other age classes. If Markgren's data are applicable to moose populations in southcentral Alaska, one-half of the Susitna River study area population was at prime breeding age in 1976 and 1977.

A number of investigators have expressed concern that low bull:cow ratios could influence conception rates (McIlroy 1974, Bishop and Rausch 1974, Bailey et al. 1978 and others). Rausch (1967) noted differences in fetus size on the northern Kenai Peninsula where bull:cow ratios were low. A similiar observation was made by VanBallenberghe (pers comm.) in the eastern portion of GMU 13. Whether varying fetus sizes were the result of low bull:cow ratios or other factors is unknown. Because McIlroy (1974) had expressed concern that low bull:cow ratios were influencing conception rates, 59 moose were rectally palpated in spring 1977 and 52 (88%) were pregnant. This pregnancy rate compares favorably with that observed in other portions of Alaska: eastern portion of GMU 13, 88 percent (VanBallenberghe pers. comm.), GMU 9, 84 percent (Faro and Franzmann 1978) and GMU 5, 90 percent (Smith and Franzmann 1979). We concluded that in the areas sampled during 1977, pregnancy rates were normal and that bull:cow ratios were adequate to allow normal reproduction. This does not, however, eliminate the possibility that cow moose were being bred during second or third estrus, but we have no observations of late parturition. We conclude that low bull:cow ratios were not responsible for low fall calf:cow ratios.

Condition Assessment

Criteria developed by Franzmann and LeResche (1978) were utilized to assess the physical condition status of Susitna River moose. Blood data for fall-collared moose are presented in Appendix III. Fall Hb values exceeded 20 gm/100 ml and were so high that precise values could not be obtained with the instrument utilized. Packed cell volume (PCV) values were also high, ranging from 51.4 to 56.0 percent, and averaging 53.3 percent. Other selected mean fall blood values had the following ranges and total means (expressed as mg/100 ml unless indicated otherwise): calcium, 10.4 to 12.3 with mean of 11.3; phosphorus, 4.5 to 6.2 averaging 5.1; glucose, 153.0 to 195.8 averaging 180.3; and total protein, 7.6 to 8.2 with a mean of 8.0. These values indicate moose in good physical condition which was expected for samples collected in fall seasons (Franzmann pers. comm.).

Blood values of adult moose sampled in GMU 13 in March 1977 and 1979 were compared with values obtained from other Alaskan moose populations (data taken from Smith and Franzmann 1979) sampled during the spring season (Table 2). Samples are listed in order of high to low PCV values which Franzmann and LeResche (1978) believed to be the most useful parameter for assessing condition class. They believed the following values represented adult moose in average or better condition: PCV - 50 percent; Hb - 18.6 g/100 ml; calcium - 10.4 mg/100 ml; phosphorus - 5.2 mg/100 ml; total protein - 7.5 g/100 ml; albumin - 4.5 g/100 ml; beta globulin -0.7 g/100 ml; and glucose - 140 g/100 ml. For the five most important parameters determined from six moose populations, GMU 13 samples from 1975 and 1977, respectively, rated as follows: calcium - third and first; phosphorus - first and sixth; total protein - third and fifth; Hb - second and third; and PCV - third and second. Based upon this comparison GMU 13 moose (1975 and 1977) appeared to be in relatively good physical condition for at least three parameters during both study years. Both phosphorus and total protein, however, were below the

Table 2. Comparison of moose blood and morphometric condition parameters from Alaskan populations sampled in late winter and spring (sample size in parenthesis, table modified from Smith and Franzmann 1979).

Blood Values		Copper River Delta (Mar.1974) Mean	SD	GMU 13 (Mar.1977) Mean	SD	GMU 13 (Apr.1975) Mean	SD	GMU 15C (Apr.1975) Mean	SD	GMU 14C (Feb.1976) Mean	SD
Calcium	mg/dl	10.38	0.74(44)	11.23	0.80(49)	10.91	0.86(58)	9.61	0.98(29)	10.33	0.81(19)
Phosphorus	mg/dl	5.50	0.69(44)	4.48	1.03(49)	5.63	0.99(59)	4.72	1.08(29)	4.74	1.51(18)
Glucose	mg/dl	147.0	37.5(44)	152.4	26.6(49)	127.8	20.2(59)	91.3	16.2(29)	109.9	16.3(18)
Total Protein	g/dl	7.07	0.57(45)	7.14	.63(54)	7.43	0.40(61)	6.70	0.83(30)	7.20	0.54(18)
Albumin	g/dl	3.82	0.39(45)	-	-	5.21	0.39(61)	4.21	0.51(30)	4.80	0.41(18)
Beta globulin	g/dl	0.72	0.09(45)	-	-	0.60	0.11(61)	0.55	0.12(30)	0.60	0.07(18)
Hemoglobin	g/dl	19.8	0.5(46)	18.8	1.38(25)	19.7	0.7(60)	18.7	1.5(29)	15.4	1.2(17)
PCV	%	53.2	4.2(46)	50.2	3.5(51)	49.2	3.7(60)	45.9	3.9(29)	43.4	2.8(19)
Total Length	cm	301.5	81.(23)	288.5	18.0(38)	295.6	10.9(115)	288.9	14.2(210)	-	-
Chest Girth	cm	201.3	13.8(25)	195.4	12.7(34)	191.3	14.3(105)	182.2	16.3(194)	-	-
Hind Foot	cm	81.5	1.8(16)	-	-	80.0	2.9(79)	79.9	3.8(203)	-	-
Shoulder Height	cm	-	-	-	-	185.5	11.1(7)	174.9	14.1(65)	-	-

Table 2. Continued.

Blood Values		Yakutat (Mr.1978) Mean	SD	GMU 13 (Mar.1979) Mean	SD	Moose Research Center (Feb.,Mar.,Apr.) Mean	SD	GMU 9 (Apr.1977) Mean	SD
Calcium	mg/dl	10.98	0.57(41)	9.52	1.14(13)	9.81	0.64(39)	10.80	0.43(57)
Phosphorus	mg/dl	3.71	1.06(41)	4.90	0.84(13)	3.90	1.09(39)	4.35	0.86(57)
Glucose	mg/dl	143.8	23.1(41)	107.9	21.0(13)	116.2	26.1(39)	158.1	22.2(57)
Total Protein	g/dl	7.45	0.43(41)	5.65	.60(13)	6.60	0.44(39)	7.79	0.43(57)
Albumin	g/dl	5.38	0.30(41)	-	-	3.76	0.46(39)	5.05	0.28(57)
Beta globulin	g/dl	0.62	0.09(41)	-	-	0.58	0.10(39)	0.74	0.11(57)
Hemoglobin	g/dl	16.7	1.3(42)	16.9	1.5(11)	15.9	2.2(39)	16.4	1.3(54)
PCV	%	40.6	3.6(42)	40.6	3.6(11)	39.9	4.6(39)	39.0	5.4(56)
Total Length	cm	289.2	13.0(39)	286.0	17.5(13)	282.6	9.1(254)	302.1	6.8(54)
Chest Girth	cm	202.6	12.2(39)	188.1	14.2(13)	179.5	11.1(252)	201.1	12.2(53)
Hind Foot	cm	79.4	13.7(37)	84.1	5.5(13)	79.3	1.9(246)	80.8	1.8(12)
Shoulder Height	cm	-	-	-	-	175.9	8.1	-	-

desirable levels of 5.25 mg/100 ml and 7.5 g/100 ml, respectively, presented by Franzmann and LeResche (1978). Since many of the blood parameters compared favorably with the Copper River Delta moose herd, which was considered a healthy, productive moose population, it was concluded that the GMU 13 moose sampled in 1975 and 1977 were in relatively good physical condition. This was not, however, necessarily the case for all GMU 13 moose, as indicated in Appendix IV (Of the eight tagging sites, the Devil Mountain moose had many of the lowest parameters indicating that these moose may have been nutritionally stressed during a mild winter). It was also not the case for GMU 13 moose sampled in 1979.

Moose sampled in March 1979, as part of a yearling mortality study (Job 1.27R) although not from exactly the same areas sampled in 1975 and 1977, had the lowest blood parameters of moose sampled to date in GMU 13. They were comparable to values obtained at Yakutat (GMU 5), on the Alaska Peninsula (GMU 9) and at the Moose Research Center, all of which were judged to be nutritionally stressed during mild or average winters (Faro and Franzmann 1978 and Smith and Franzmann 1979). Franzmann and LeResche (1978) based their moose condition measurement "upon the premise" that animal form and composition are dictated largely by the interactions of the complexes of climate and nutrition (Ledger 1968)." The GMU 13, 1979 values represented moose which were nutritionally stressed due to winter severity. Winter 1978-79 was the second most severe winter in terms of total snowfall since the U.S. Soil Conservation Service began keeping records in 1952.

Bishop and Rausch (1974) mentioned that habitat deficiencies were a possible contributing factor to poor "productivity and survival" of moose in the Nelchina Basin study area. Therefore, it was important to gain information on this particular aspect by utilizing blood parameters to see if further investigation was warranted. Franzmann and LeResche's (1978) condition assessment technique suggests that if moose are in good condition following relatively mild or average winters then it is probable that range quality likely is not limiting moose survival. Based upon this premise, we concluded (from samples collected in 1975 and 1977) that range deterioration was not a problem in the areas sampled. We do believe, however, that studies of range quantity and quality are needed to assess the potential of the basin to support future increases in moose numbers. Casual observations of willow made during this study suggest many decadent plants resulting from excessive winter moose usage. In addition, no substantial fires have occurred within the last 30 to 35 years, and many old burns are advancing to mature spruce habitat creating a further loss of productive moose range.

Movements

Between late October 1976 and May 1979, 1190 relocations were obtained for 43 radio-collared moose. During this reporting period a paper entitled "Moose Movements and Habitat Use Along the Susitna River near Devils Canyon" was prepared by Kenton P. Taylor and Warren B. Ballard and presented by Taylor at the 15th North American Moose Conference at

Kenai, Alaska. An abstract of that paper is presented in Appendix V. In addition, two interim reports were prepared for Susitna Dam studies; one was prepared under contract for the U.S. Fish and Wildlife Service (Ballard and Taylor 1978) while the other was a 6-month progress report under contract with the Alaska Power Authority for continuation of the original study. This report supersedes all previous reports. Movements and history for the 43 radio-collared moose were as follows:

Moose 8017 (Fig. 1) was collared on 27 October 1976, approximately 8 km (5 mi) northwest of the Maclaren River bend. By 22 November she migrated approximately 40 km (25 mi) south to the head of the west fork of the Gulkana River. She overwintered in that area and between 13 and 27 May 1977 migrated 89 km (55 mi) back to a site approximately 8 km (5 mi) SW of the tagging site, where she had given birth to a calf by 1 June. She resided in that area until some time between 7 and 23 July when she lost her calf. She then migrated approximately 40 km (25 mi) north to an area approximately 11 km (7 mi) up from the mouth of the west fork of the Maclaren River where she remained through fall 1977. Contact with this moose ended in November 1977, probably due to radio failure.

Moose 8018 (Fig. 2) was collared on 27 October 1976 approximately 5 km (3 mi) upstream from the mouth of Butte Creek. She was accompanied by a calf when collared and they remained in the Butte Creek area until early December 1977. Between 3 and 24 December they had moved approximately 31 km (19 mi) southeast to the Susitna River bend area. By 7 February 1977 they were located at Kelly Lake, approximately 58 km (36 mi) south of the tagging site, where they overwintered. She was last observed with her calf on 25 April. Between 27 May and 30 May 1977 she moved 19 km (12 mi) northwest of her winter range to the Maclaren River bottom lands where she gave birth to one calf. Between 10 June and 12 July she lost her calf and returned 45 km (28 mi) to the vicinity of the tagging site where she remained through fall and winter. Between 29 May and 31 May 1978 she produced one calf, but she remained in the Butte Creek area and did not migrate during 1977-78. Both cow and calf remained in the Butte Creek area at least up to 27 September 1978 when they were last observed.

Moose 8019 (Fig. 3) was with a calf when collared on 21 October 1976, 6 km (4 mi) NW of Susitna Lodge where they remained at least until 19 November. By 16 December she and the calf had moved 37 km (23 mi) down the Susitna River almost to the mouth of Coal Creek, but they were found 32 km (20 mi) back to the north toward the mouth of Wickersham Creek by 19 January. They remained in that area until 10 May, after which she was not observed with the calf, but then gave birth to a new calf between 3 and 6 June, 6 km (4 mi) SE of her winter location. Between 6 and 7 June she was not observed with her calf and she remained in the vicinity of the tagging site until 22 August. By 5 October she had moved 8 km (5 mi) NW, to

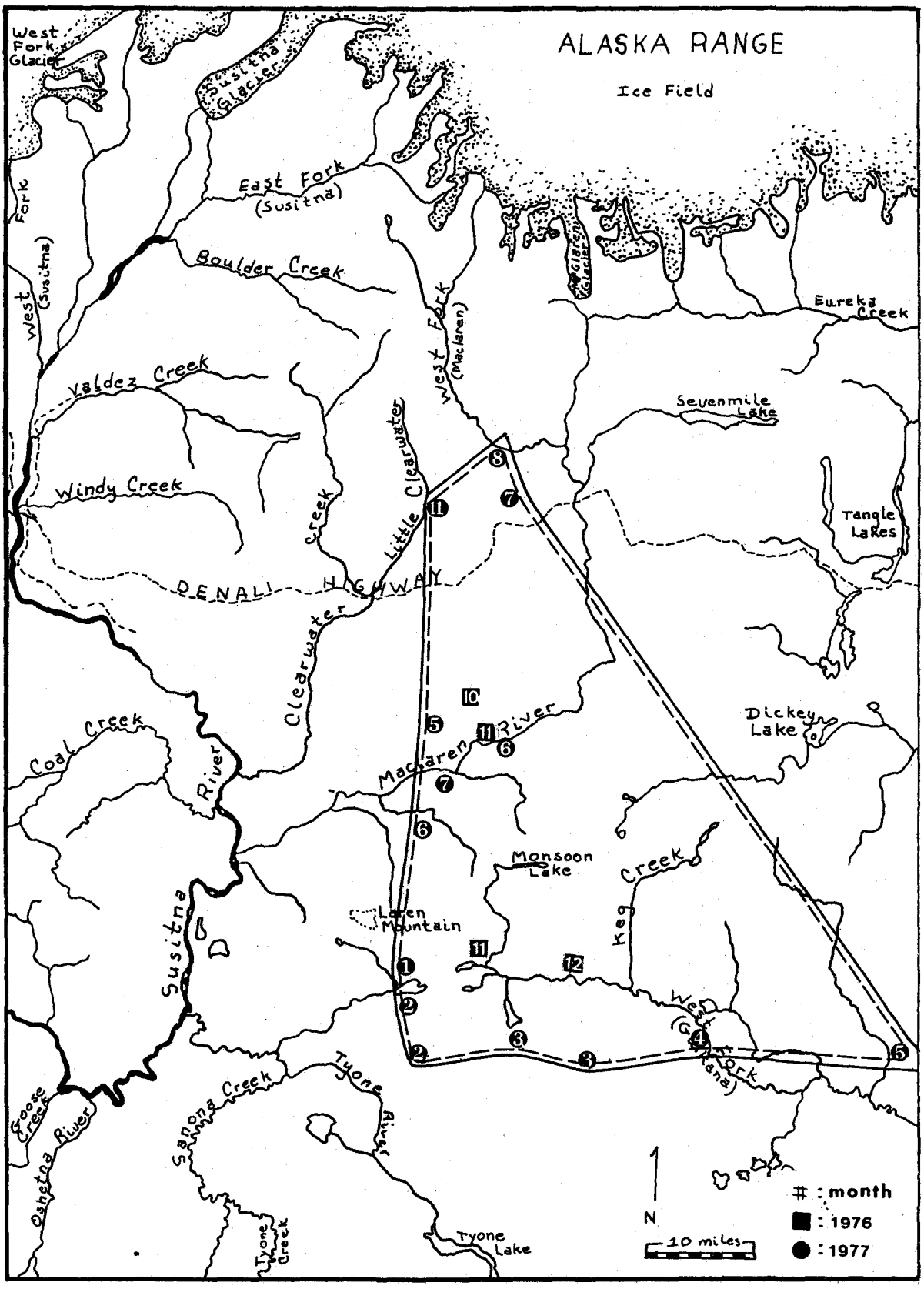


Fig. 1. Annual home range and monthly locations of moose 8017 from October 1976 through November 1977 in the Susitna River Study Area.

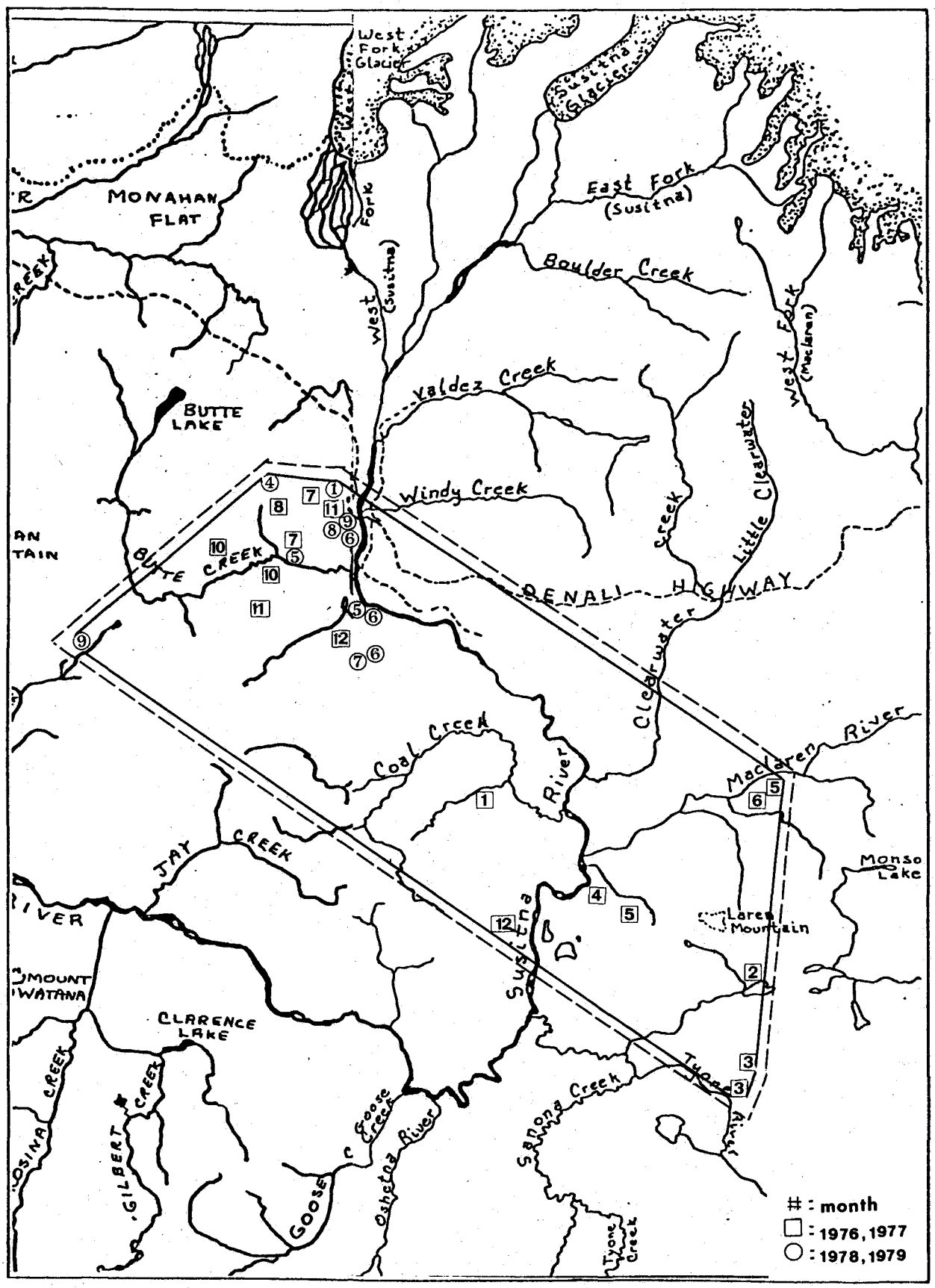


Fig. 2. Annual home range and monthly locations of moose 8018 from October 1976 through September 1978 in the Susitna River Study Area.

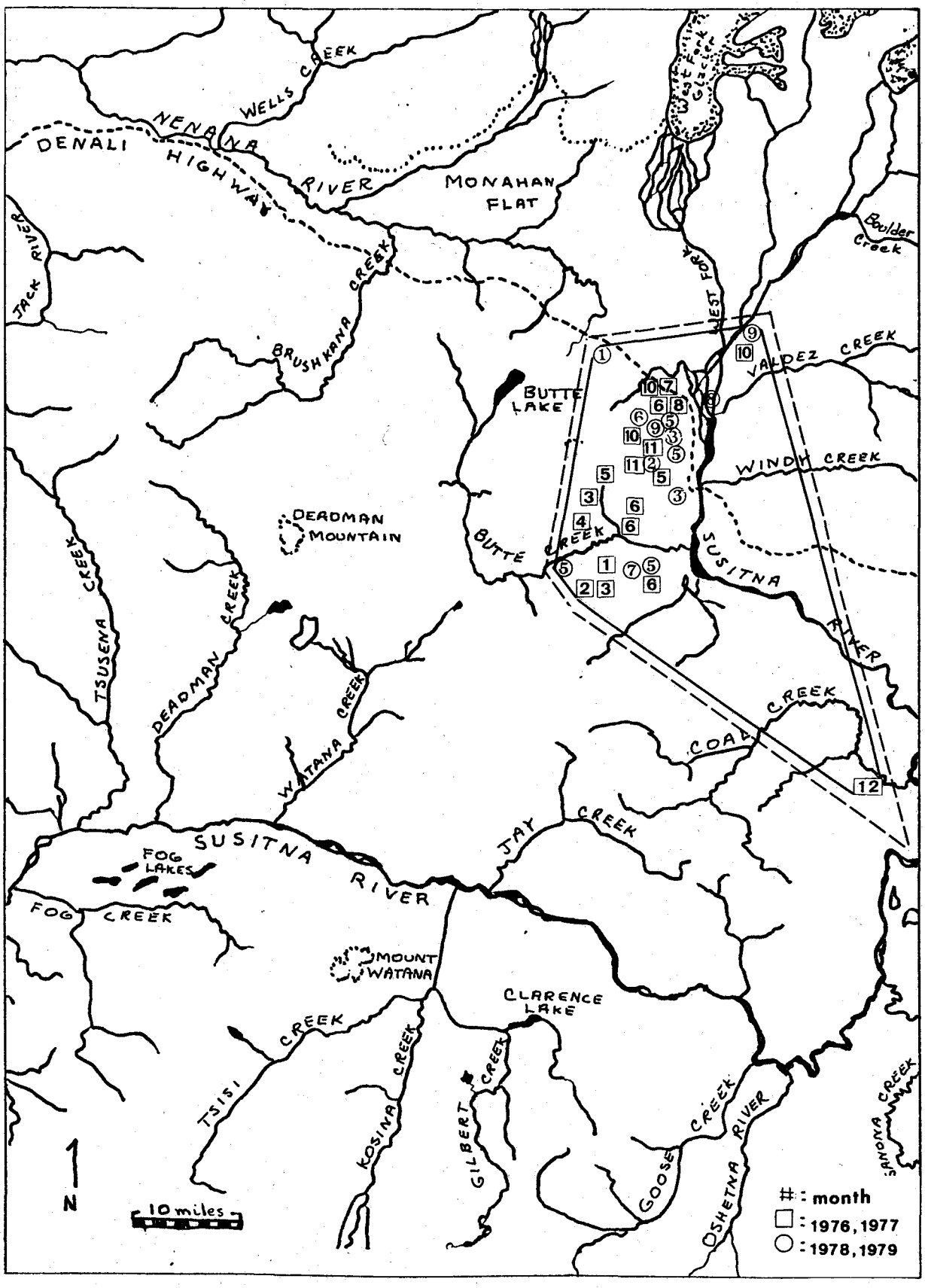


Fig. 3. Annual home range and monthly locations of moose 8019 from October 1976 through May 1979 in the Susitna River Study Area.

just above the mouth of Valdez Creek, but then by 30 October moved back to the tagging site where she remained through fall 1977. She wintered in the vicinity of the tagging site and gave birth to twin calves in the same area between 8 and 25 June 1978. Between 7 July and 23 August 1978 she lost one calf. The cow and calf remained in the vicinity of Gracious House until late September when they moved to the mouth of Valdez Creek as she had done in 1977 probably for breeding purposes. They wintered west of Gracious House and were last observed on 3 May 1979.

Moose 8020 (Fig. 4) was collared on 22 October 1976, west of Susitna Lodge, where she remained through 2 November. She moved 13 km (8 mi) by 22 November, 0.4 km (0.25 mi) north of the Denali Highway. She remained within an area approximately 34 km^2 (13 mi^2) through fall 1977: moving upland in both spring and fall and to the lowlands during summer. She was observed with twins on 7 June, then with triplets between 16 to 18 June. All four moose summered on the lowlands northwest of Butte Lake north of the Denali Highway. By mid-September they moved south of the highway to elevations ranging between 3-4,000 feet (914-1219 m) where they spent winter 1977-78. Moose 8020 was not observed with a new calf during 1978. Through summer and winter 1978-79 she continued to associate with her yearlings until at least 29 March 1979 when last observed.

Moose 8021 (Fig. 5) was collared approximately 6 km (4 mi) south of the Denali Highway along Brushkana Creek on 22 October. By 2 November she had moved 13 km (8 mi) to the north crossing the Nenana River, but by 22 November she moved south 16 km (10 mi) to 6 km (4 mi) NW of Butte Lake. She continued to exhibit considerable movement until 5 June when she gave birth to one calf. They spent the summer north of the Denali Highway on Monahan Flats. Radio contact with moose 8021 was temporarily terminated on 16 July 1977 due to a frequency shift and was not resumed until 10 May 1978. At this time she was located just north of the Denali Highway approximately 1.6 km (1 mi) east of Seattle Creek. Between 10 May and 31 May she moved 11 km (6.5 mi) east where she gave birth to one calf. Both summered in the same area occupied during 1977. Between 25 August and 18 September she, with her calf, moved approximately 13 km (8 mi) northeast to just north of Monahan Lake, possibly for breeding purposes. After this date we did not monitor the activities of this pair until April 1979 at which time the cow was located within the summer range utilized the previous 2 years.

Moose 8022 (Fig. 6) was collared on 28 October 1976 approximately 26 km (6 mi) up from the mouth of Watana Creek. As winter progressed she moved to lower elevations along the Susitna River. Between 22 April and 25 May 1977 she moved 21 km (13 mi) north then 13 km (8 mi) south, spending the summer in a relatively small area at the bend of Watana Creek. She was not observed with a calf during 1977.

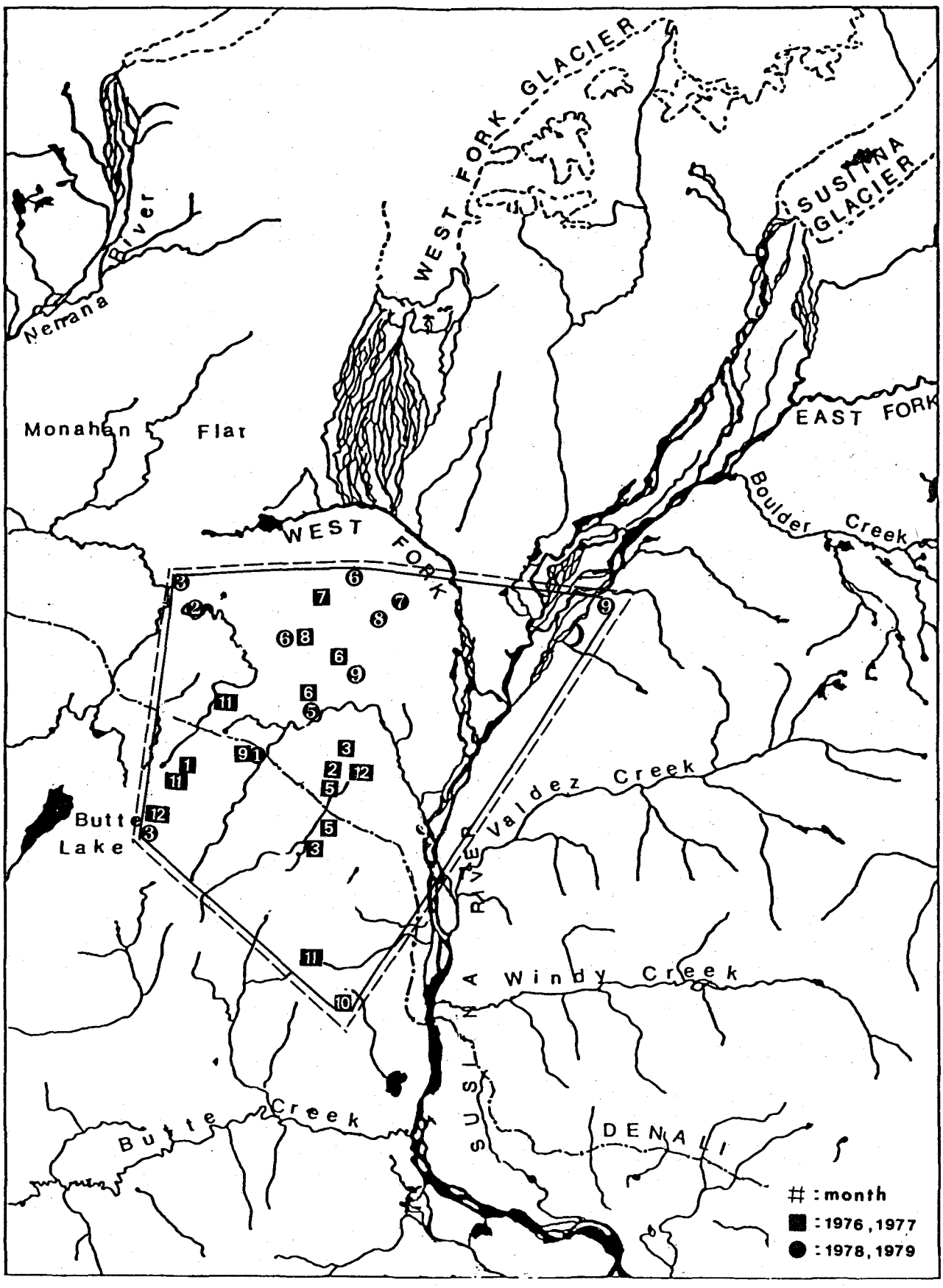


Fig. 4. Annual home range and monthly locations of moose 8020 from October 1976 through March 1979 in the Susitna River Study Area.

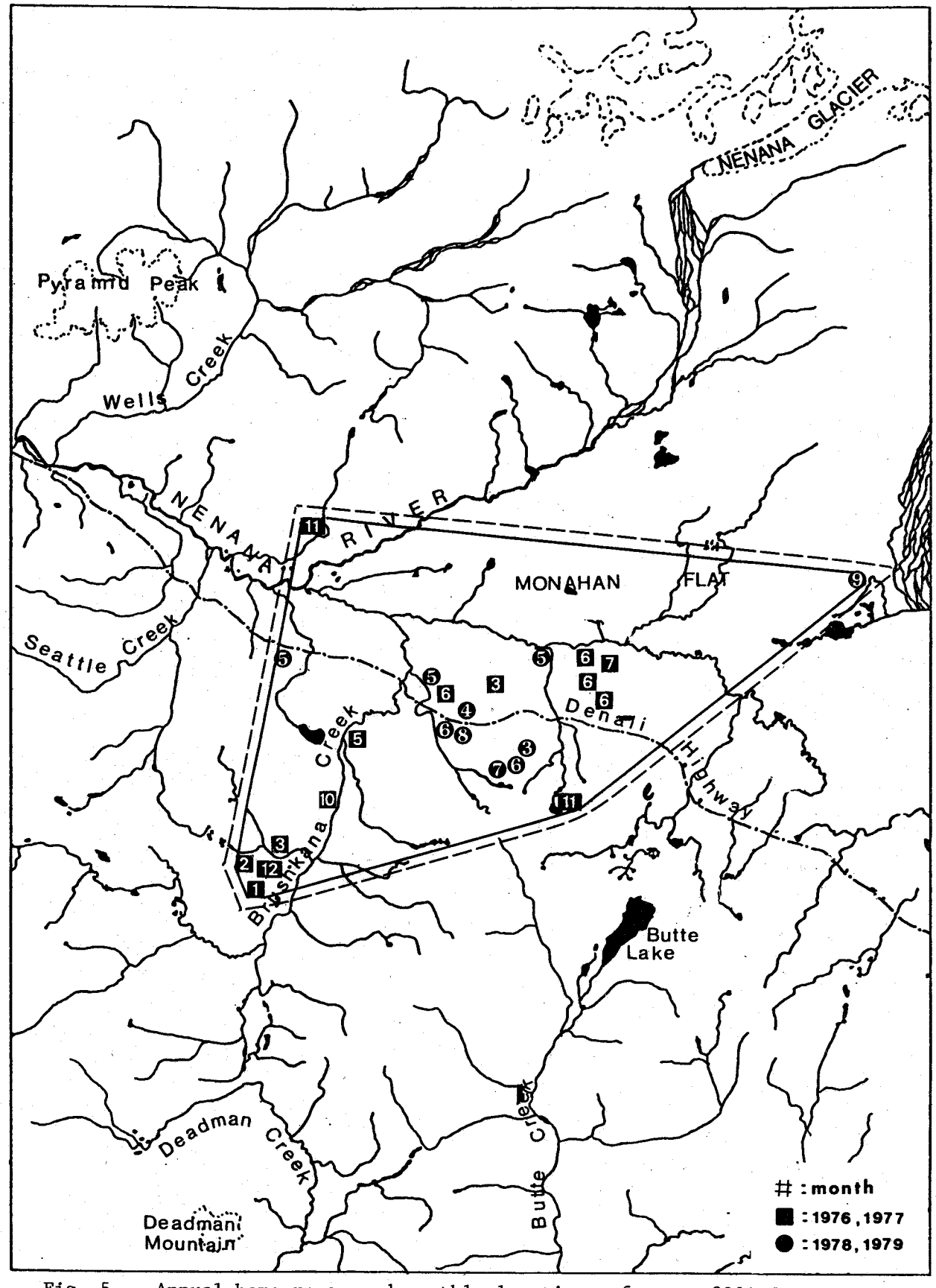


Fig. 5. Annual home range and monthly locations of moose 8021 from October 1976 through April 1979 in the Susitna River Study Area.

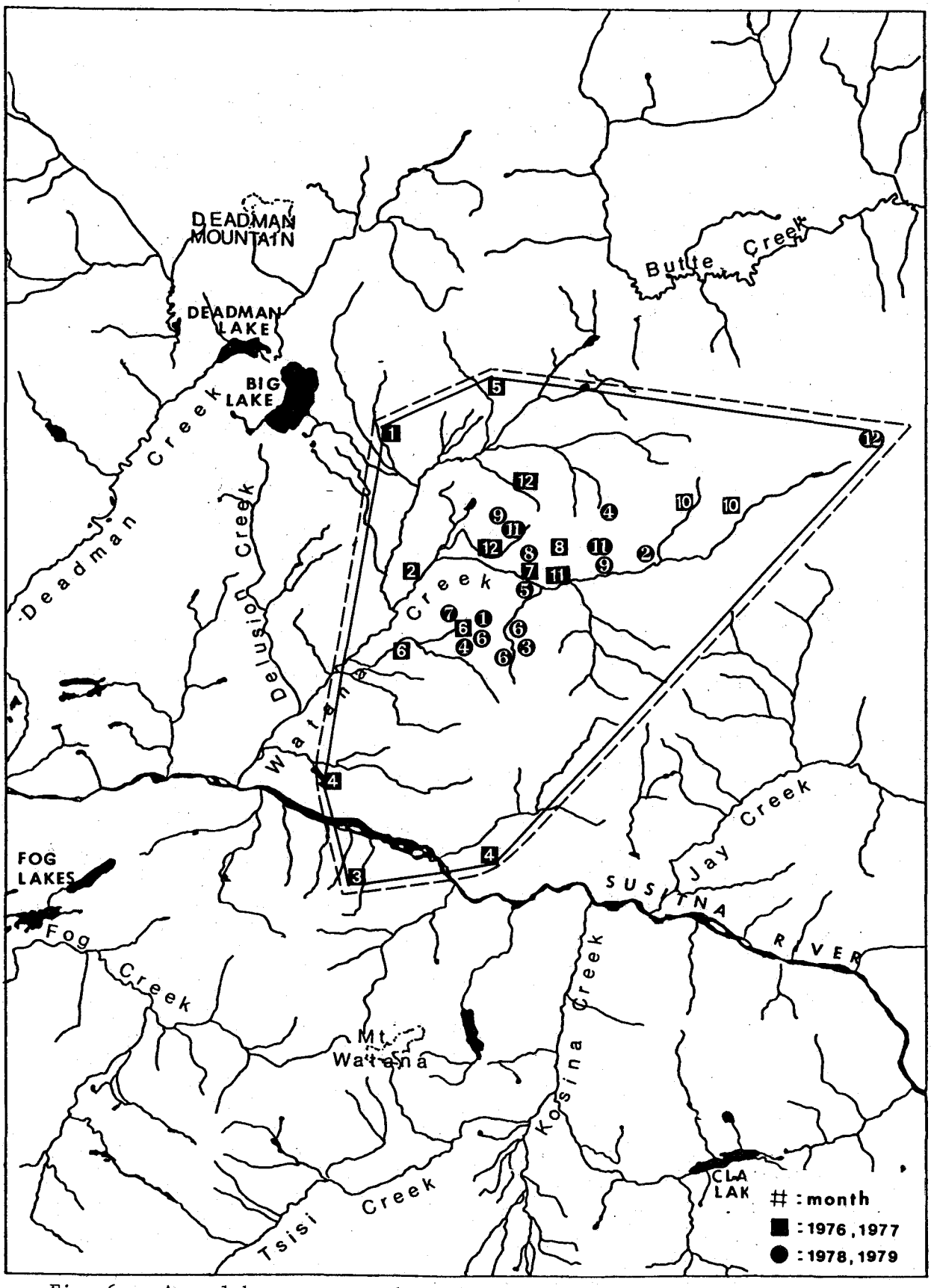


Fig. 6. Annual home range and monthly locations of moose 8022 from October 1976 through March 1979 in the Susitna River Study Area.

During winter 1977-78 she did not return to the Susitna River, instead remaining in the vicinity of her summer range. In 1978 she produced one calf by 30 May, but then lost it by 8 July. Both summer and winter movements during 1978-79 were similar to those described during 1977-78. She was last observed on 28 March 1979.

Moose 8029 (Fig. 7) was collared on 27 October 1976, 3 km (2 mi) east of Round Mountain. She was found along the Maclaren River 8 km (5 mi) south of her tagging location on 19 November. By 19 January she had moved 10 km (6 mi) downstream to the Maclaren River cabin. She remained in the area through winter and spring. By 25 May she moved north of the river 3 km (2 mi) to higher elevation where she gave birth to twins which were missing by 1 June. She spent most of the summer along the river, until 22 November when she returned to the tagging site. During winter and summer 1977-78 and 1978-79 moose 8029's movements were similiar to the above description. However, in 1978 she produced twins, one of which was lost between 25 October and 12 December. She was last observed with a calf on 4 April 1979.

Moose 8030 (Fig. 8) was collared on the west side of the Susitna River approximately 10 km (6 mi) downstream from the mouth of the Maclaren River on 22 October 1976. Between 19 November and 22 April she migrated 44 km (27 mi) down the Tyone River to the north end of Susitna Lake. On 30 May she gave birth to one calf on an island where they remained until 23 July. They remained in the same vicinity during summer, then between 30 August and 5 October moved 44 km (27 mi) back to the tagging site where they remained over winter 1977-78. She followed this same pattern during 1978-79, also producing one calf. She and her calf were last observed on 31 March 1979.

Moose 8031 (Fig. 9) was collared on 22 October 1976 on the north side of the Susitna River opposite the Oshetna River. This moose's movements were restricted to the Susitna River bend area north of the river during the period of study. Her winter and summer ranges overlapped, although she did exhibit a propensity to move from these areas during September and October. She was not observed with a calf during 1977-78 but did produce and successfully raise a calf during 1978-79.

Moose 8032 (Fig. 10) was collared on 23 October 1976 at the mouth of Pass Creek. By 2 November she had moved 19 km (12 mi) down Clearwater Creek. She continued her southerly movement until 19 January; a straight line migration crossing the Maclaren and going down Monsoon Lake Creek 48 km (30 mi). She overwintered along the creek and began a northward movement on 31 March reaching Clearwater Lake by 30 May where she gave birth to one calf. They had moved north of the parturition site about 5 km (3 mi) by 11 July but did not return to the tagging site. Instead, they migrated south to a canyon area 5 km (3 mi) west of the wintering area where they remained through fall and winter 1977-78.

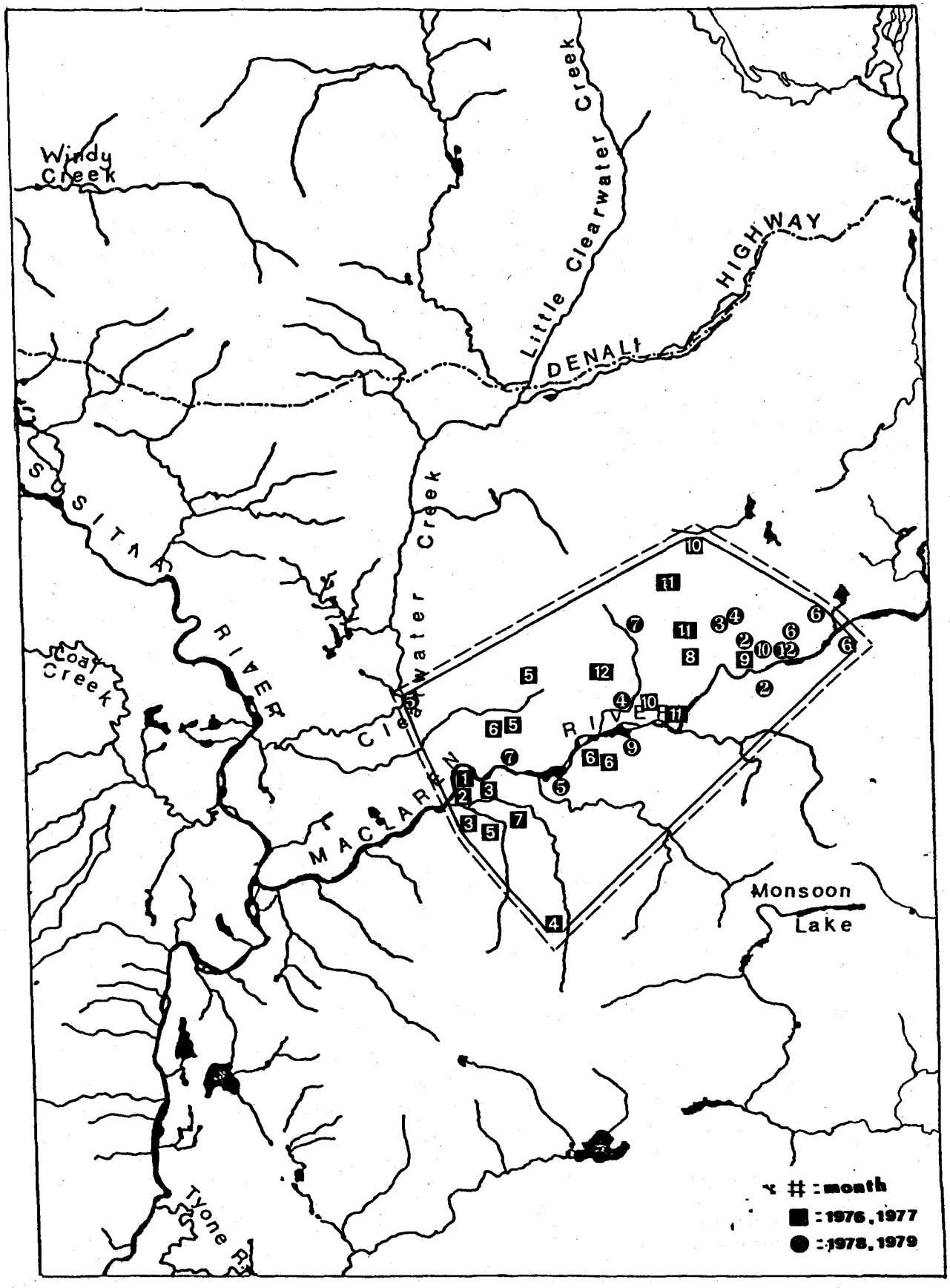


Fig. 7. Annual home range and monthly locations of moose 8029 from October 1976 through April 1979 in the Susitna River Study Area.

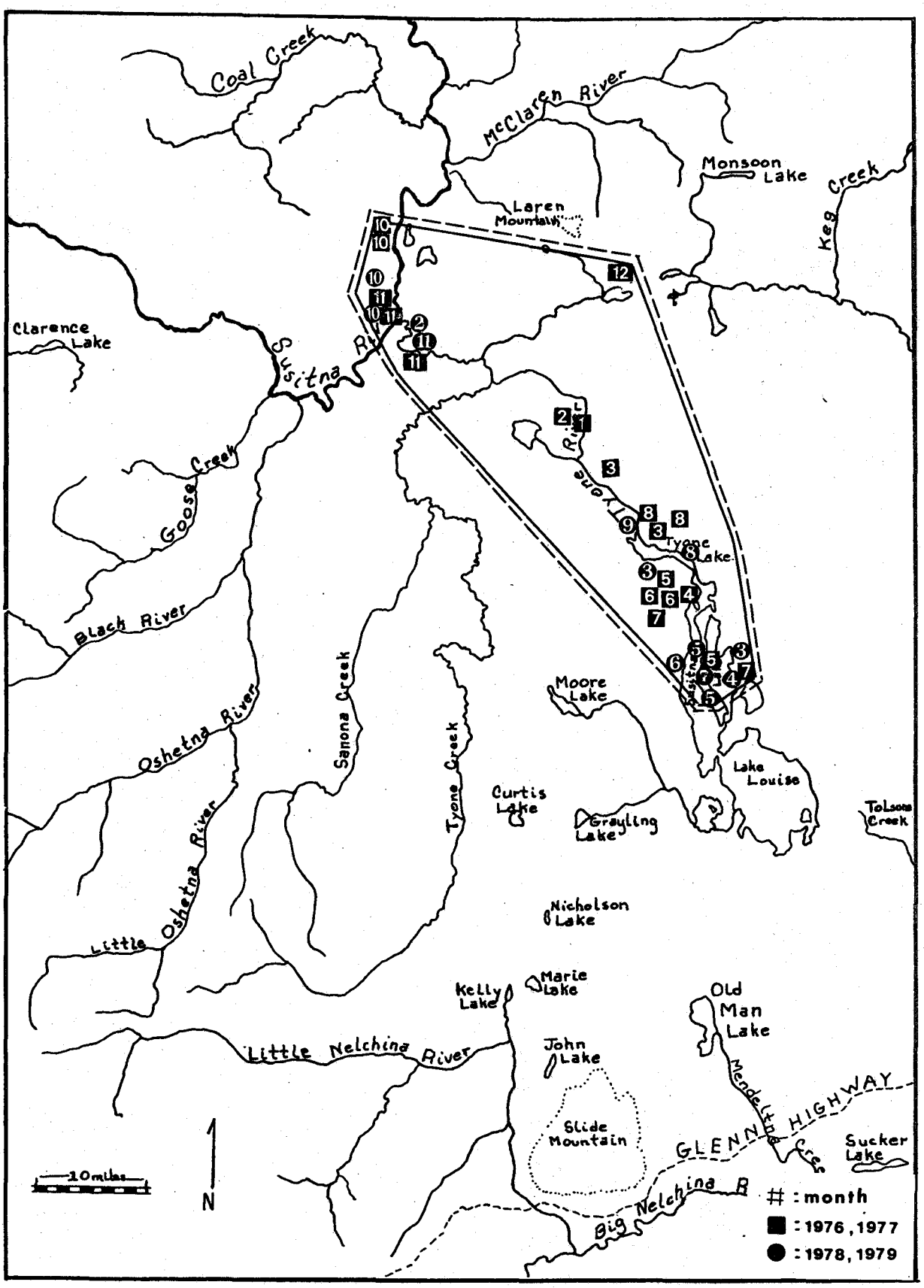


Fig. 8. Annual home range and monthly locations of moose 8030 from October 1976 through March 1979 in the Susitna River Study Area.

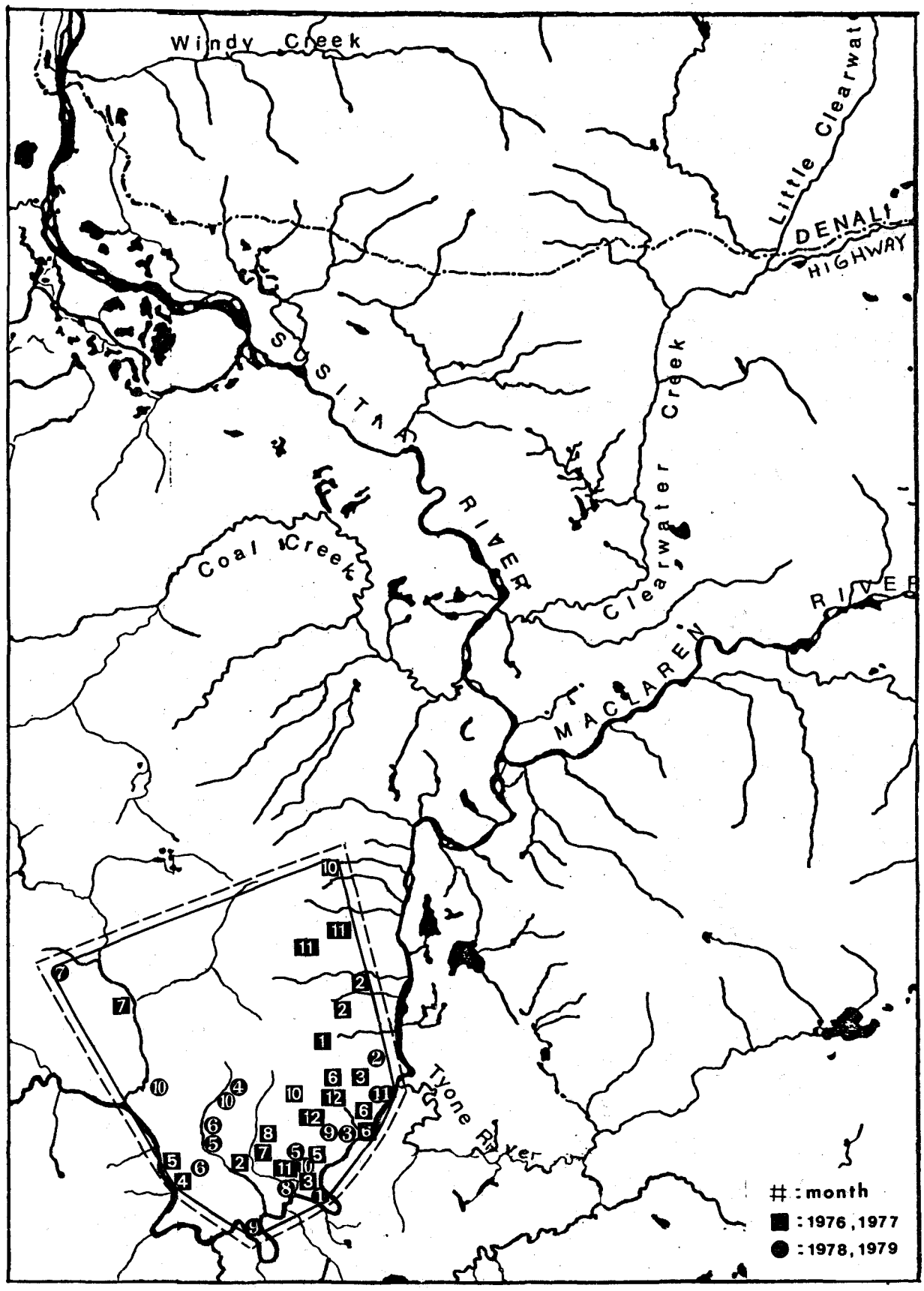


Fig. 9. Annual home range and monthly locations of moose 8031 from October 1976 through May 1979 in the Susitna River Study Area.

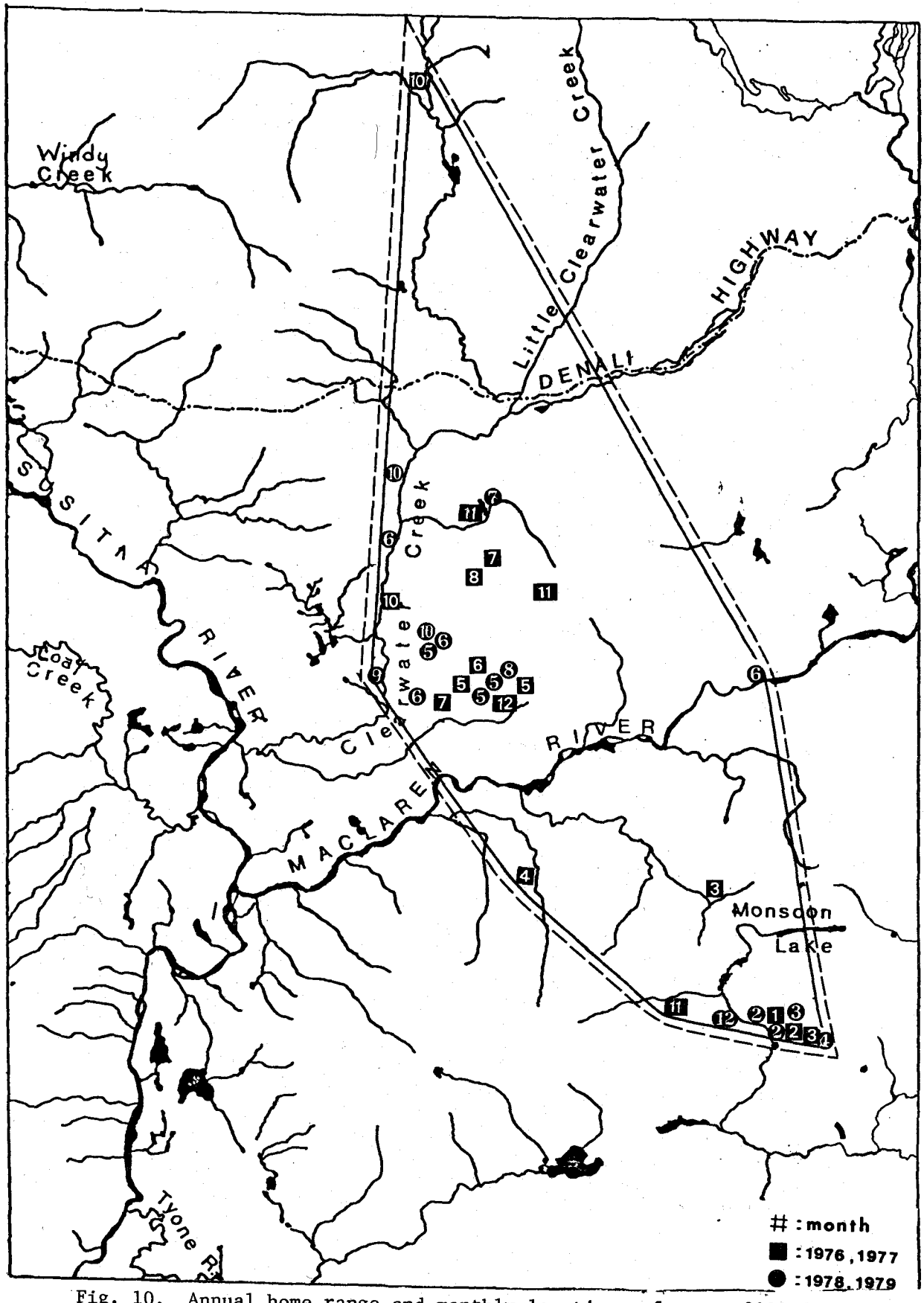


Fig. 10. Annual home range and monthly locations of moose 8032 from October 1976 through April 1979 in the Susitna River Study Area.

Between 31 March and 13 May 1978 moose 8032 and her calf returned to the summer range utilized in 1977. By 29 May she produced another calf, but lost it by 3 June. During summer and winter 1978-79 she repeated the same pattern of movements as those of 1977-78 except she was never observed returning to the site at which she was originally collared. She was last observed on 16 April 1979.

Moose 8033 (Fig. 11) was collared on 28 October 1976, 5 km (3 mi) NW of the mouth of Valdez Creek. She remained within an area approximately 62 km^2 (24 mi^2), just north of Valdez Creek through at least 5 October 1977. Movements consisted of changes in elevation ranging up to 300 m but not coinciding with any particular season. She moved to Valdez Creek by late May and was observed with twins on 29 May. By 6 August both calves were missing. Radio failure was recorded on 6 August and our last observation was on 5 October 1977.

Moose 8034 (Fig. 12) was collared on 28 October 1976 approximately 2 km (1 mi) south of Seattle Creek. By 22 November she had moved approximately 61 km (10 mi) SE to Brushkana Creek where she remained until at least 7 February. She moved to lower elevations as winter progressed and then calved just north of the Denali Highway 5 km east of Brushkana Creek. She and this calf remained within a 3 km^2 (1 mi^2) area through June and by mid-July moved to Butte Lake where they remained through summer.

Her movements during 1977-78 and 1978-79 were similar except that she was never observed returning to the tagging site. During September 1978 she was observed at Klunistana Creek approximately 18 km (1 mi) NW of her summer range. She gave birth to twins by 6 June, but lost both by 25 June 1978. She was last observed on 29 March 1979.

Moose 8035 (Fig. 13) was collared on 27 October 1976 approximately 6 km (4 mi) east of Round Mountain. Between 2 November and 16 December 1976-77 she moved approximately 52 km (32 mi) southwest to the mouth of the Oshetna River where she wintered. Between 5 March and 22 April 1978 she began migrating back to the vicinity of the tagging site, reaching it by 25 May, where she remained through summer. She was not observed with a calf during summer 1977.

During 1977-78, through December 1978, she repeated the same movement patterns observed during 1976-77. She gave birth to one calf by 3 June and it survived to 21 December 1978, but was not observed after that date. Between 21 December and 14 April she moved from the wintering area of the previous two seasons to an area approximately 82 km (51 mi) to the south on Mendeltna Creek, below the Glenn Highway. We did not attempt to observe her after this date, however, the radio signal indicated that by June she had returned to Round Mountain on the Maclaren River.

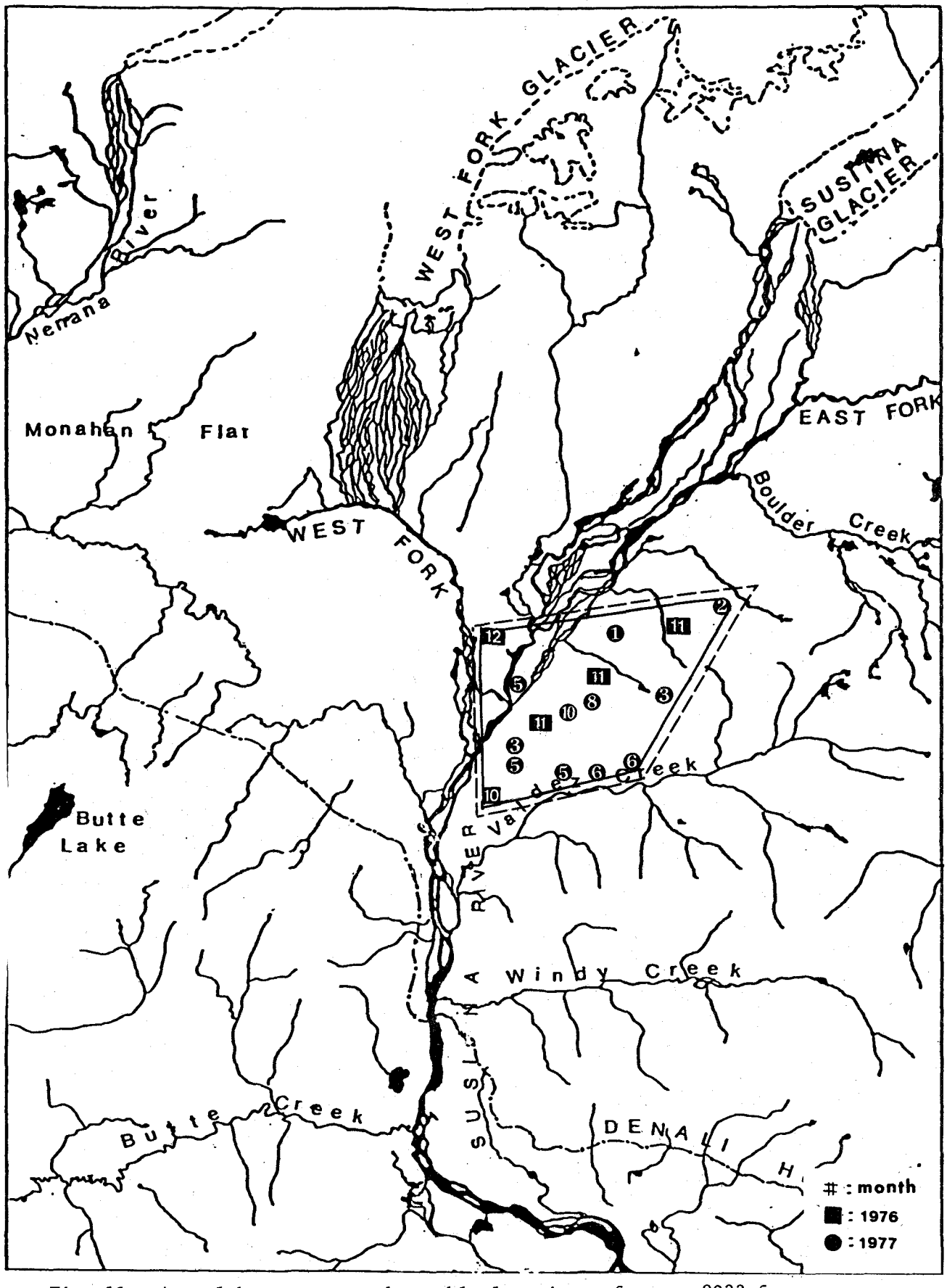


Fig. 11. Annual home range and monthly locations of moose 8033 from October 1976 through October 1977 in the Susitna River Study Area.

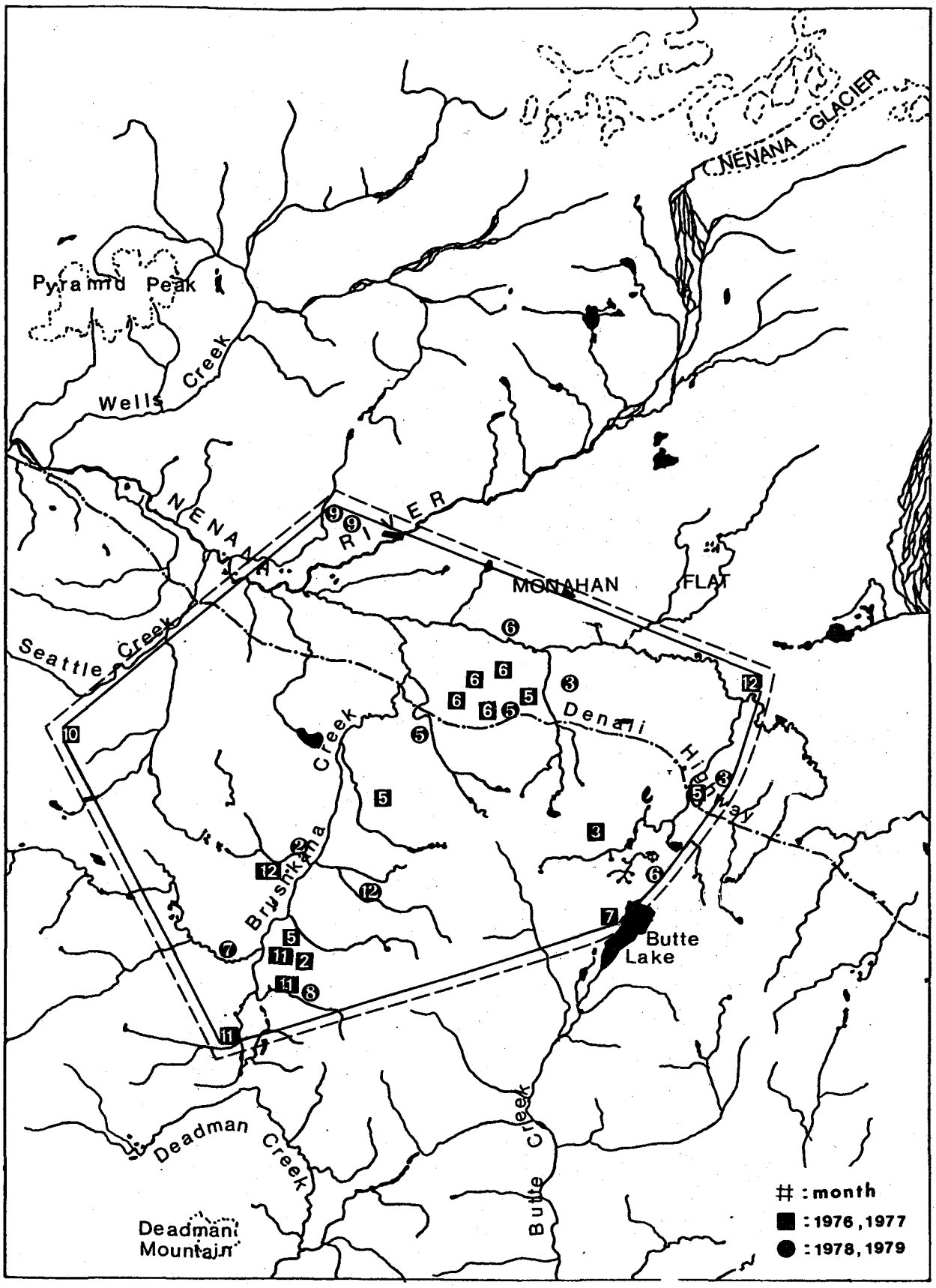


Fig. 12. Annual home range and monthly locations of moose 8034 from October 1976 through March 1979 in the Susitna River Study Area.

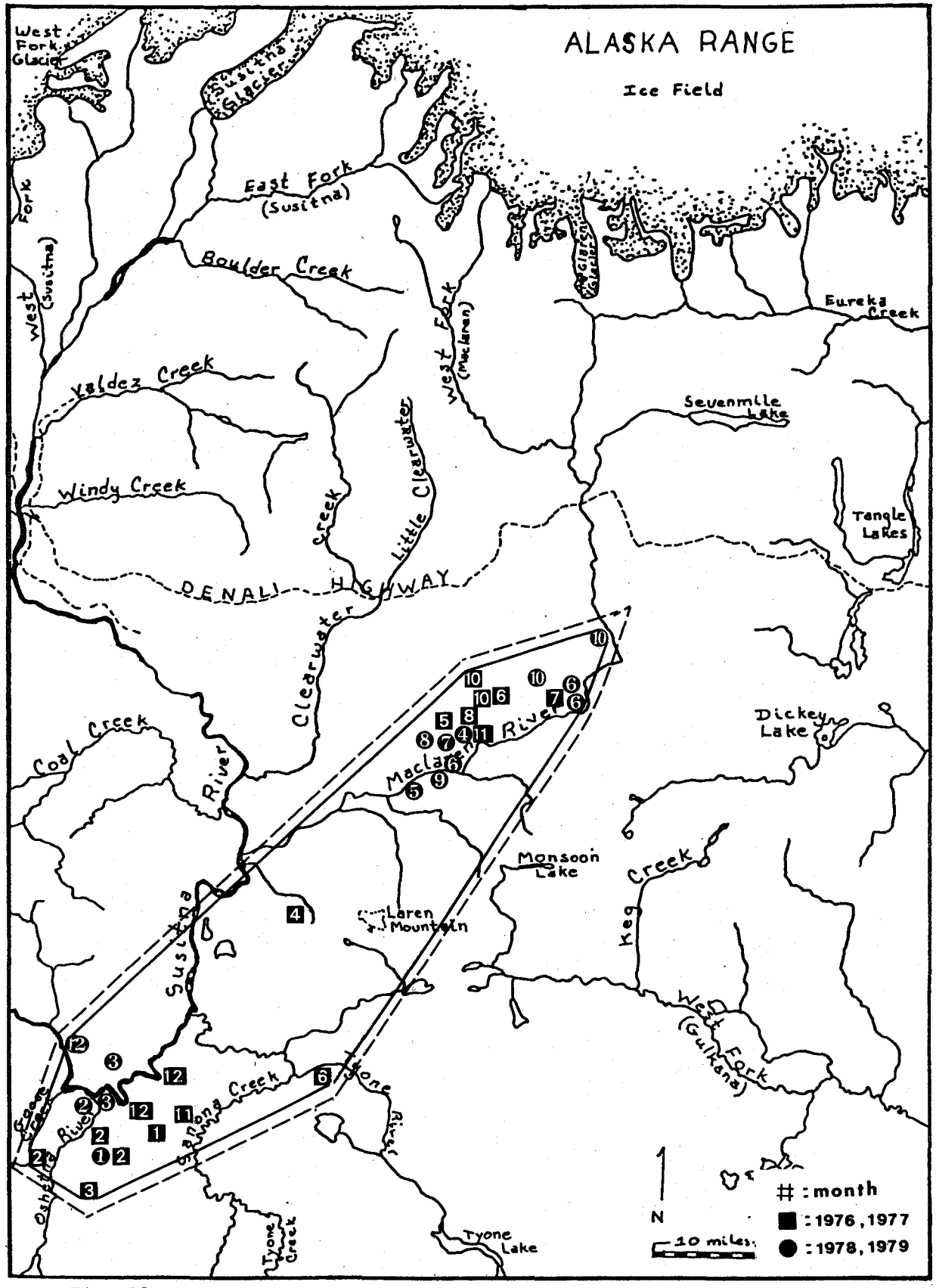


Fig. 13. Annual home range and monthly locations of moose 8035 from October 1976 through April 1979 in the Susitna River Study Area.*

* Does not include movement made to south of Glenn Highway during winter 1978-79.

Moose 8036 (Fig. 14) was collared on 28 October 1976 just below West Fork Glacier and by 2 November had moved south 18 km (1 mi) to a lower elevation. She remained within a 49 km^2 (19 mi^2) area through winter and spring and by 29 May 1977 had given birth to one calf. By 5 June she had moved to the Susitna River and had lost her calf. She spent the remainder of the summer and first half of the fall 13 km (8 mi) to the north at elevations above 900 m. By 31 October she had moved back to the lowlands where she wintered during 1977-78.

During 1978 she repeated the above movements, giving birth to twins by 6 June. One calf was lost by 25 June. She and the remaining calf occupied the same summer range used in 1977 and returned 11 km (7 mi) to the vicinity of the tagging site by late September, possibly for breeding purposes. They spent winter 1978-79 on the west fork Susitna River flats and were last observed on 29 March 1979.

Moose 8037 (Fig. 15) was accompanied by a calf when collared on 28 October 1976, above the Denali Highway between Little Clearwater Creek and the Maclaren River. By 22 November she and the calf migrated south down Monsoon Lake Creek to 16 km (10 mi) south of the headwaters of the west fork of the Gulkana River; a straight line movement of 81 km (50 mi). They overwintered in that area within an old spruce burn. She was last observed with her calf on 13 May. She had given birth to another calf in the same area by 3 June. By 12 July they had migrated north 97 km (60 mi) to Boulder Creek above the Denali Highway and east of the Maclaren River. They remained in the area through the summer. By 5 October they had moved south to just east of Round Mountain and by 22 November had returned to the wintering area where they remained through winter 1977-78.

During late spring 1978 she again gave birth to a calf (adjacent to the wintering area used in 1976-77 and 1977-78). Between 19 and 26 June 1978 they migrated northward, reaching Boulder Creek by 7 July 1978 where they remained at least until 17 August. Between 17 August and 22 September they again moved approximately 40 km (25 mi) south to an area 5 km (3 mi) south of Monsoon Lake. Surprisingly, between 5 and 25 October they again migrated to Boulder Creek. After 25 October 1978 we lost radio contact with the pair.

Moose 8038 (Fig. 16) was collared approximately 3 km (2 mi) southeast of Big Lake on 27 October 1976. Between 27 October and 22 November she had moved approximately 10 km (6 mi) southeast to Watana Creek where she remained through winter 1976-77. Between 22 April and 26 May she moved 5 km (3 mi) back toward Big Lake where she gave birth to one calf. The calf, however, was missing by 31 May. She spent summer 1978 in a relatively small area between Delusion and Watana Creeks, but again overwintered (1977-78) predominately on the east side of Watana Creek. On 30 May 1978 her radio signal was

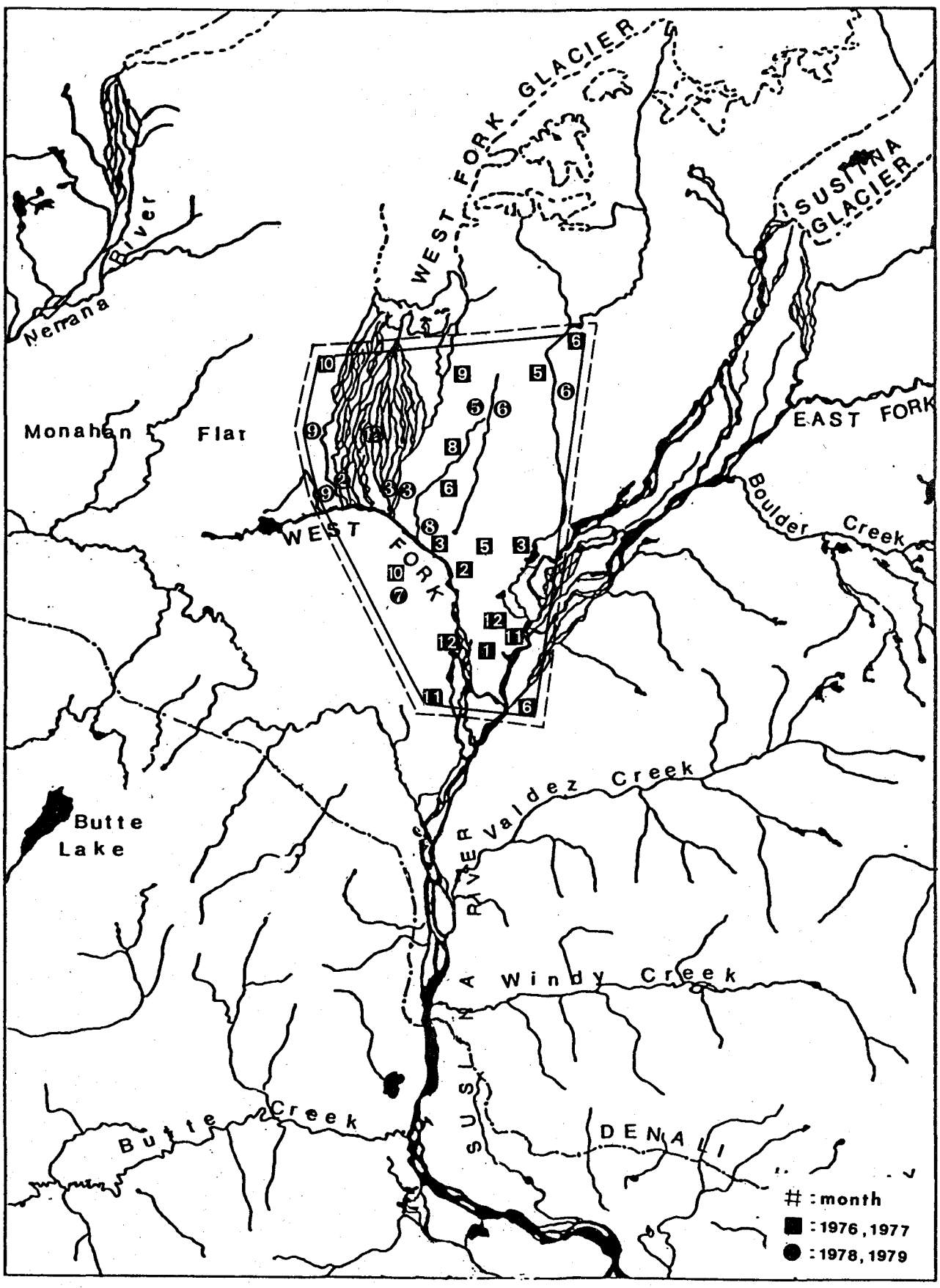


Fig. 14. Annual home range and monthly locations of moose 8036 from October 1976 through March 1979 in the Susitna River Study Area.

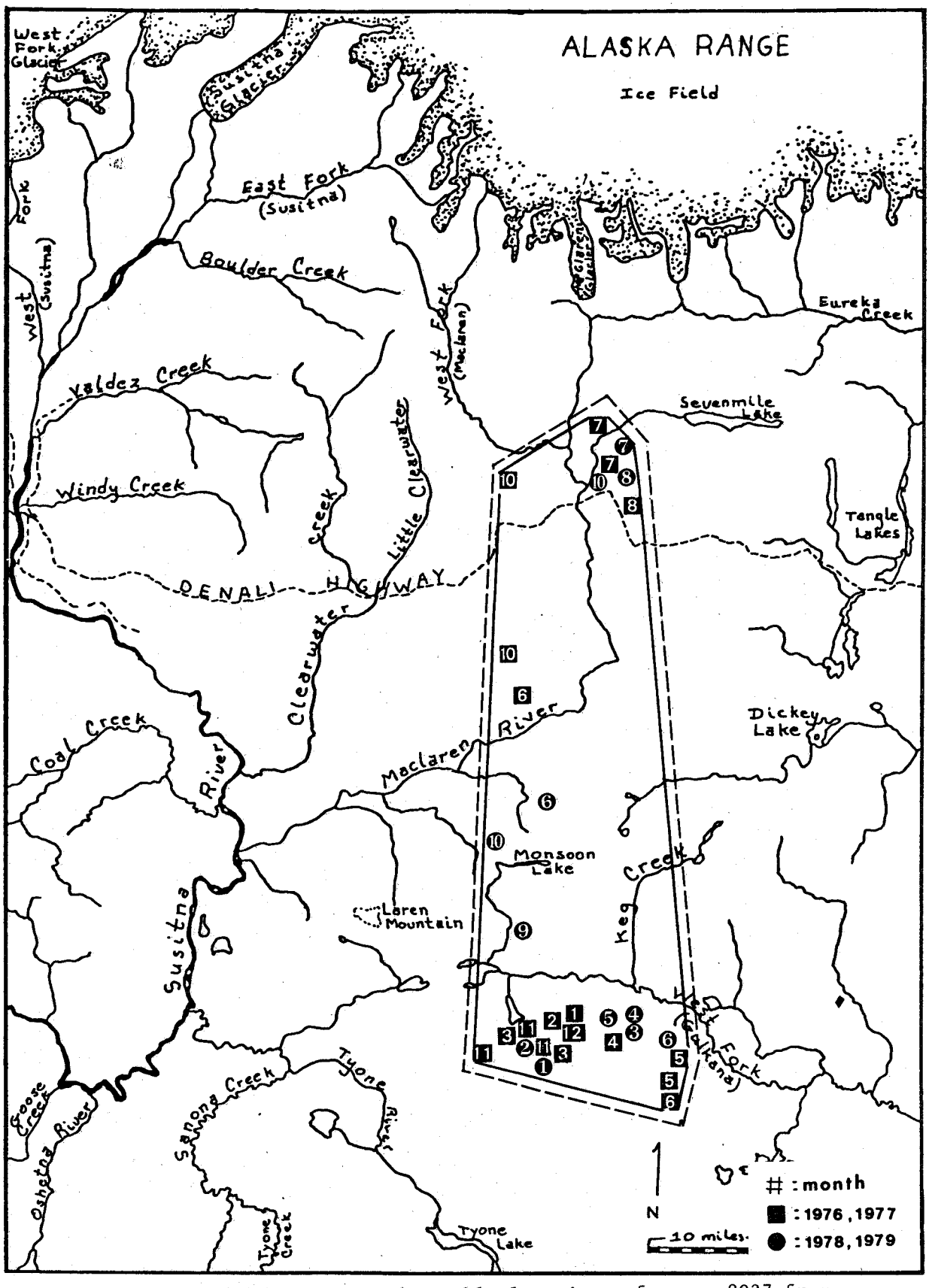


Fig. 15. Annual home range and monthly locations of moose 8037 from October 1976 through October 1978 in the Susitna River Study Area.

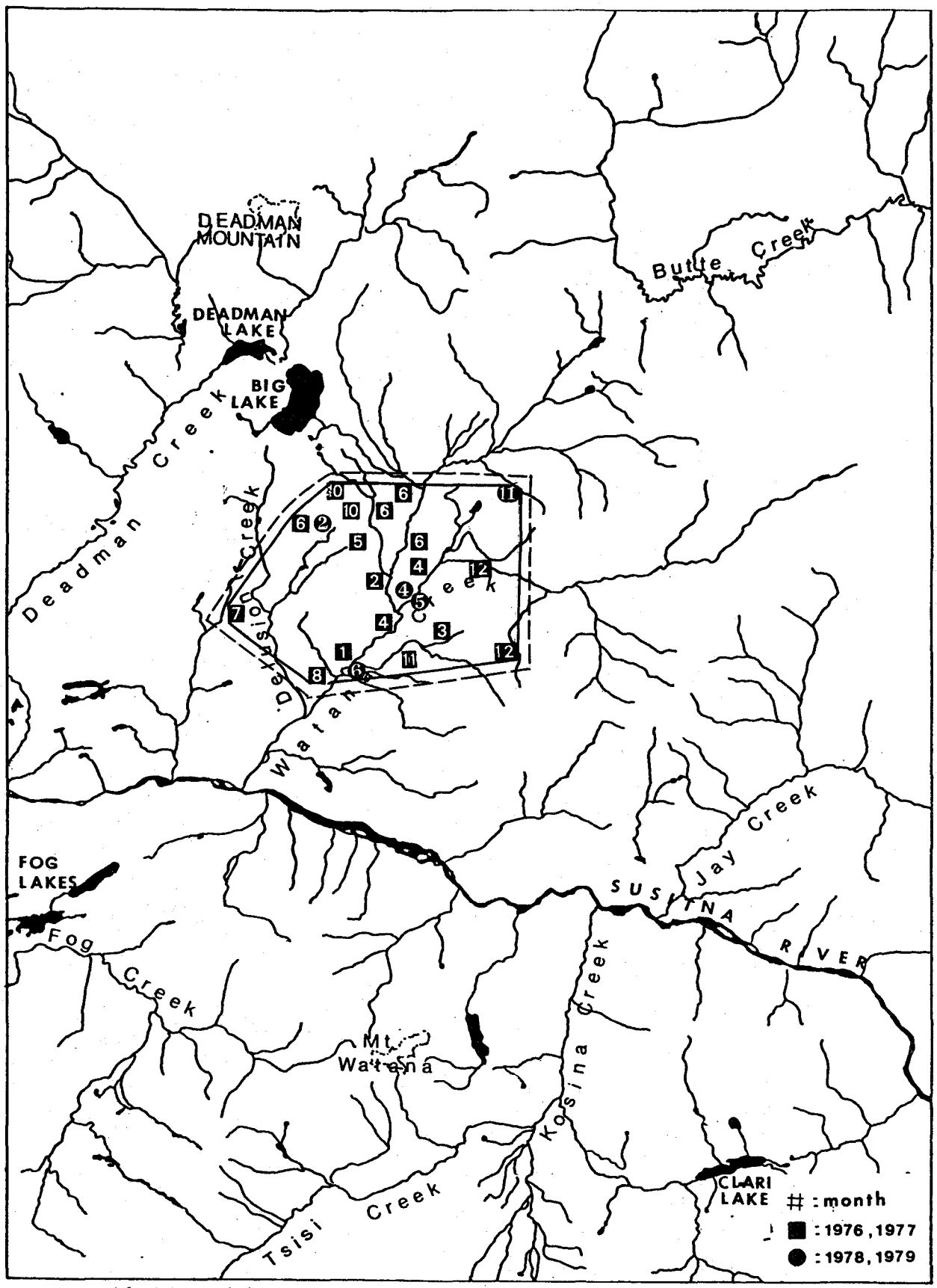


Fig. 16. Annual home range and monthly locations of moose 8038 from October 1976 through May 1978 in the Susitna River Study Area.

detected on Watana Creek. We visited the site on 8 July 1978 and were unable to retrieve the transmitter because it was located in a deep pool in the creek. The animal had either slipped the collar or died of unknown causes.

Moose 8039 (Fig. 17) was collared on 28 October 1976 west of the Maclaren River approximately 6 km (4 mi) north of the Denali Highway. By 19 November she had moved south 21 km (13 mi) to NW of the big bend on the Maclaren River. She remained on the river through winter, moving up and down the stream approximately 18 km (11 mi). She gave birth to twins by 1 June, but both were missing by 17 June. As summer progressed she moved to a slightly higher elevation on Round Mountain and remained in the area through fall and was never observed back at the tagging site during 1977.

She spent winter 1977-78 in the vicinity of the bend in the Maclaren River where she calved by 3 June 1978 and remained through summer. She was last observed with her calf on 18 September 1978 on the bend of the Maclaren River. Between 18 September and 27 October she moved 18 miles north to Glaser Lake where she died of unknown causes. Fate of the calf was unknown.

Moose 8040 (Fig. 18) was collared on 28 October 1976 approximately 26 km (16 mi) upstream from the mouth of Watana Creek. She remained within 13 km (8 mi) of the tagging site, wintering along the Watana Creek hillsides. By 26 May she had moved down the creek to lower elevations giving birth to twin calves by 8 June. Both calves were missing by 16 June. She again wintered along Watana Creek during 1977-78, but died there of unknown causes by 11 April 1978.

Moose 8042 (Fig. 19) was collared on 28 October 1976 just below West Fork Glacier and by 19 November had moved 21 km (13 mi) south to the Denali Highway. She remained within an area of approximately 26 km^2 (14 mi^2) through at least 5 August. She had given birth to one calf by 31 May but it was missing by 5 August. By 18 September she had moved 16 km (10 mi) north back to the tagging site. By 29 December she then had returned to the Denali Highway. Her movements through March 1979 were similar to those documented during the first year of study. She was never observed with a calf during 1978.

Moose 8044 (Fig. 20) was collared on 23 October 1976 13 km (8 mi) north of the Denali Highway on Little Clearwater Creek. By 23 March she had moved 13 km (8 mi) SW to just below the Denali Highway. The radio signal from this moose shifted and, therefore, we lost contact with her until 10 May when she was relocated 15 km (9 mi) west of her last known location. By 25 May she had moved 26 km (15 mi) to the east on Clearwater Creek. She then moved 8 km (5 mi) to the SW and then in the opposite direction up to the Denali Highway by 10 June, where she gave birth to one calf. By 17 June the calf was missing and she began moving in a southwesterly direction but returned to the same area by 5 October. Between 5 October and 2 November she had moved 15 km (9 mi) up Big Clearwater Creek but then returned to the Denali Highway by 22 November.

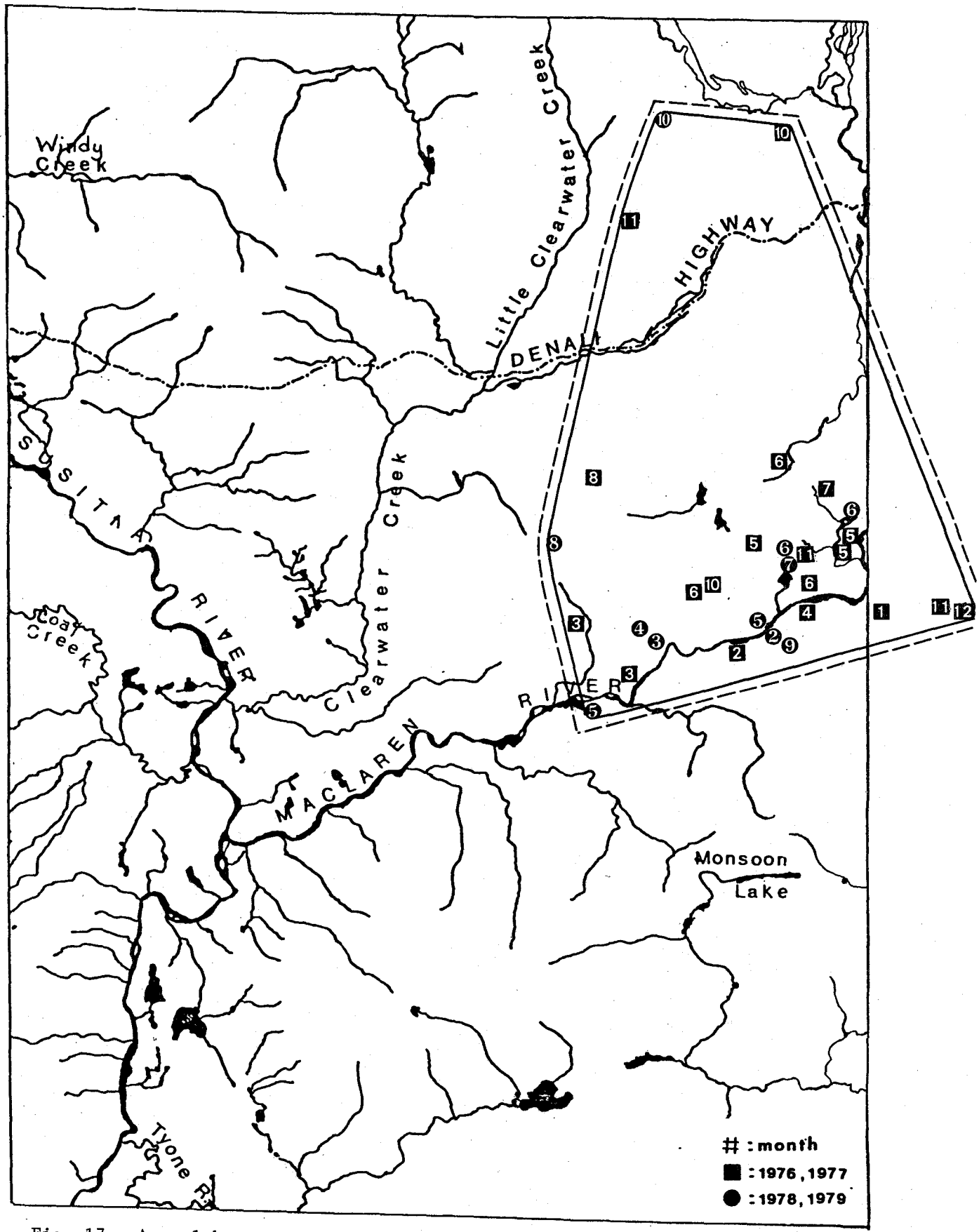


Fig. 17. Annual home range and monthly locations of moose 8039 from October 1976 through October 1978 in the Susitna River Study Area.

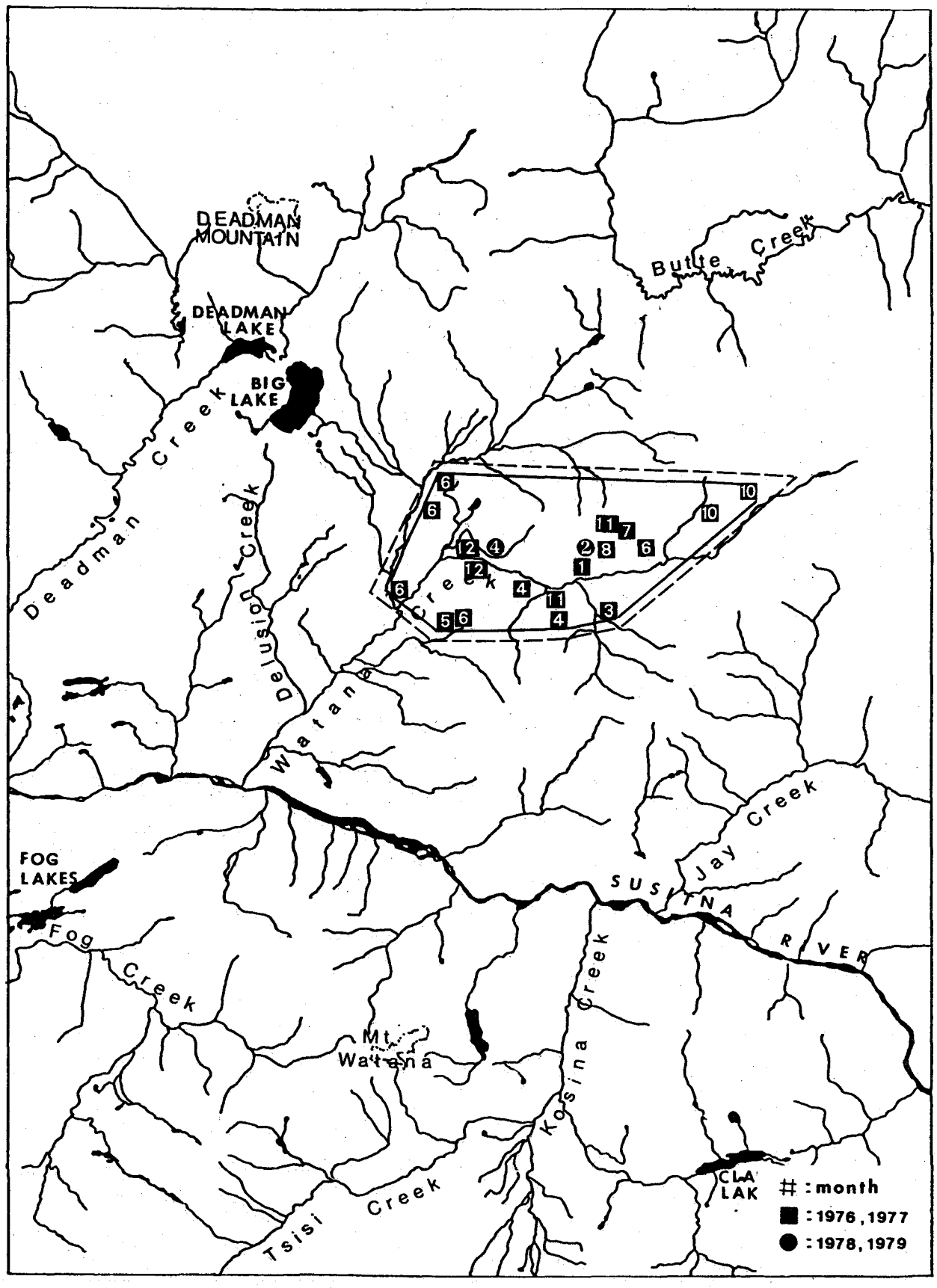


Fig. 18. Annual home range and monthly locations of moose 8040 from October 1976 through April 1978 in the Susitna River Study Area.

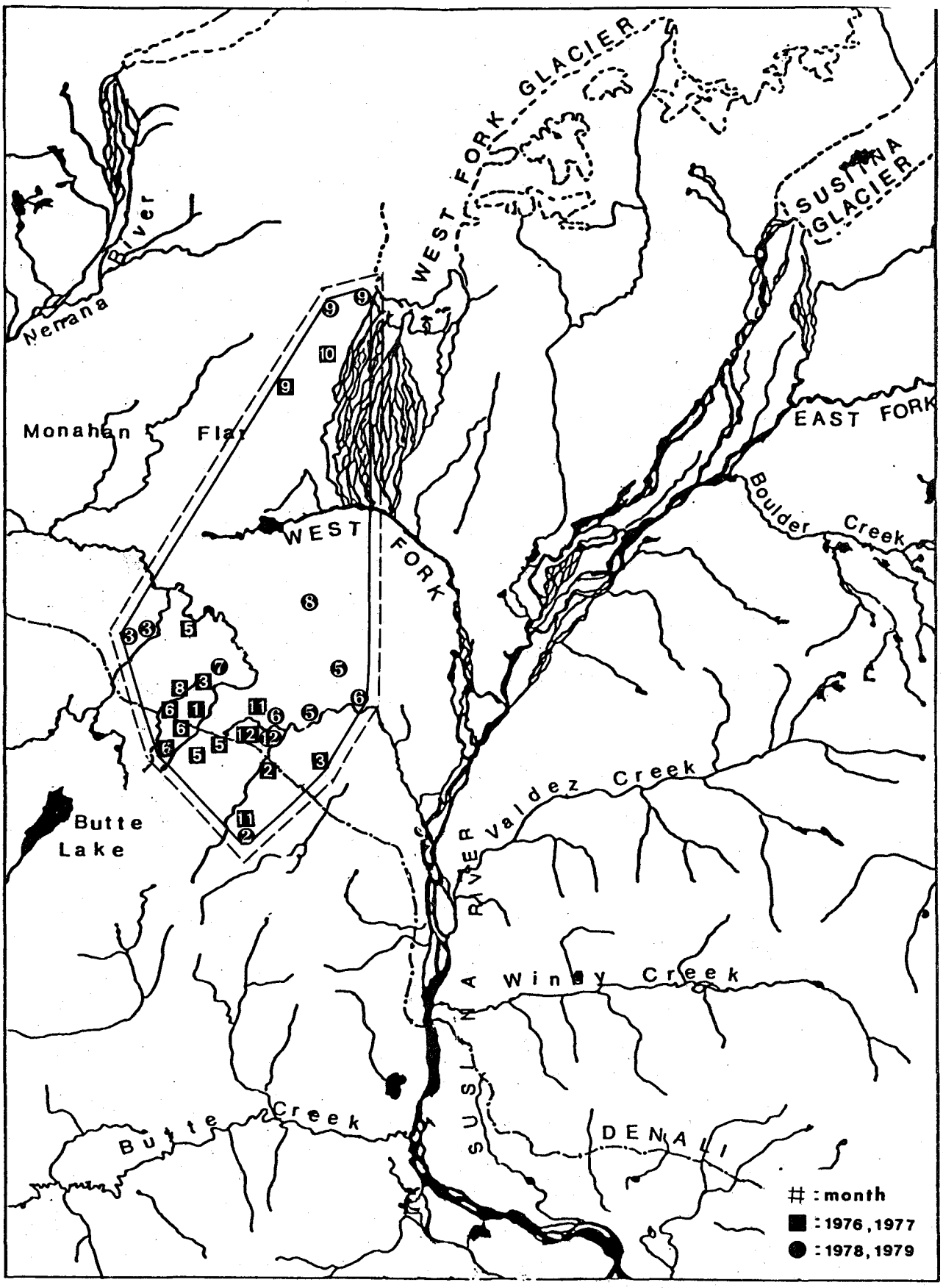


Fig. 19. Annual home range and monthly locations of moose 8042 from October 1976 through March 1979 in the Susitna River Study Area.

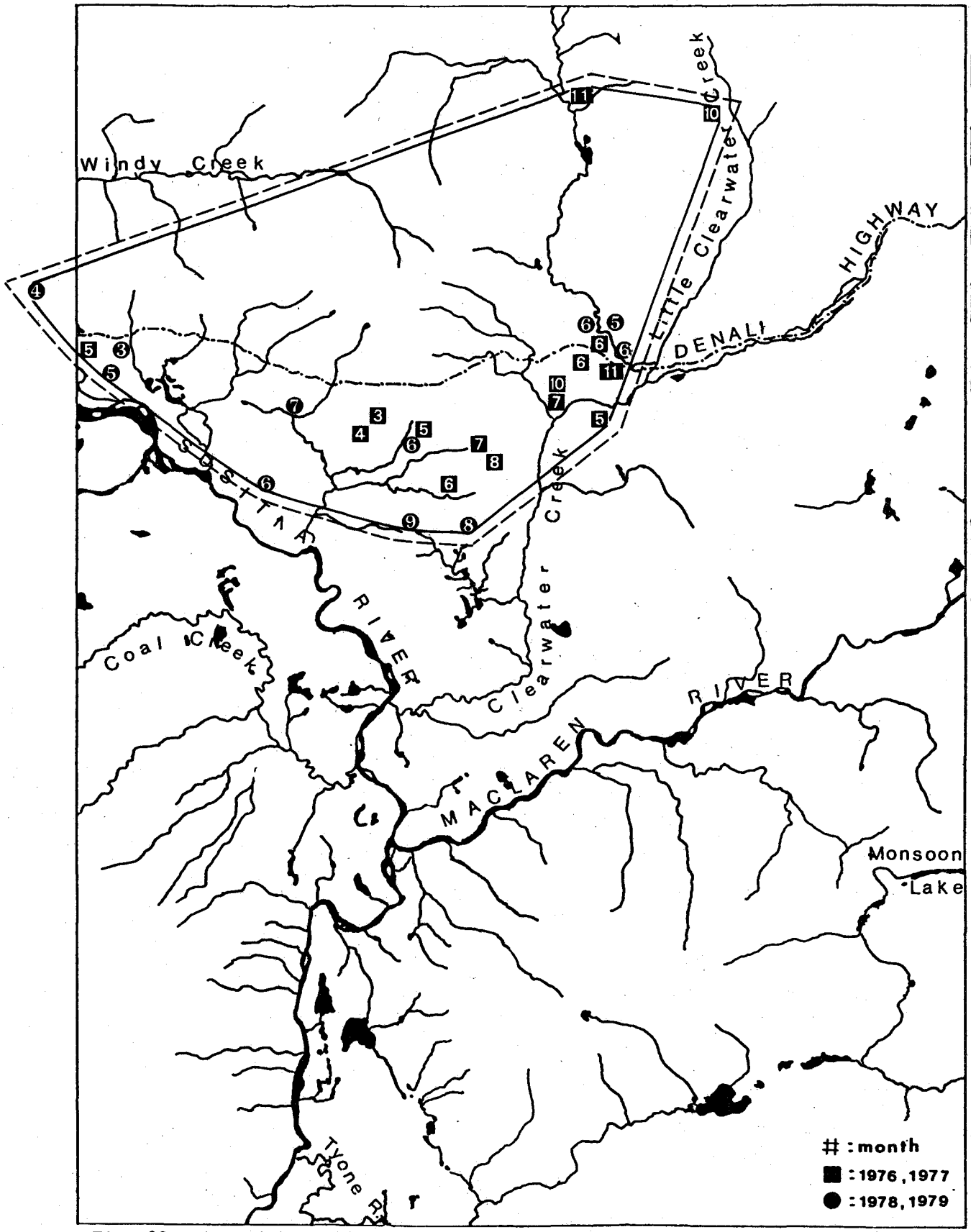


Fig. 20. Annual home range and monthly locations of moose 8044 from October 1976 through April 1979 in the Susitna River Study Area.

She wintered and summered in 1977-78 in the same areas occupied during 1976-77. She was first observed with a calf during 1978 on 27 May, but lost it by 7 June. We do not know if she returned to the head of Clearwater Creek during fall 1978, but she did overwinter in the same area used previously. She was last observed in late April 1977.

Moose 8570 (Fig. 21) was collared on 20 March 1977 at the junction of Brushkana River and Monahan Flats Creek. By 10 May she had moved approximately 16 km (10 mi) to the junction of Wells Creek and the Nenana River. Between 10 and 25 May she moved 29 km (18 mi) to Monahan Flats where she gave birth to one calf. After 25 May we never observed her with a calf, although she stayed in the calving area until 31 May. In early summer she moved north 15 km (9 mi), spending the remainder of the summer and fall at higher elevations on the northeastern headwaters of the Nenana River.

Through the remainder of the study, moose 8570 continued to exhibit an east-west movement pattern; wintering near the mouth of Seattle and Brushkana Creeks and summering on Monahan Flats and the headwaters of the Nenana River. She appeared to travel to the area below Nenana Glacier during the rutting season. During 1978 she produced a calf on 8 June. Both were last observed on 3 May 1979.

Moose 8571 (Fig. 22) was collared on 20 March 1977 approximately 8 km (5 mi) south of the Maclaren River on the west side of the Susitna River. She was accompanied by her calf when collared. Both remained in the vicinity of the tagging site through spring. She had given birth to a calf by 30 May, but lost it by 24 June. Moose 8571 remained within 16 km (10 mi) of the tagging site throughout the study. She occupied lower elevations during calving and winter seasons and higher elevations during snow-free periods. She gave birth to a calf by 11 June in 1978. Both were observed together up to 16 April 1979 when the calf was missing.

Moose 8572 (Fig. 23) was collared on 22 March 1977 approximately 1.6 km (1 mi) north of the mouth of Maclaren River. She had crossed the river by 30 March and then moved 10 km (6 mi) SW to higher elevations where, during the summer, she occupied an area of approximately 47 km^2 (18 mi^2). During October and November she remained at higher elevations south of the river. Although she was pregnant when collared, she was never observed with a calf.

During winter 1977-78 moose 8572 occupied a relatively small home range on the Western Alphabet Hills. Her winter range overlapped the summer range. During summer 1978 she gave birth to a calf between 7 July and 17 August; the latest parturition date observed during this study. Both continued to utilize the same home range utilized in 1977-78 and were last observed on 20 February 1979.

Moose 8573 (Fig. 24) was collared on 19 March 1977 approximately 13 km (8 mi) east of the mouth of Watana Creek. During winters 1977-78 and 1978-79 she occupied winter range between Watana and Jay Creeks

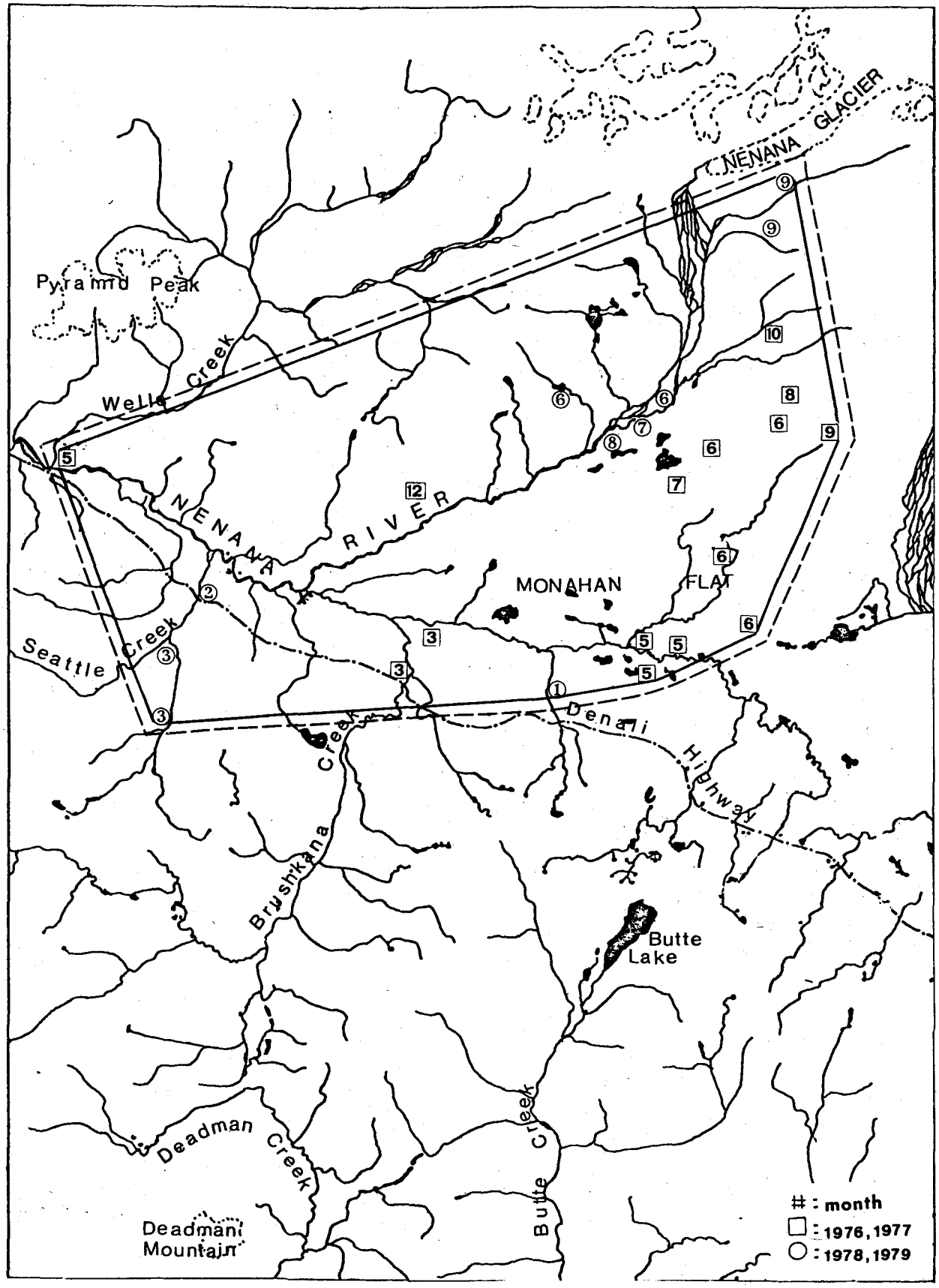


Fig. 21. Annual home range and monthly locations of moose 8570 from March 1977 through May 1979 in the Susitna River Study Area.

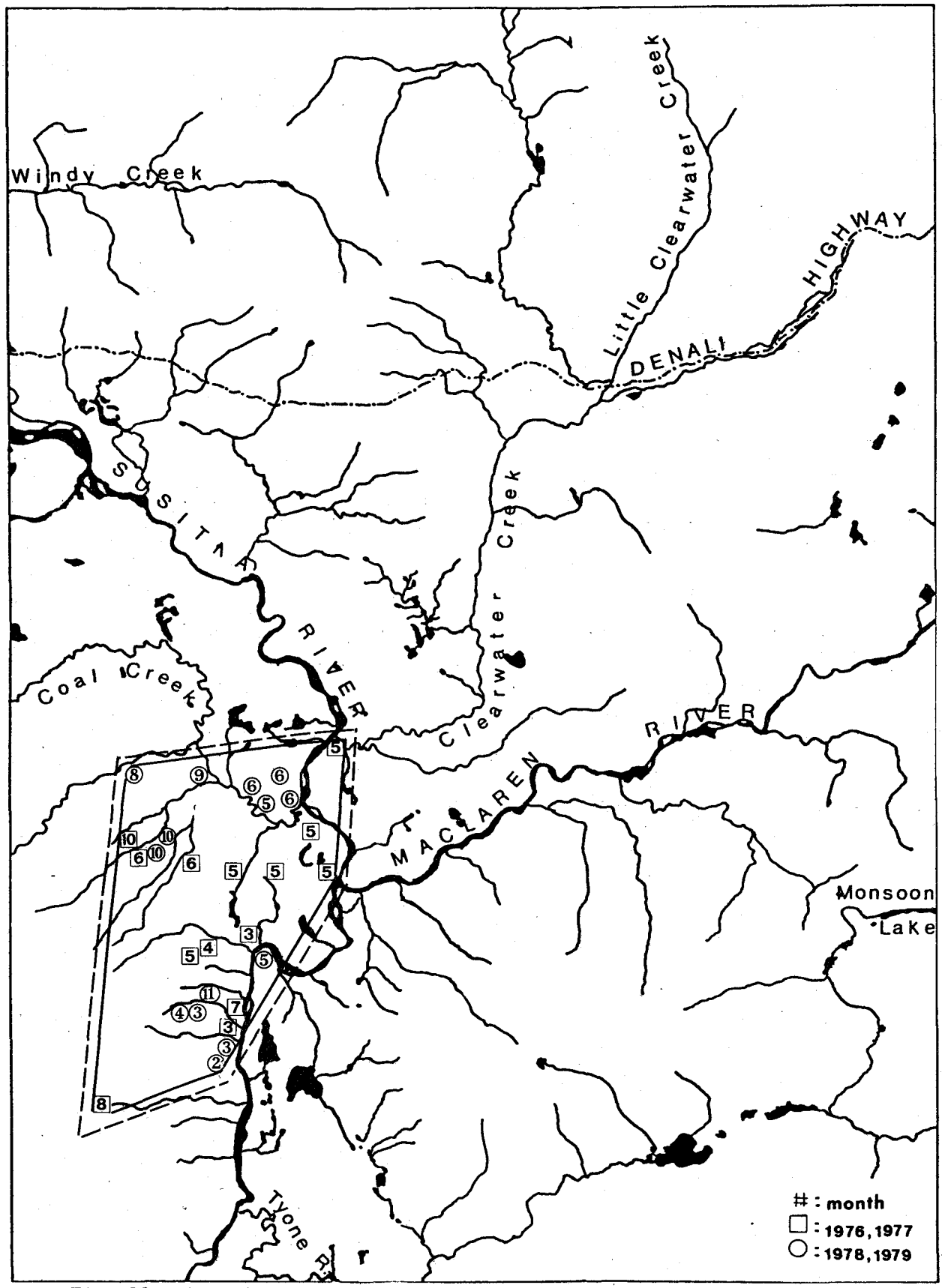


Fig. 22. Annual home range and monthly locations of moose 8571 from March 1977 through April 1979 in the Susitna River Study Area.

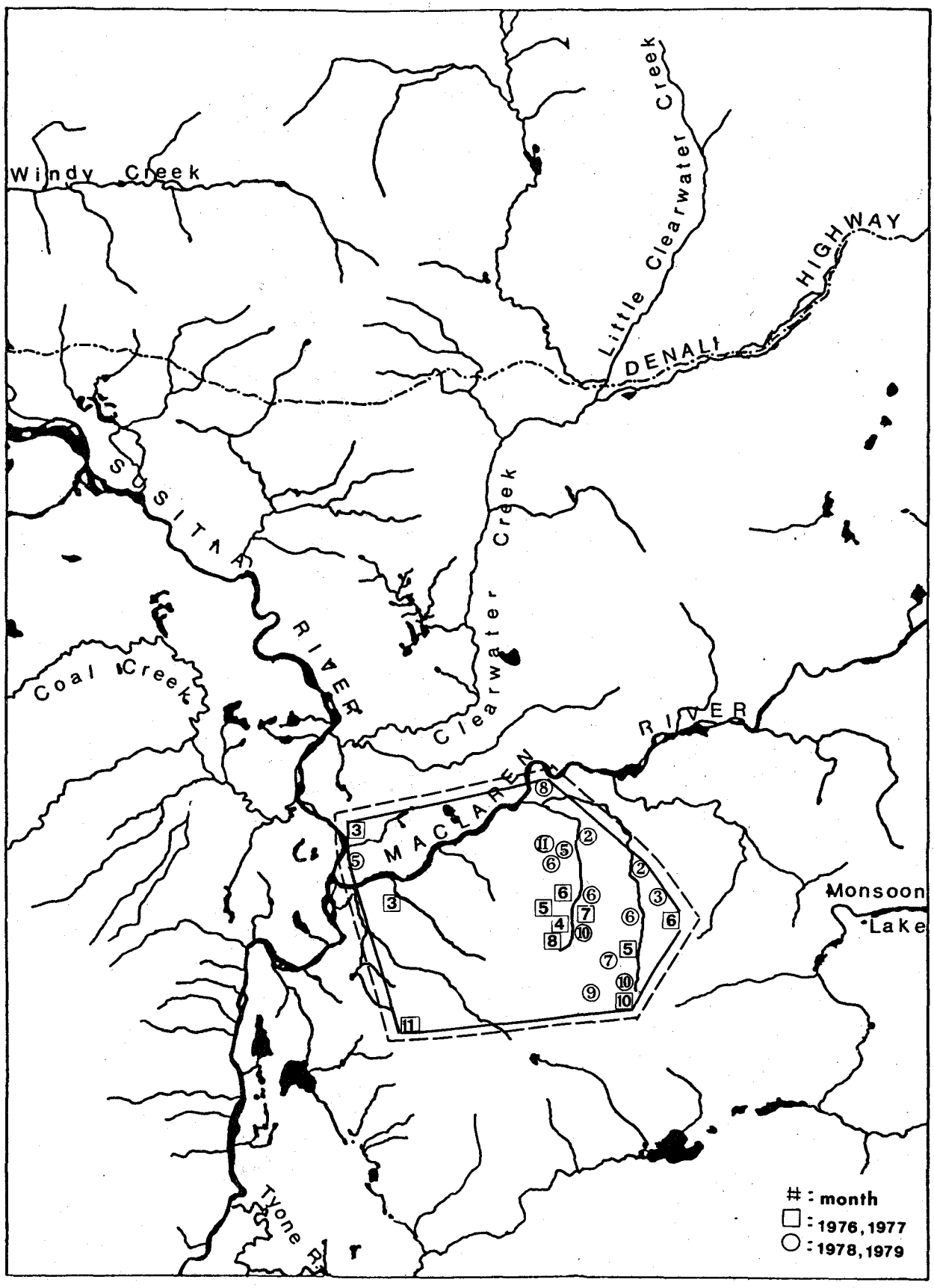


Fig. 23. Annual home range and monthly locations of moose 8572 from March 1977 through February 1979 in the Susitna River Study Area.

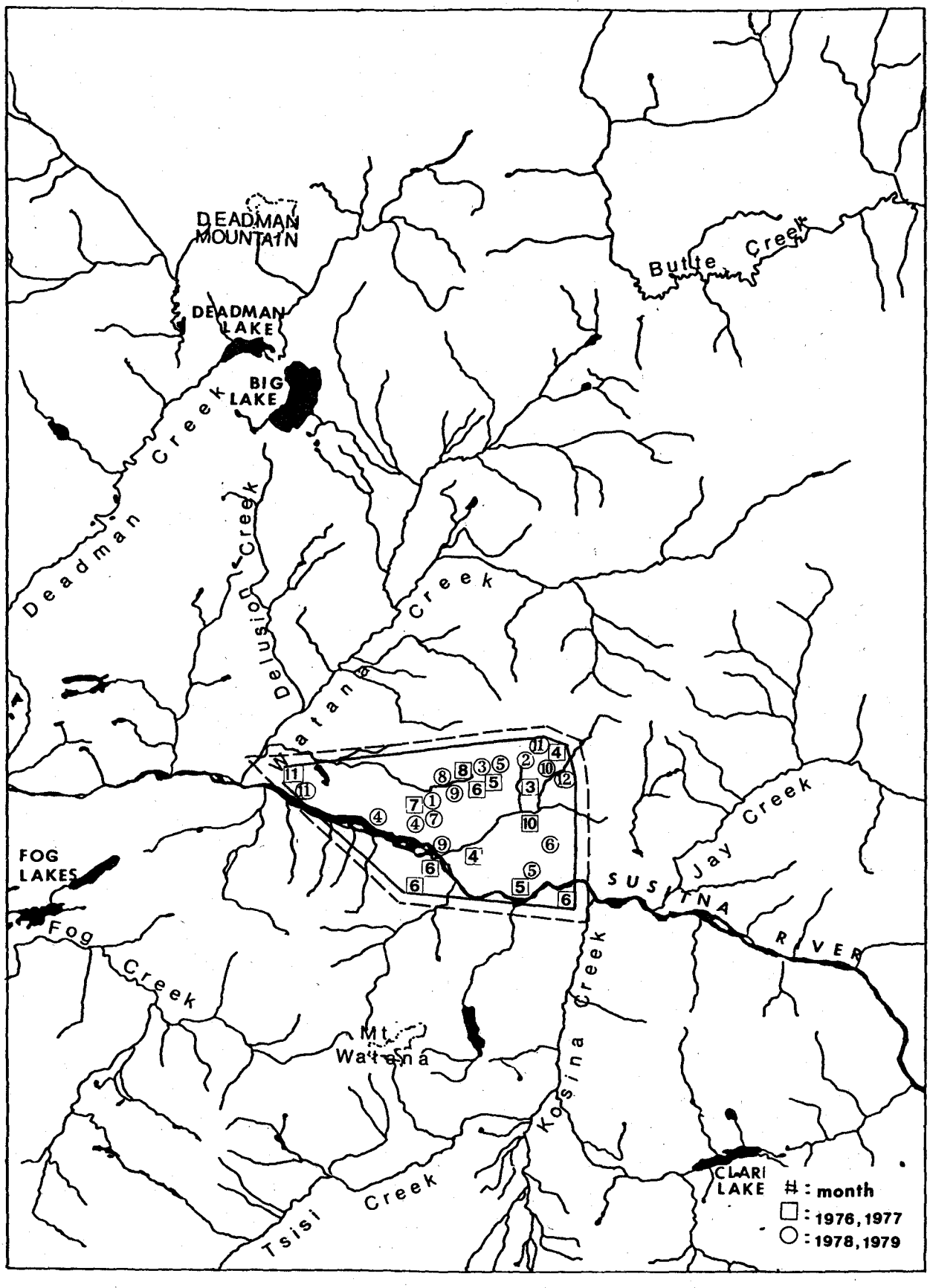


Fig. 24. Annual home range and monthly locations of moose 8573 from March 1977 through May 1979 in the Susitna River Study Area.

on the north side of the Susitna River. Her winter range overlapped her summer range, except that during summer she crossed the Susitna River and occupied a small area within 0.6 km (1 mi) of the river. She was not observed with a calf during 1977, but did give birth to one by 3 June 1978. Both were last observed on 3 May 1979.

Moose 8574 (Fig. 25) was collared 20 March 1977 at the junction of the west and middle Forks of Susitna River. By 31 March she had moved 13 km (8 mi) west and by 10 May had moved SW 8 km (5 mi) to the Denali Highway. She gave birth to one calf just below the highway but the calf was missing by 25 June. Between 25 June and 18 September she moved westward to the spruce-dominated hills 6 km (4 mi) north of Valdez Creek where she remained through 30 October 1977. During winters 1977-78 and 1978-79 she ranged across the eastern end of Monahan Flats. Her summer range was considerably smaller than her winter range although they overlapped. She was not observed with a calf during 1978 or 1979 and was last observed on 29 March 1979.

Moose 8575 (Fig. 26) was collared on 21 March 1977 approximately 5 km (3 mi) upstream from the mouth of the Maclaren River. Between 30 March and 22 April she migrated approximately 82 km (51 mi) south to Tolsona Ridge and the Glenn Highway. She was not observed with a calf during 1977 but remained in the area during summer, ranging as far south as Sucker Lake. She returned to the Western Alphabet Hills between 13 September and 5 October 1977. She reached her wintering area along the Maclaren River by 22 November where she remained until 4 May 1978.

Between 4 May and 9 May 1978, she again migrated to Tolsona Ridge where she gave birth to one calf. Her calf was radio-collared as part of a moose calf mortality study and was subsequently killed by a brown bear (*Ursus arctos*) during June (Ballard et al. In press). She remained on her summer range until 5 October 1978 at which time she migrated back to her winter range arriving by 25 October 1978. By 7 March 1979 she was back on Tolsona Ridge. She was last observed on 16 March 1979.

Moose 8576 (Fig. 27) was collared on 19 March 1977 approximately 13 km (8 mi) east of the mouth of Watana Creek. Her movements and history were nearly identical to that described for moose 8573 except that this moose's calf, which was born by 30 May 1978, was lost by 12 June and she never crossed the Susitna River. She was last observed on 29 March 1979.

Moose 8577 (Fig. 28) was collared on 20 March 1977 approximately 10 km (6 mi) north of the mouth of Tyone River on the west side of the Susitna River. She moved 16 km (10 mi) NE and spent spring and summer just northeast of the mouth of Clearwater Creek. By 1 November she had moved up Clearwater Creek to the Denali Highway where she remained through the fall. Although recorded as pregnant, she was never observed with a calf during 1977. Her winter and summer ranges overlapped during 1977-78 and 1978-79, ranging from the

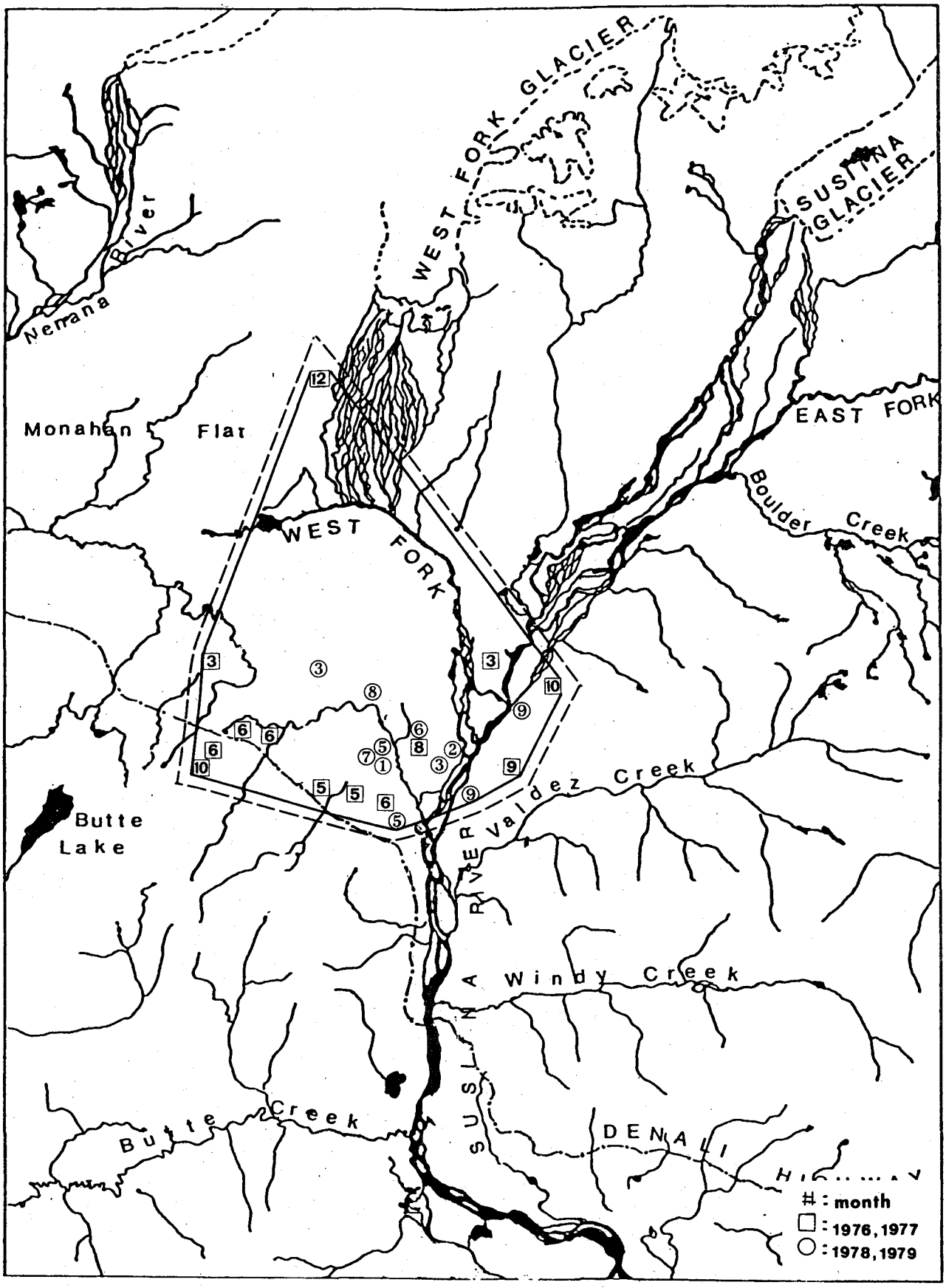


Fig. 25. Annual home range and monthly locations of moose 8574 from March 1977 through March 1979 in the Susitna River Study Area.

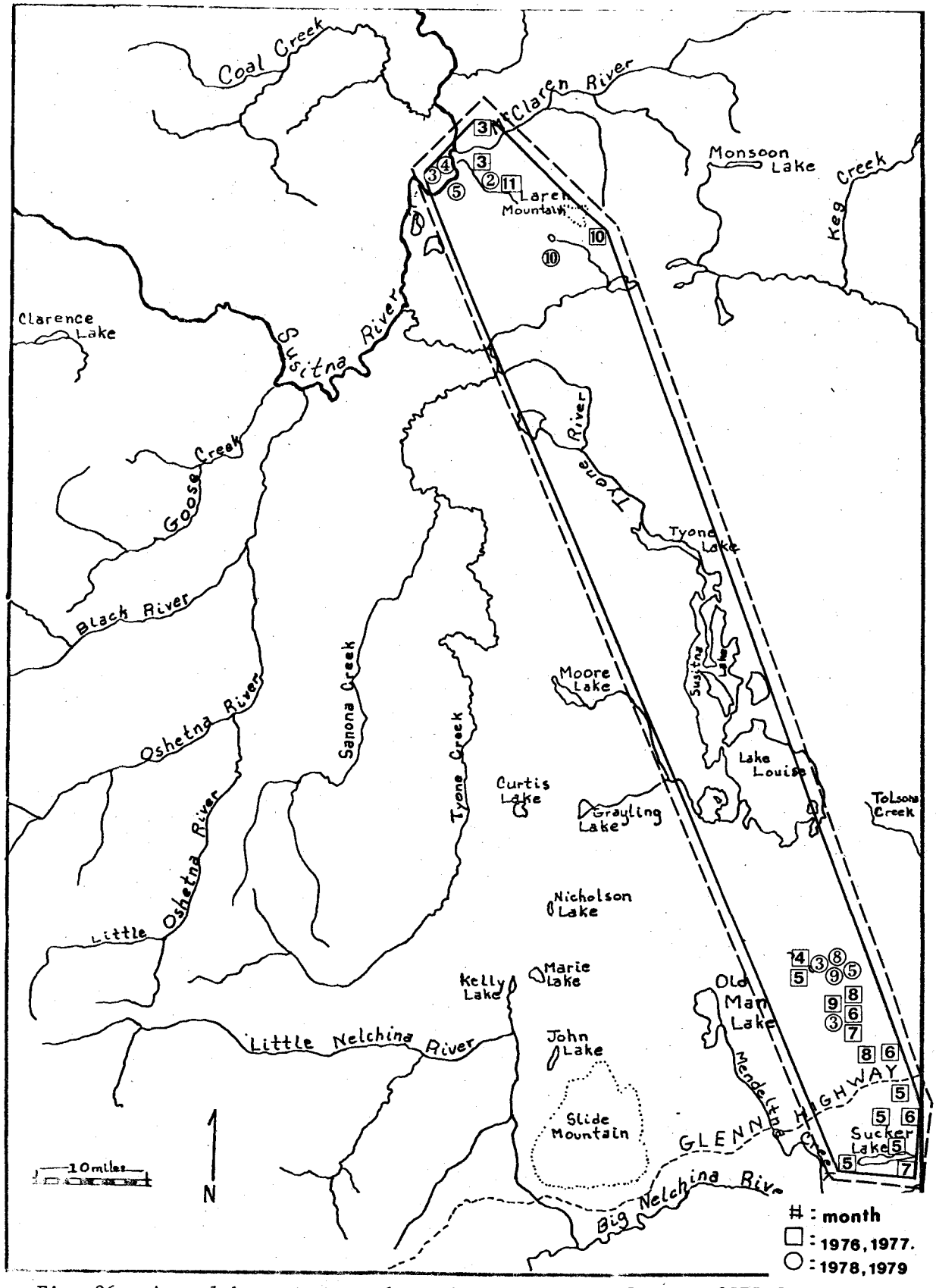


Fig. 26. Annual home range and monthly locations of moose 8575 from March 1977 through March 1979 in the Susitna River Study Area.

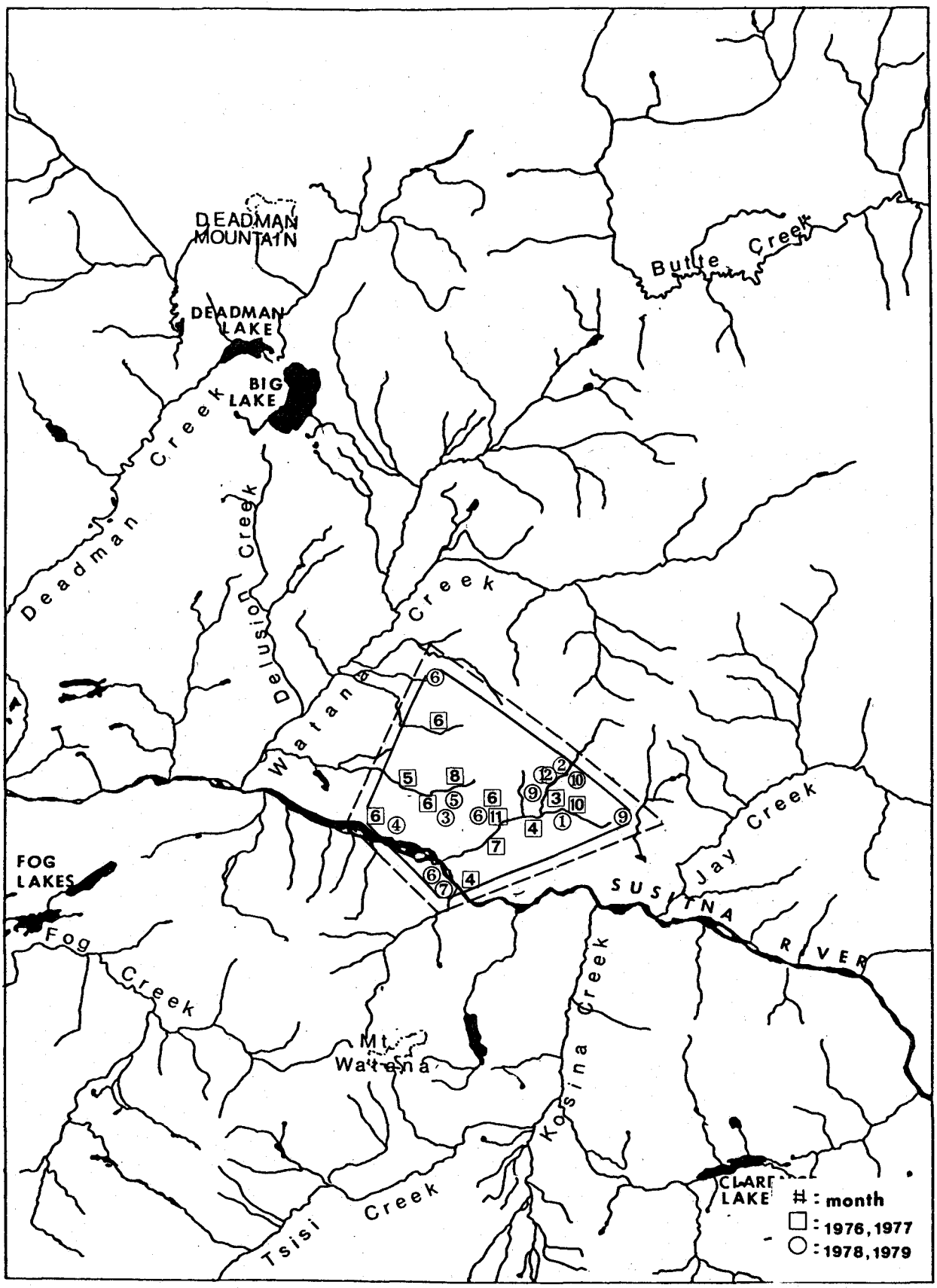


Fig. 27. Annual home range and monthly locations of moose 8576 from March 1977 through March 1979 in the Susitna River Study Area.

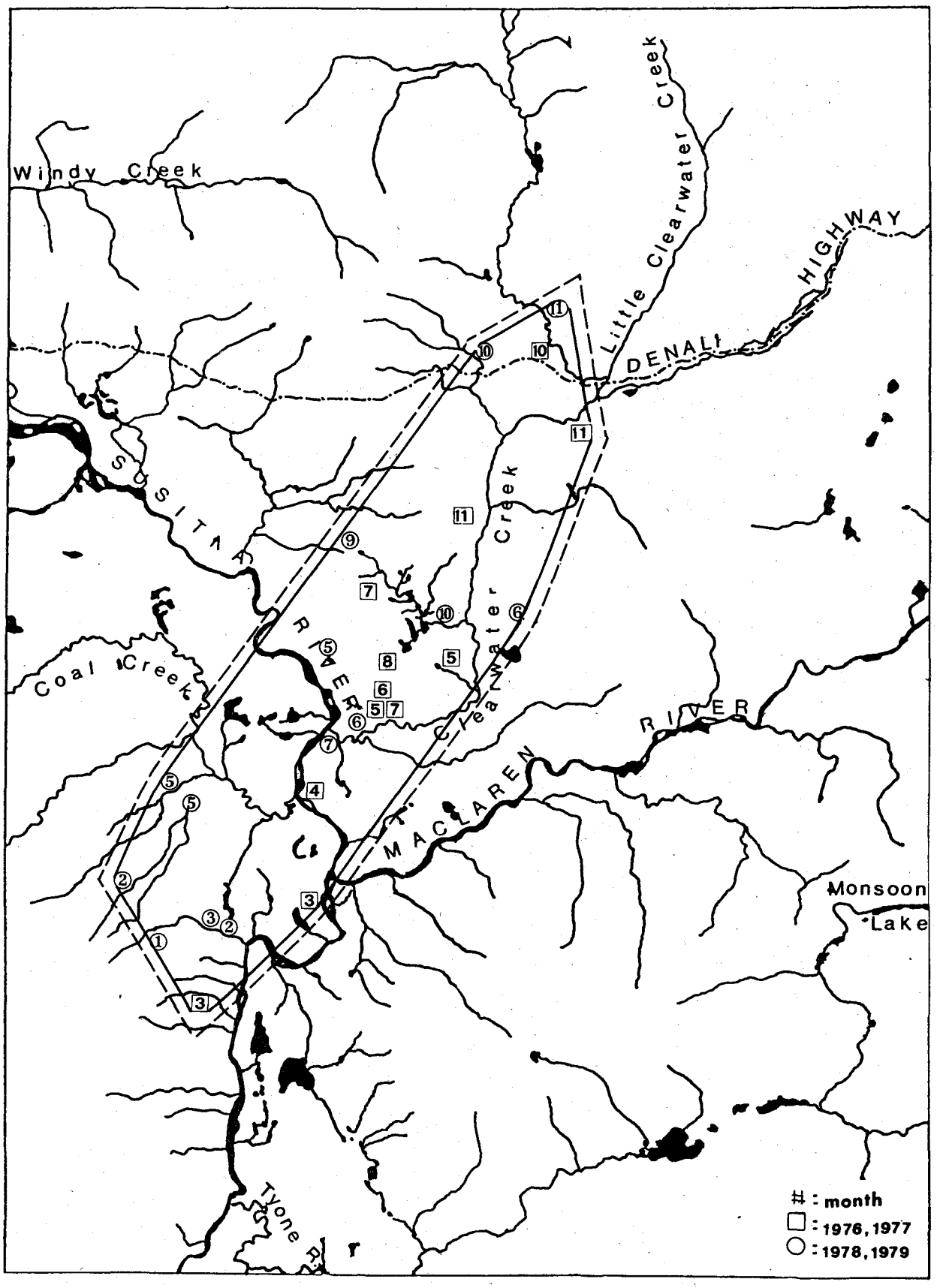


Fig. 28. Annual home range and monthly locations of moose 8577 from March 1977 through February 1979 in the Susitna River Study Area.

Denali Highway at Clearwater Creek to 103 km (3,400 ft) elevation, west of the Susitna River opposite the mouth of the Maclaren River. She gave birth to a calf by 29 May in 1978 and they were last observed on 20 February 1979.

Moose 8578 (Fig. 29) was collared on 20 March 1977 just north of the Susitna River, approximately 5 km (3 mi) west of the mouth of Tyone River. She remained north of the river until between 22 April and 13 May when she crossed the Susitna River at Goose Creek. She occupied a relatively small summer home range in the vicinity of lower Goose Creek and the Oshetna River. She was never observed with a calf. She remained in that area through winter 1977-78 and early summer 1978 and apparently did not return to the tagging site. Between 18 August and 26 October 1978 we lost radio contact with her. She was finally relocated 177 km (110 mi) to the southeast approximately 23 km (14 mi) up from the mouth of the Dadina River, apparently having established a new home range. She was last observed in that locale on 25 October 1979.

Moose 8579 (Fig. 30) was collared on 20 March 1977 on the north side of the Susitna River between the mouths of the Oshetna and Tyone Rivers. Between 20 March and 13 May this moose occupied the benchland at the big bend in the Susitna River. Between 13 May and 3 July she moved northward approximately 19 km (12 mi) to the headwaters of Coal Creek. She was not observed with a calf during 1977. She remained in the Coal Creek drainages through summer and fall returning to the bend in the Susitna River sometime between November and March 1978. She repeated her northward movements to the headwaters of Coal Creek and gave birth to one calf by 3 June. The calf was missing by 7 June. Her summer movements were similar to 1977, except that between 26 June and 7 July she moved approximately 34 km (21 mi) to the northeast to a location just east of Clearwater Creek below the Denali Highway. However, by 17 August she had returned to her 26 June location at Coal Creek. During winter 1978-79 she apparently wintered opposite the mouth of the Maclaren River where she was last observed on 4 April 1979.

Moose 8580 (Fig. 31) was collared on 18 March 1977 at Devil Mountain. By 22 April she had moved up the Susitna River approximately 8 km (5 mi). After this date we lost radio contact with this moose indicating she either emigrated from the area or her transmitter failed.

Moose 8581 (Fig. 32) was collared on 18 March 1977 approximately 3 km (2 mi) north of the mouth of Valdez Creek. She remained in the vicinity of the junction between the middle and west forks of the Susitna River until 31 May, at which time she began moving northward. By 25 June she had wandered to within 6 km (4 mi) of Susitna Glacier. Although she was found pregnant when tagged, she was never observed with a calf through spring and summer. She remained on the upper half of the west fork through the summer, but by 18 September had begun moving downstream toward Valdez Creek where she wintered. By 27 May she had moved up the middle fork of the

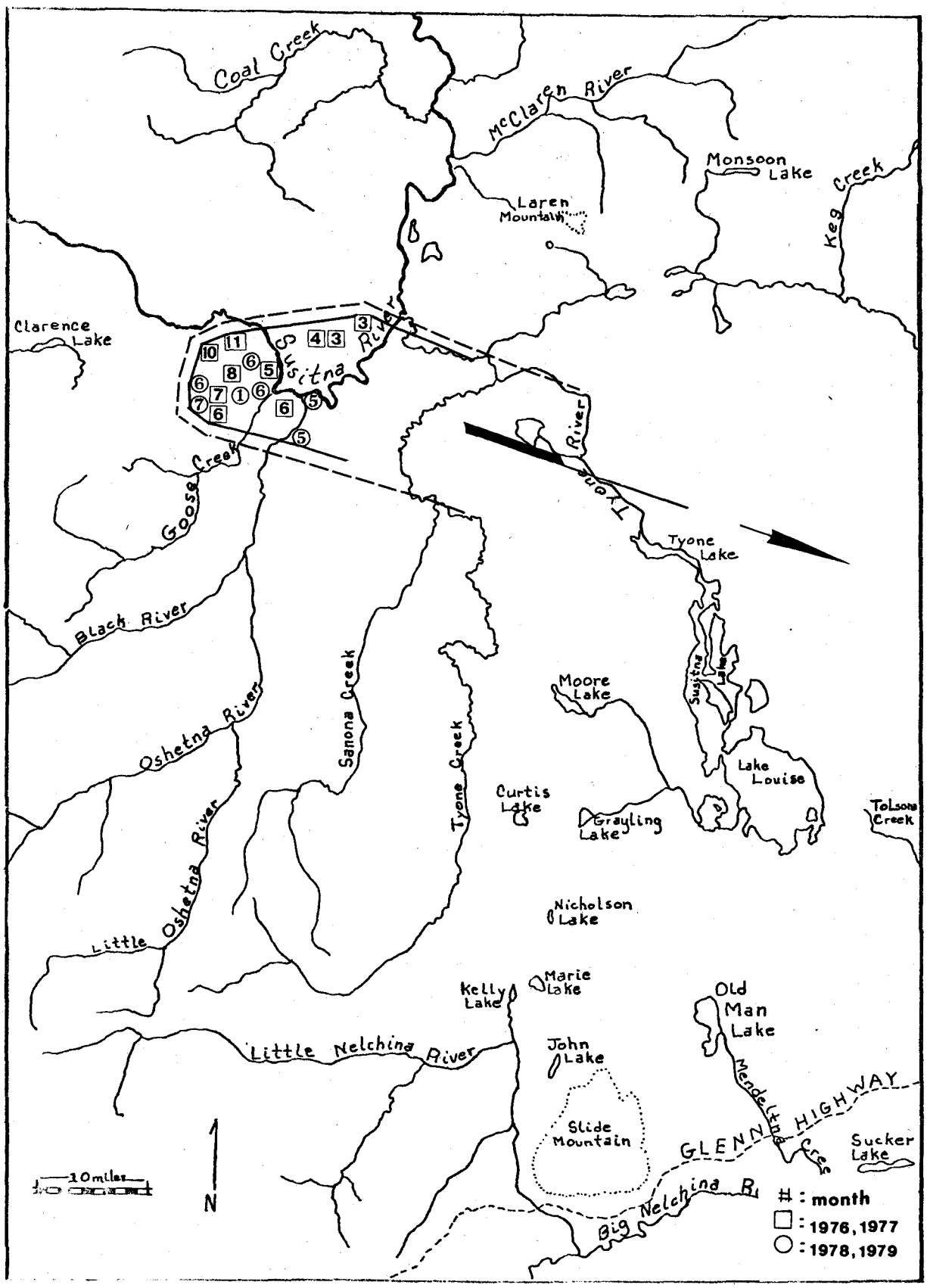


Fig. 29. Annual home range and monthly locations of moose 8578 from March 1977 through October 1979 in the Susitna River Study Area.

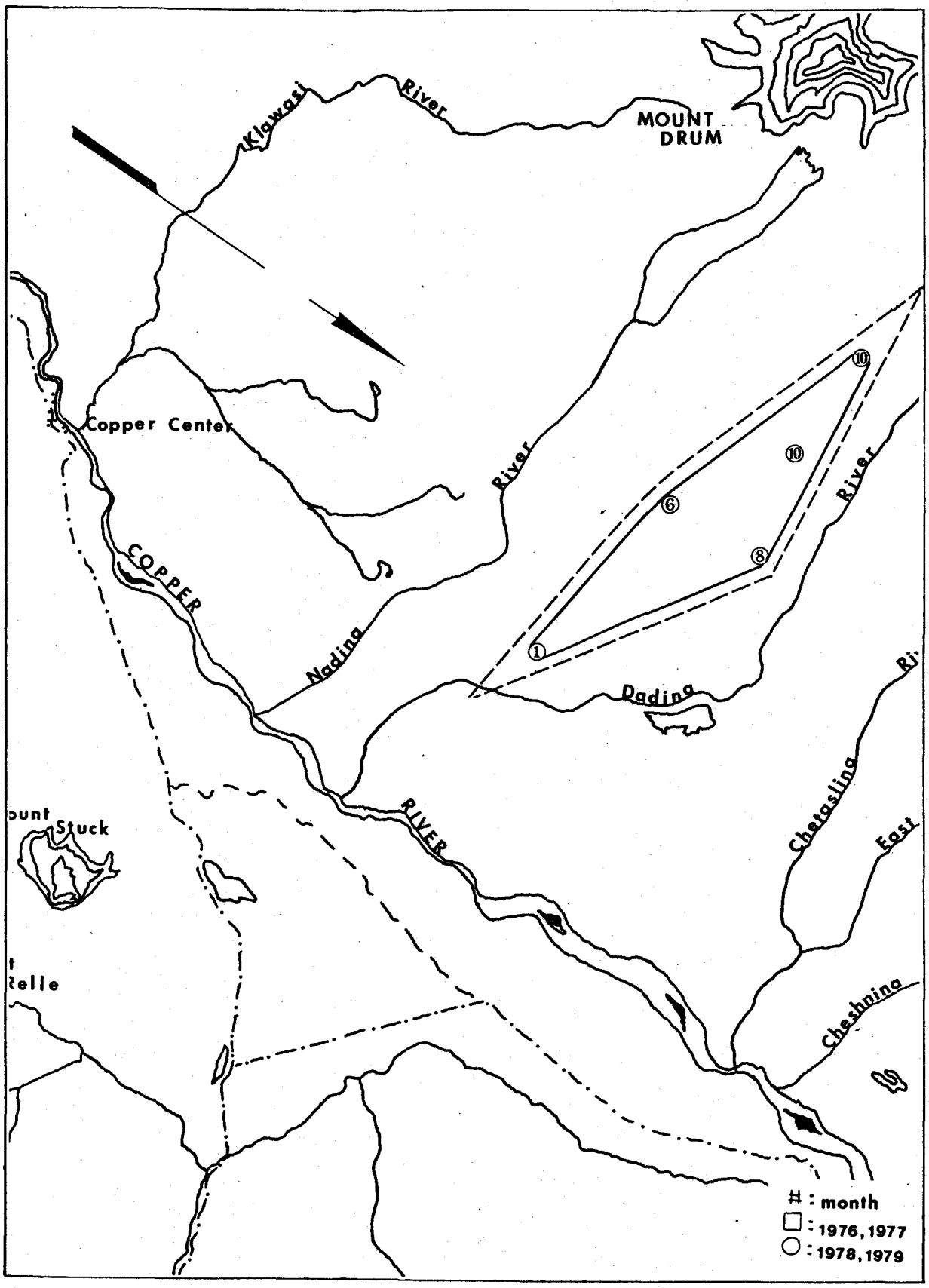


Fig. 29. Continued.

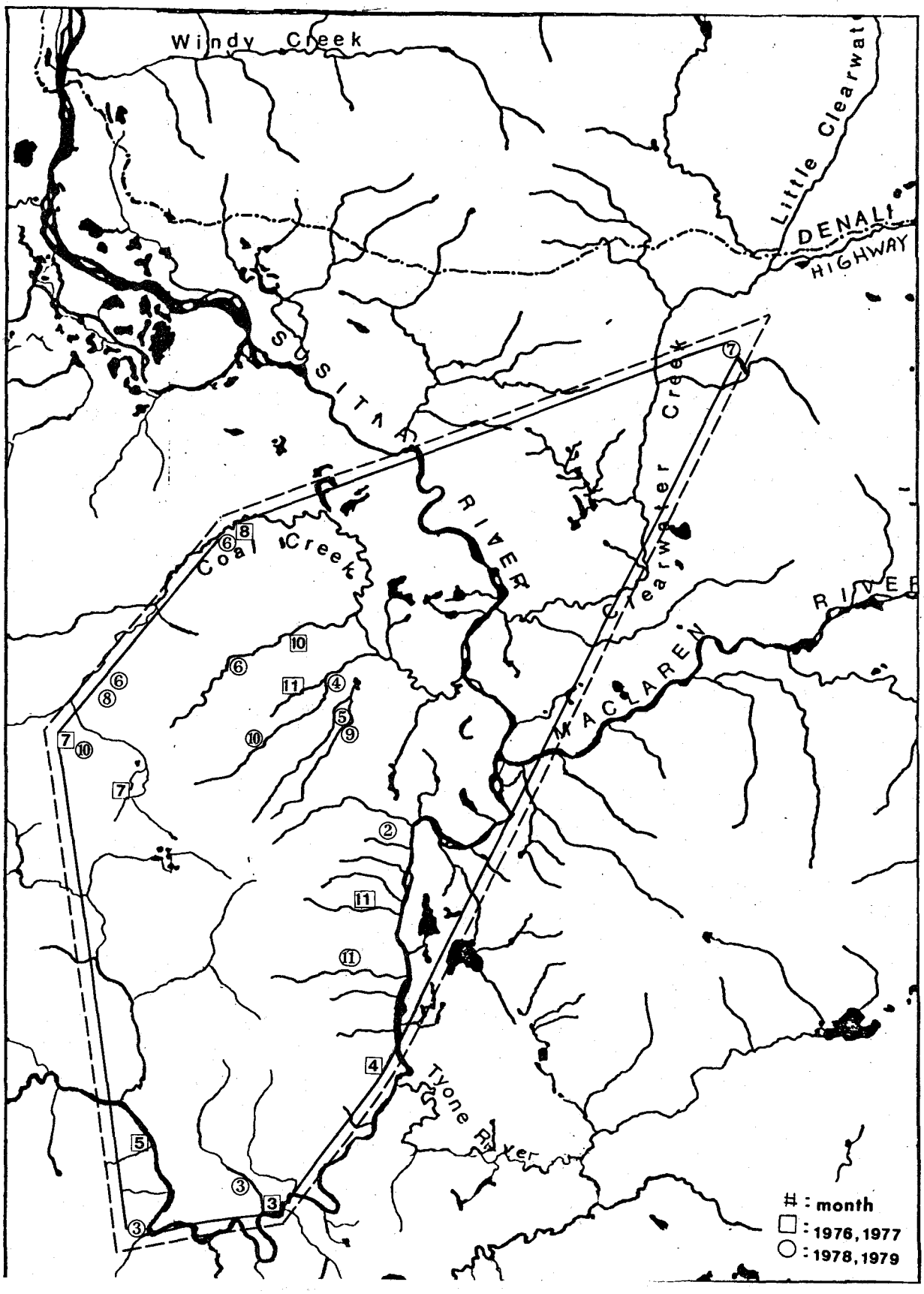


Fig. 30. Annual home range and monthly locations of moose 8579 from March 1977 through April 1979 in the Susitna River Study Area.

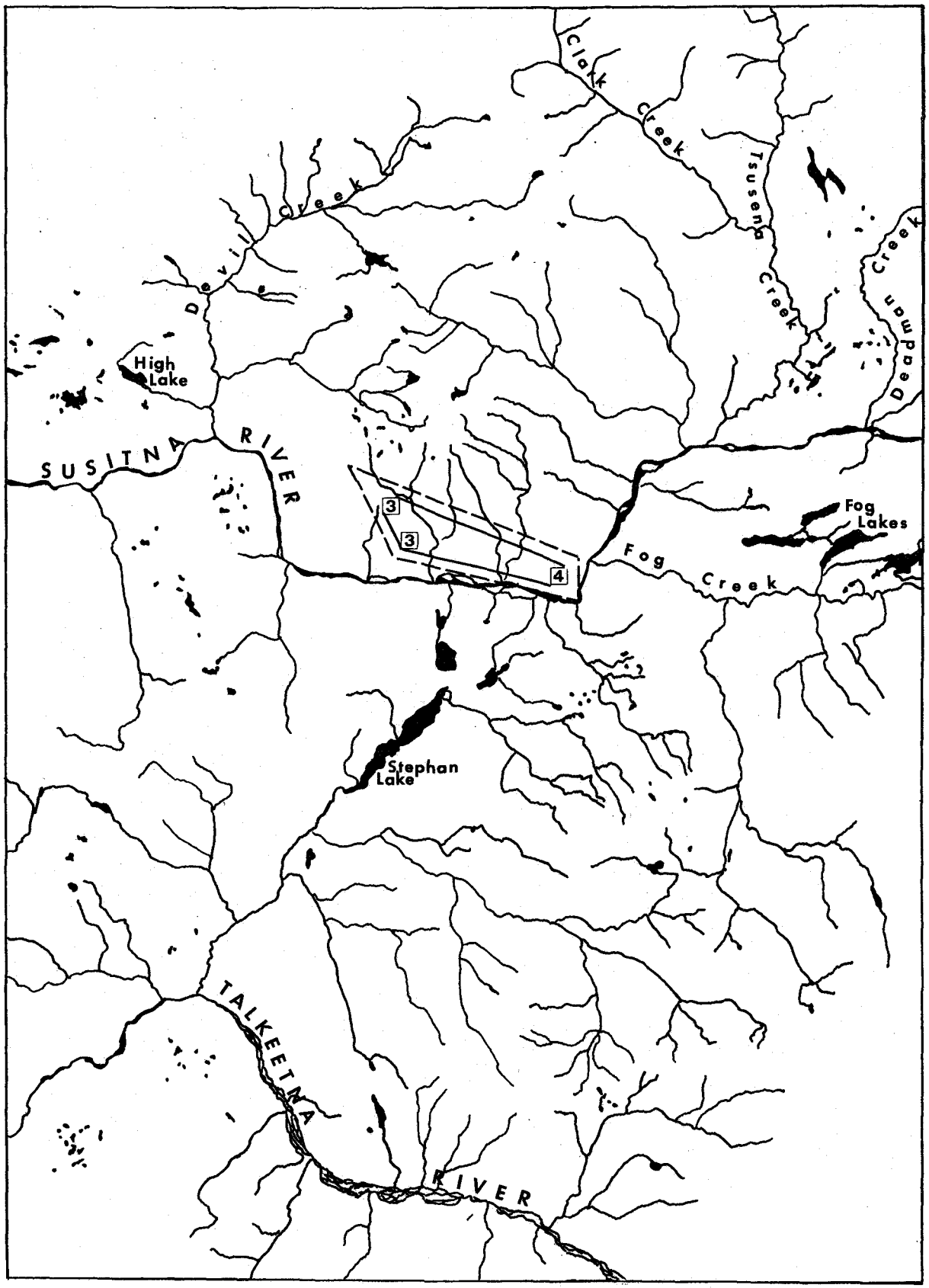


Fig. 31. Annual home range and monthly locations of moose 8580 from March 1977 through October 1977 in the Susitna River Study Area.

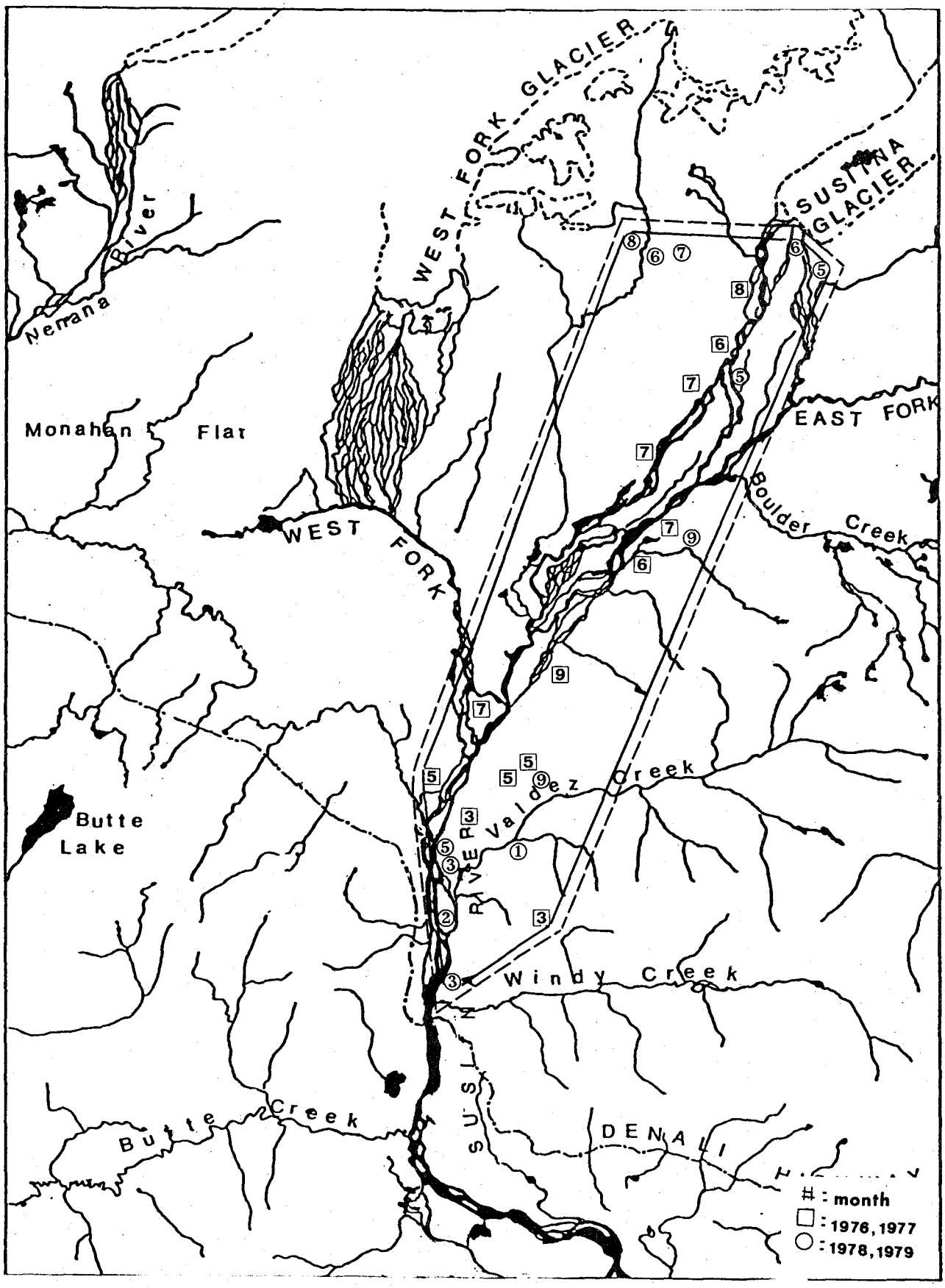


Fig. 32. Annual home range and monthly locations of moose 8581 from March 1977 through May 1979 in the Susitna River Study Area.

Susitna River to the base of the Susitna Glacier where she gave birth to twin calves by 6 June but, by 23 August one twin was missing. By 18 September she and the remaining calf had moved back down to Valdez Creek where they overwintered during 1978-79. They were last observed on 3 May 1979.

Moose 8582 (Fig. 33) was collared 22 March 1977 at the mouth of the Maclaren River. By 22 April she was moving in an easterly direction and subsequently moved 16 km (10 mi) to higher elevation just northeast of Laren Mountain. She spent summer and fall in that vicinity. She was pregnant in March, but was never observed with a calf.

During 1978-79 she had a similar movement pattern to that observed in 1977-78 except that in late June 1978 she had moved approximately 31 km (19 mi) up from the mouth of the Maclaren River. She gave birth to twins by 7 June in 1978, but both were lost by 11 June. On 6 June 1979, when last observed, she had another set of twin calves.

Moose 8583 (Fig. 34) was collared on 18 March 1977 at Devil Mountain. She was not pregnant when collared. Between 22 April and 26 May 1977 she had moved approximately 10 km (6 mi) east. She occupied a relatively small area opposite and above Fog Creek on the north side of the Susitna River where she remained until 13 October 1978. Between 13 October and 21 December 1978 she returned to within 4 km (2.5 mi) of the tagging site, but then returned to her summer range. She was not observed with a calf during 1977, but by 30 May 1978 she had given birth to one but lost it between 3 and 12 June. She was last observed on 28 March 1979.

Moose 8584 (Fig. 35) was collared on 18 March 1977 just below Devil Mountain. She remained in the vicinity of Devil Mountain until 22 April 1977. Between 22 April and 31 May she moved approximately 19 km (12 mi) southeast, crossing the Susitna River just east of Stephen Lake, where she gave birth to twins by 3 June. She lost one calf between 8 and 16 June and the other between 16 June and 5 July. She again crossed the Susitna River in June, but then returned to her summer range where she spent winter 1977-78. By 30 May 1978 she had again given birth to twins, but these were lost by 12 June. She remained on her summer range until 21 December 1978 where she was located on the Susitna River just south of Devil Mountain. By 28 March 1979 she had returned to the tagging site where she was last observed.

Moose 8585 (Fig. 36) had a history almost identical to that described for moose 8582 except that she was never observed with a calf.

Moose 8586 (Fig. 37) had a history nearly identical to that described for moose 8584 except that she only crossed the Susitna River on two occasions; between 22 April and 3 June 1977 and between 29 January and 28 March 1979.

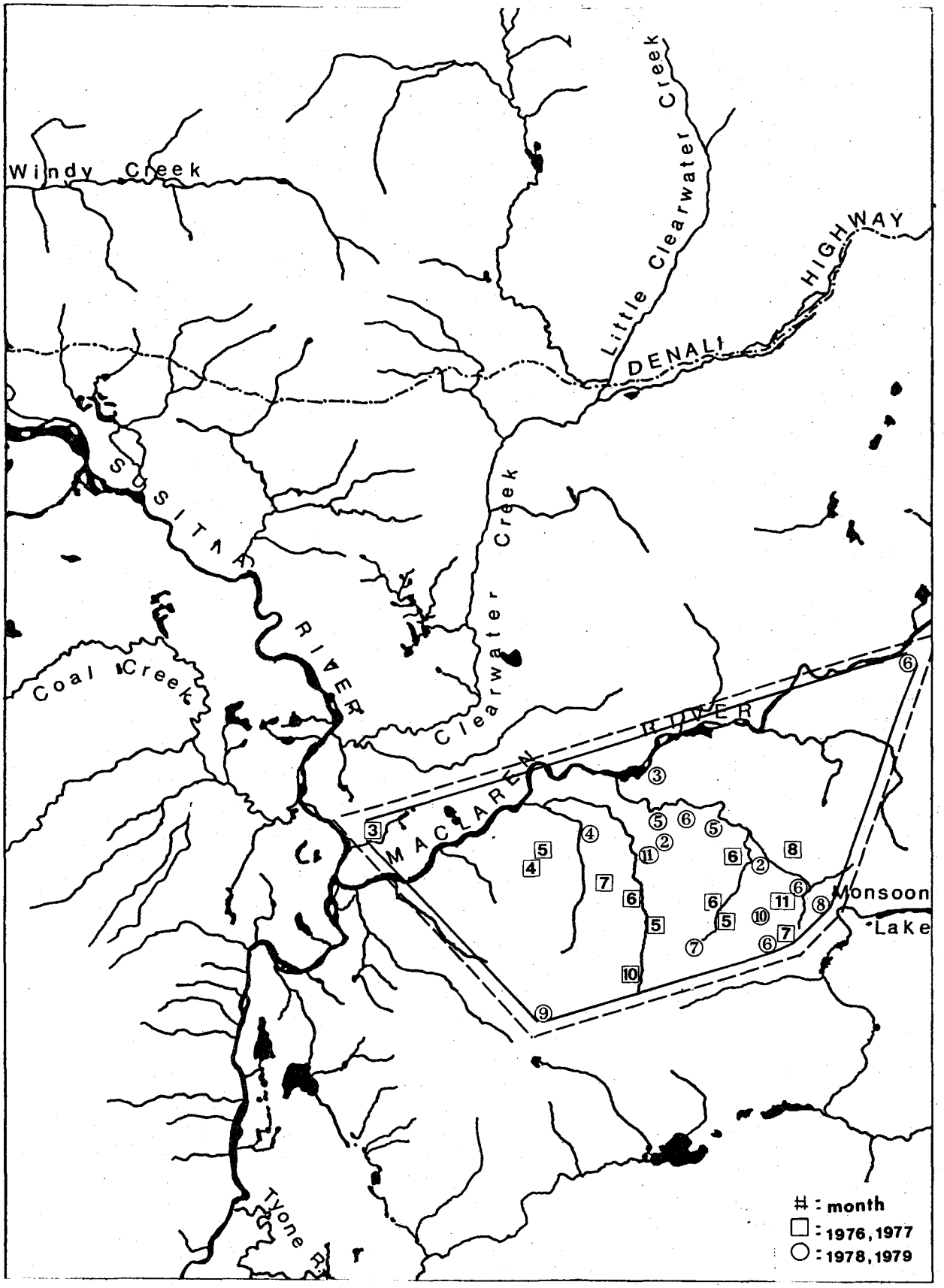


Fig. 33. Annual home range and monthly locations of moose 8582 from March 1977 through June 1979 in the Susitna River Study Area.

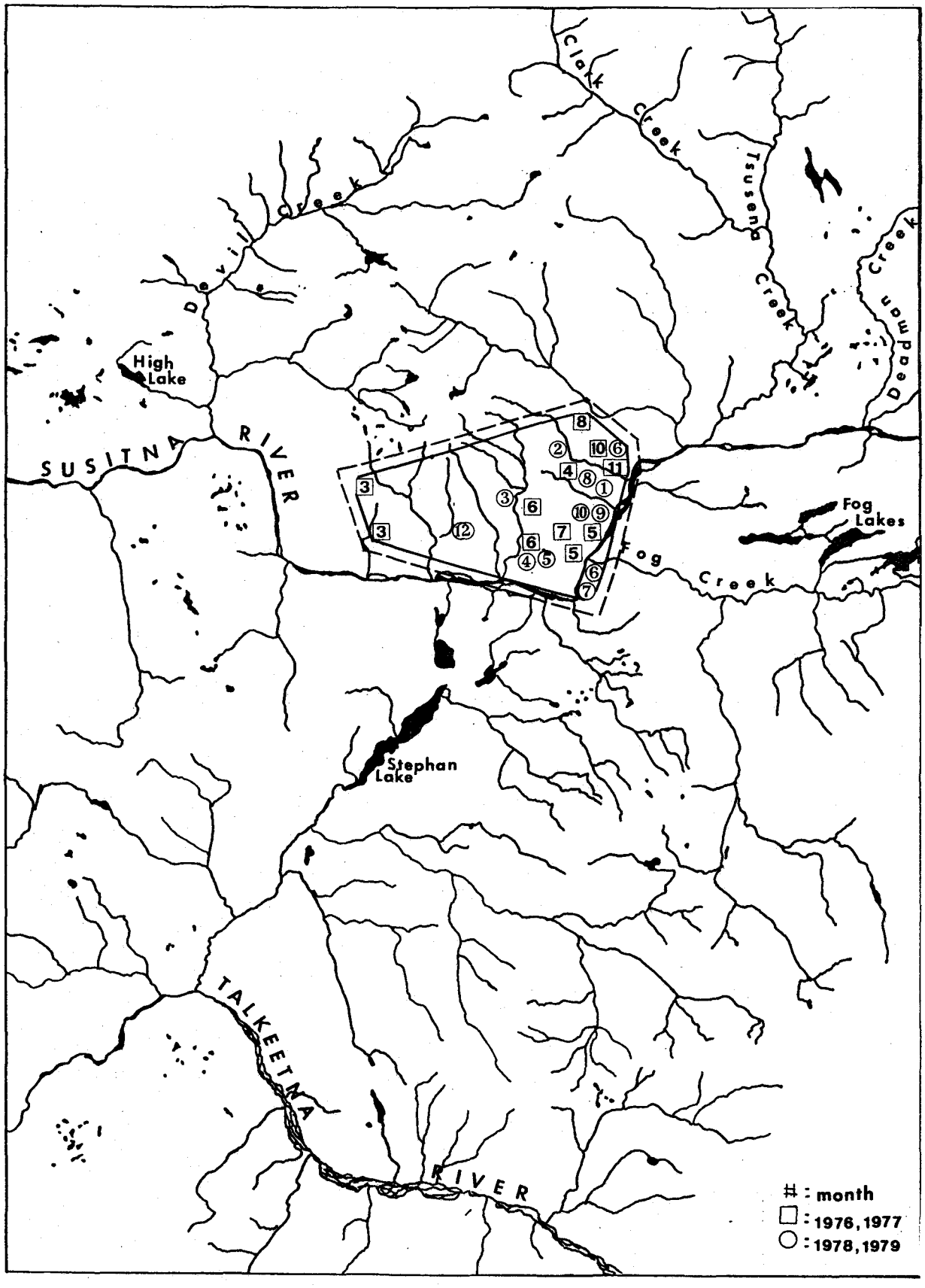


Fig. 34. Annual home range and monthly locations of moose 8583 from March 1977 through March 1979 in the Susitna River Study Area.

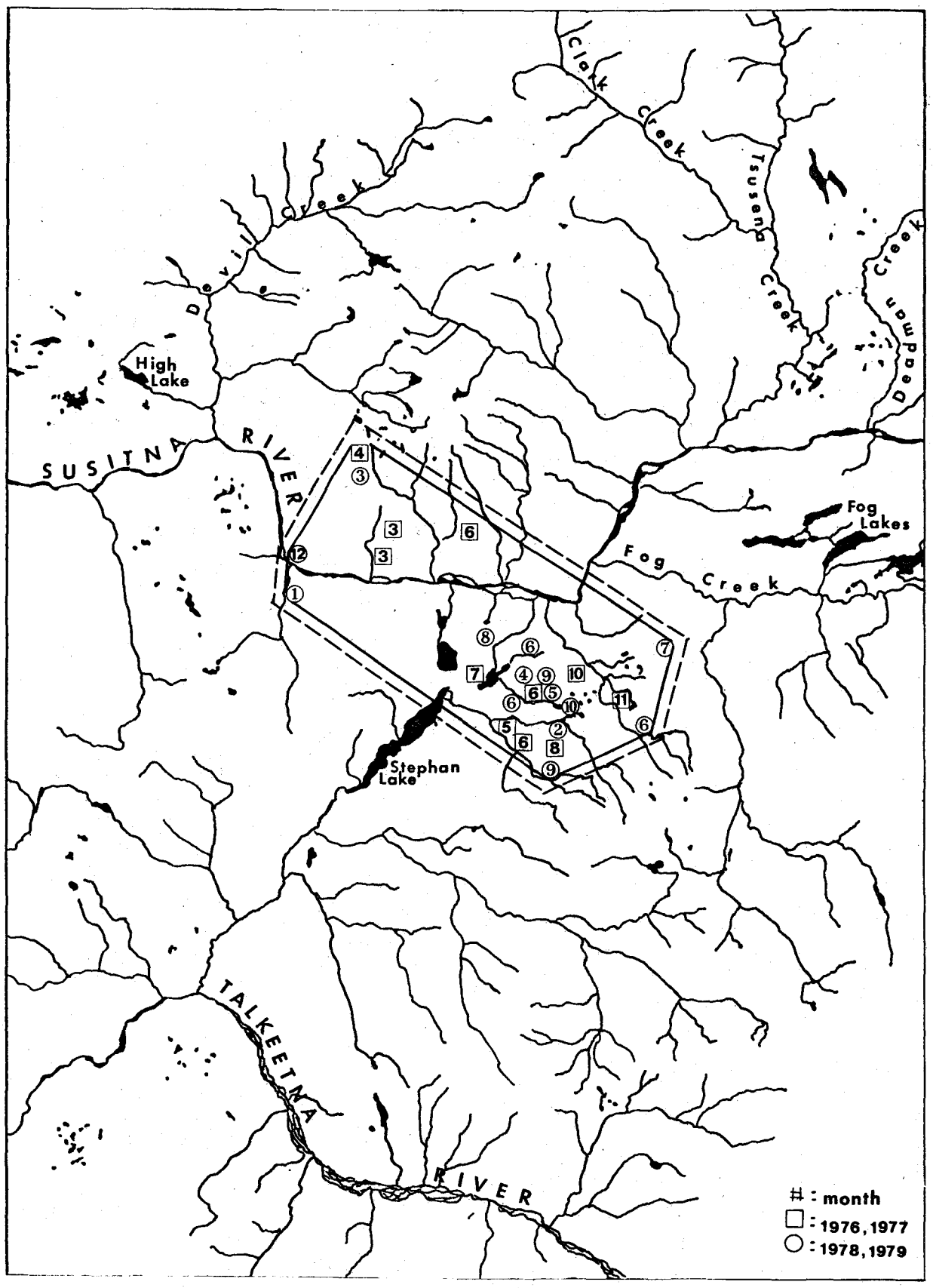


Fig. 35. Annual home range and monthly locations of moose 8584 from March 1977 through March 1979 in the Susitna River Study Area.

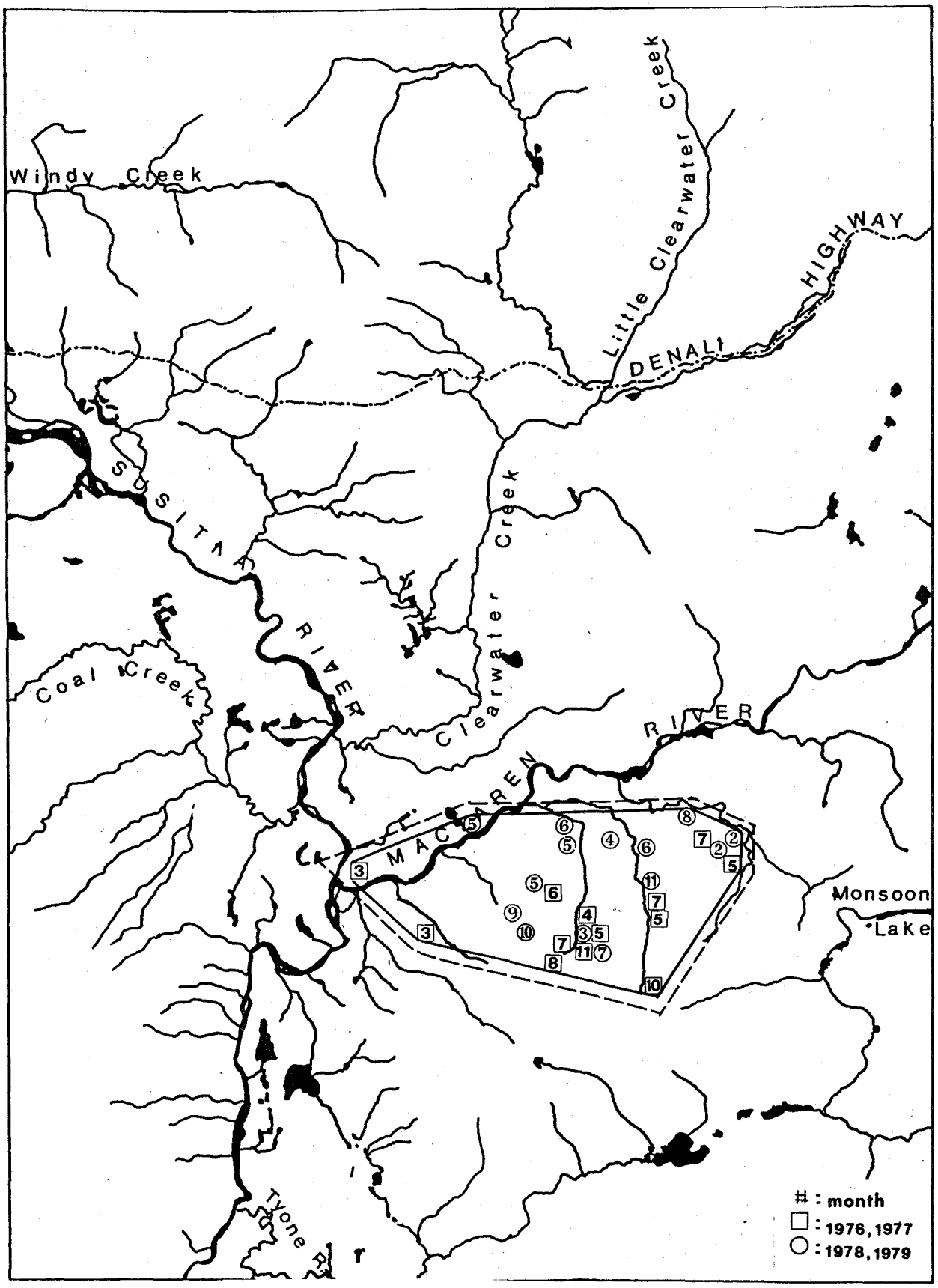


Fig. 36. Annual home range and monthly locations of moose 8585 from March 1977 through March 1979 in the Susitna River Study Area.

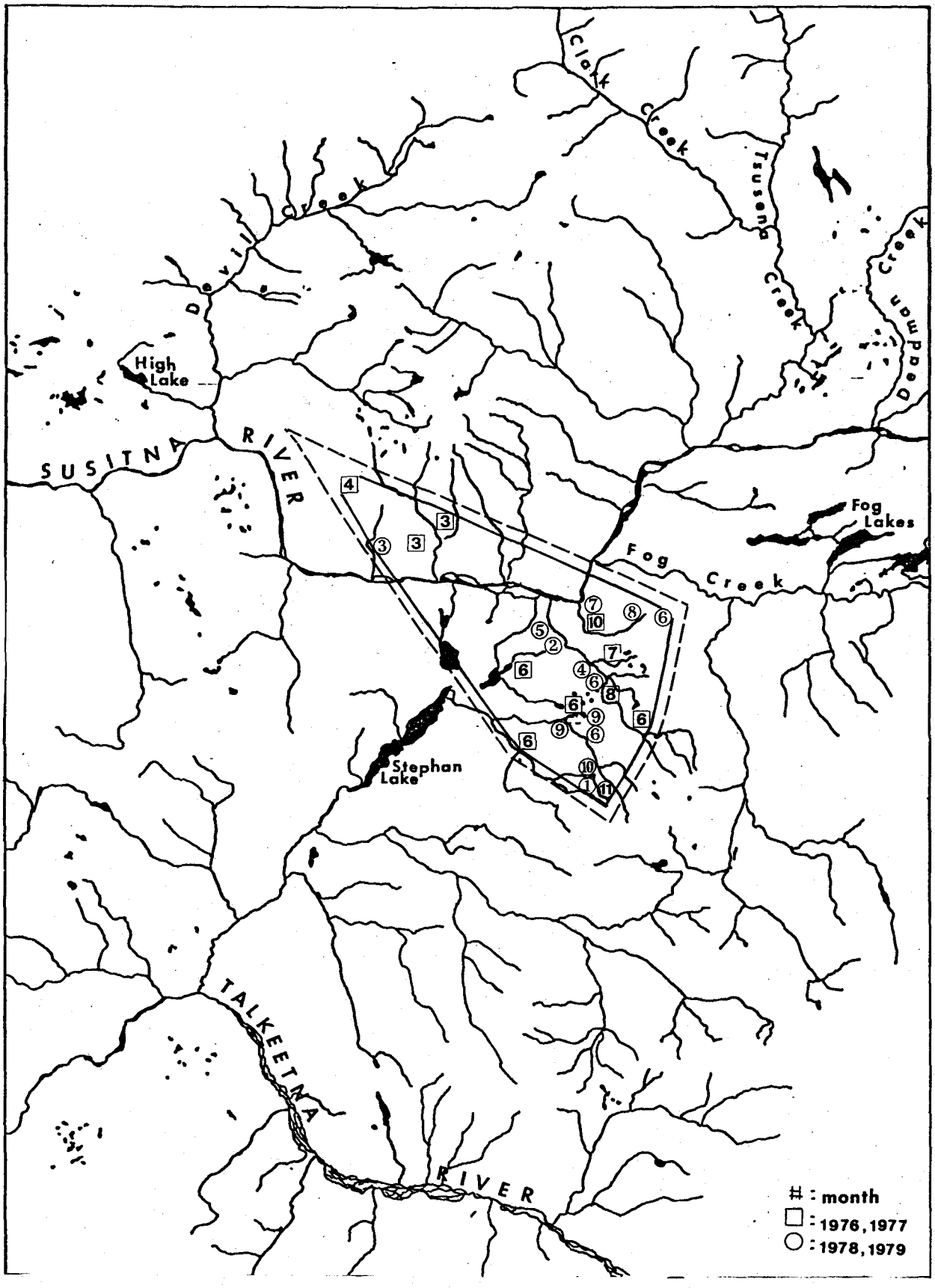


Fig. 37. Annual home range and monthly locations of moose 8586 from March 1977 through March 1979 in the Susitna River Study Area.

Moose 8587 (Fig. 38) was accompanied by a calf when collared on 20 March 1977 on Monahan Flats Creek 3 km (2 mi) east of its junction with Brushkana Creek. After collaring they moved south to higher elevations 3 km (2 mi) south of the Denali Highway. Her calf remained with her until at least 25 May and by 31 May she had given birth to another calf. She and her new calf remained near the highway within an area approximately 42 km^2 (19 mi^2) through summer and fall and winter 1977-78. She was last observed with her 1977 calf on 27 March 1978 and by 27 May had given birth to one new calf. Her movements through summer, fall and winter 1978-79 were similar to those of the previous year. She was last observed with her 1978 calf on 10 February 1979. She was last observed on 29 March 1979.

Moose 8588 (Fig. 39) was collared on 19 March 1977 approximately 6 km (4 mi) north of the mouth of Jay Creek. By 6 April she had moved 10 km (6 mi) south southwest to the Susitna River. She remained along the Susitna River occupying the river bank to elevations of 609 m (2,000 ft) until 8 June at which time she moved to higher elevations. She was not observed with a calf during 1977. During winter 1977-78 she moved back and forth between the river and elevations of 1,036 m (3,400 ft). During 1978 she gave birth to twins by 30 May, but lost both by 12 June. By 23 June she had slipped her radio collar. She was last observed on 2 November 1978.

Moose 8589 was collared on 18 March 1977 approximately 11 km (7 mi) east of Devil Mountain north of the Susitna River. By 31 March she had moved 8 km (5 mi) southwest where she was observed dead; probably as a result of drug overdose.

Moose 8040 II (Fig. 40) was collared on 14 August 1978 approximately 3 km (2 mi) northwest of the mouth of Watana Creek. She occupied a relatively small home range between Deadman and Watana Creek exceeding 731 m (2,400 ft) elevation. On one occasion (30 November 1978) she was observed approximately 8 km (5 mi) east of Watana Creek. She was last observed on 28 March 1979.

Moose 8588 II (Fig. 41) was collared on 14 August 1978 approximately 5 km (3 mi) east of the mouth of Watana Creek. Her movements were nearly identical to those of moose 8576.

Moose 5527 (Fig. 42) was collared on 14 August 1978 approximately 3 km (2 mi) east of the mouth of Jay Creek. Based on a limited number of observations, she appeared to have a small annual home range during fall and winter 1978-79. We had lost radio contact with her (reasons unknown) by 28 February 1979.

Moose 5540 (Fig. 43) was collared on 14 August 1978 along the Susitna River approximately 8 km (5 mi) east of the mouth of Jay Creek. She remained fairly close to the tagging site through early fall, but by 6 October had moved approximately 19 km (12 mi) northeast to

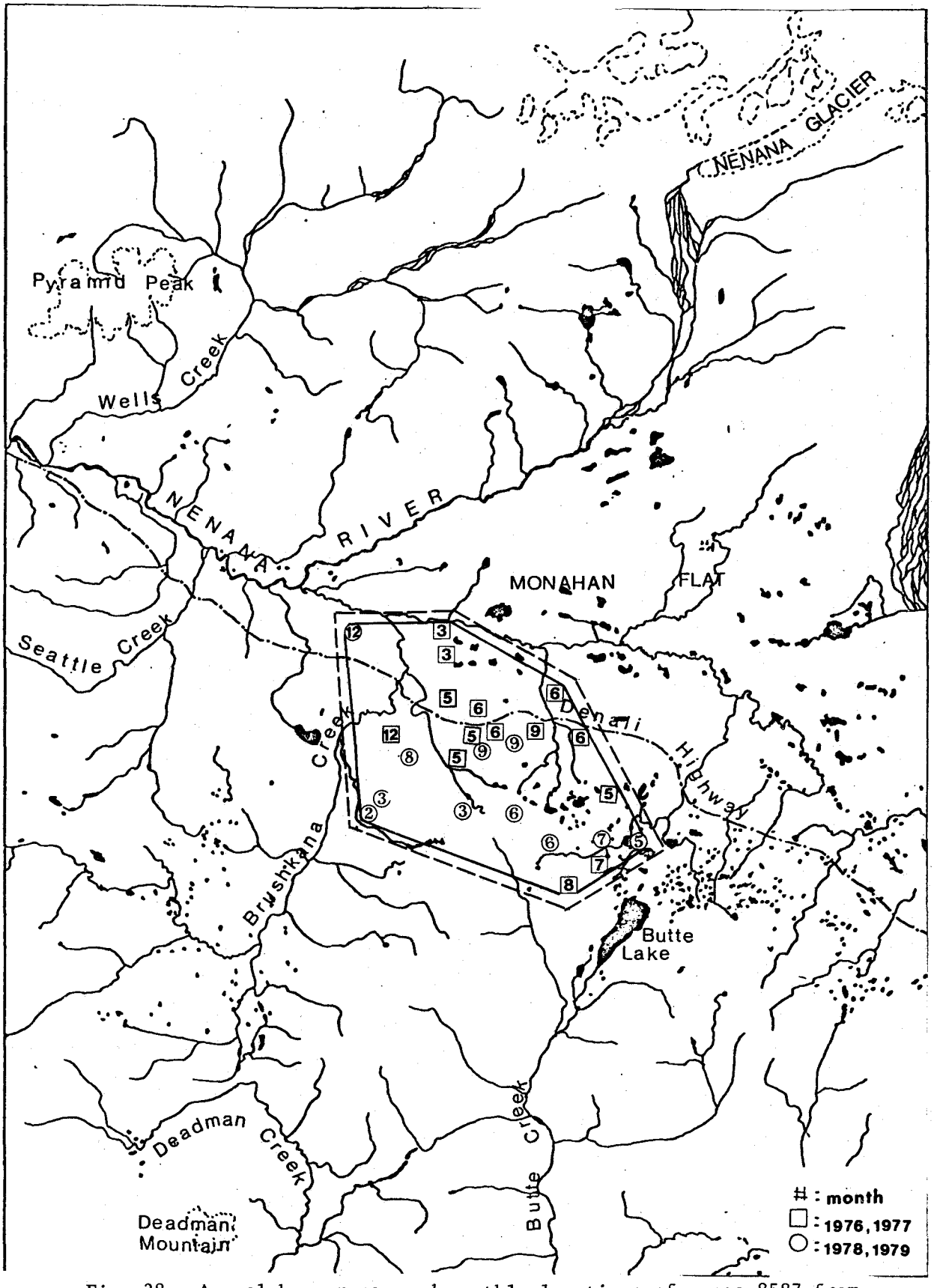


Fig. 38. Annual home range and monthly locations of moose 8587 from March 1977 through March 1979 in the Susitna River Study Area.

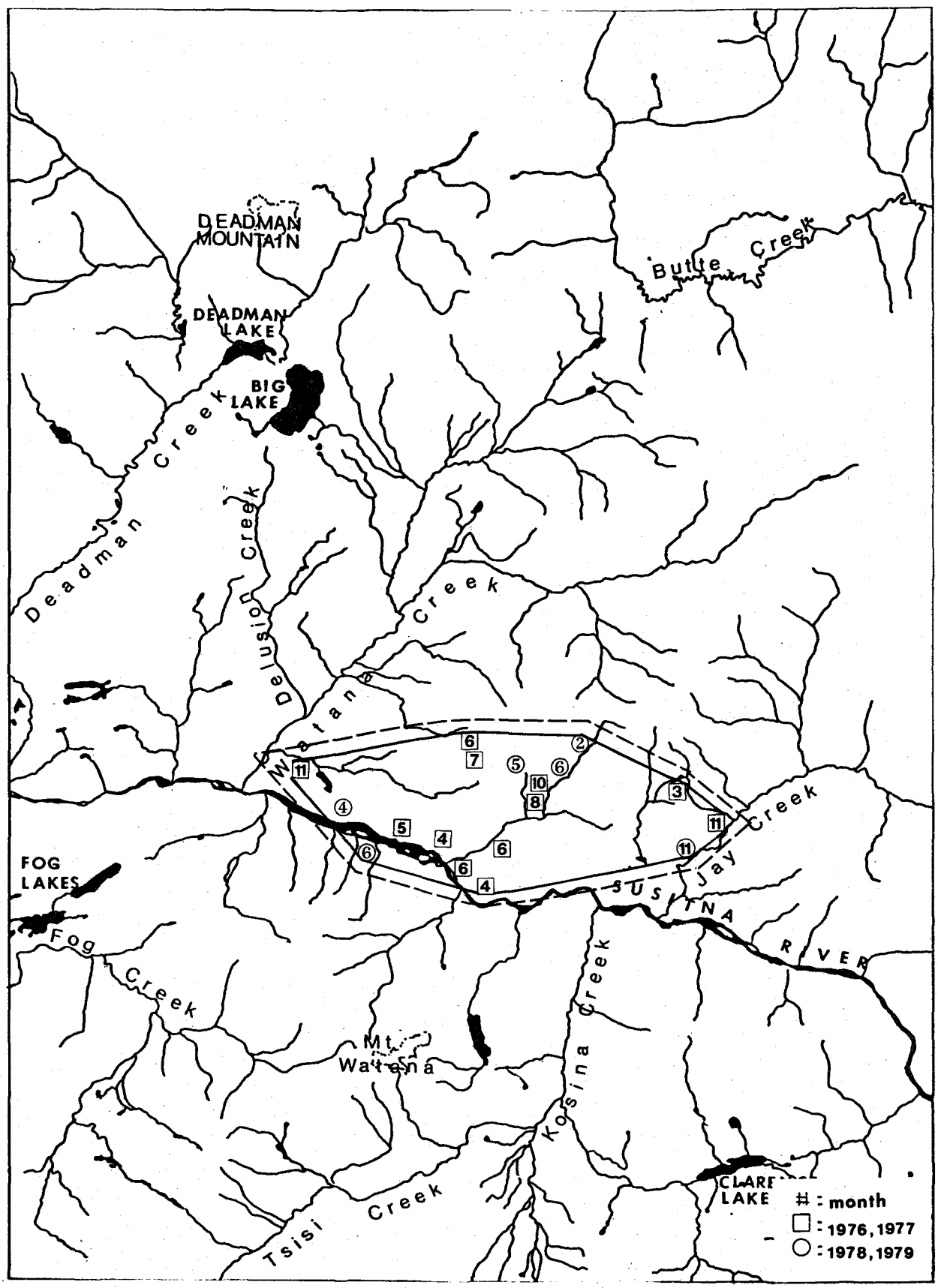


Fig. 39. Annual home range and monthly locations of moose 8588 from March 1977 through November 1978 in the Susitna River Study Area.

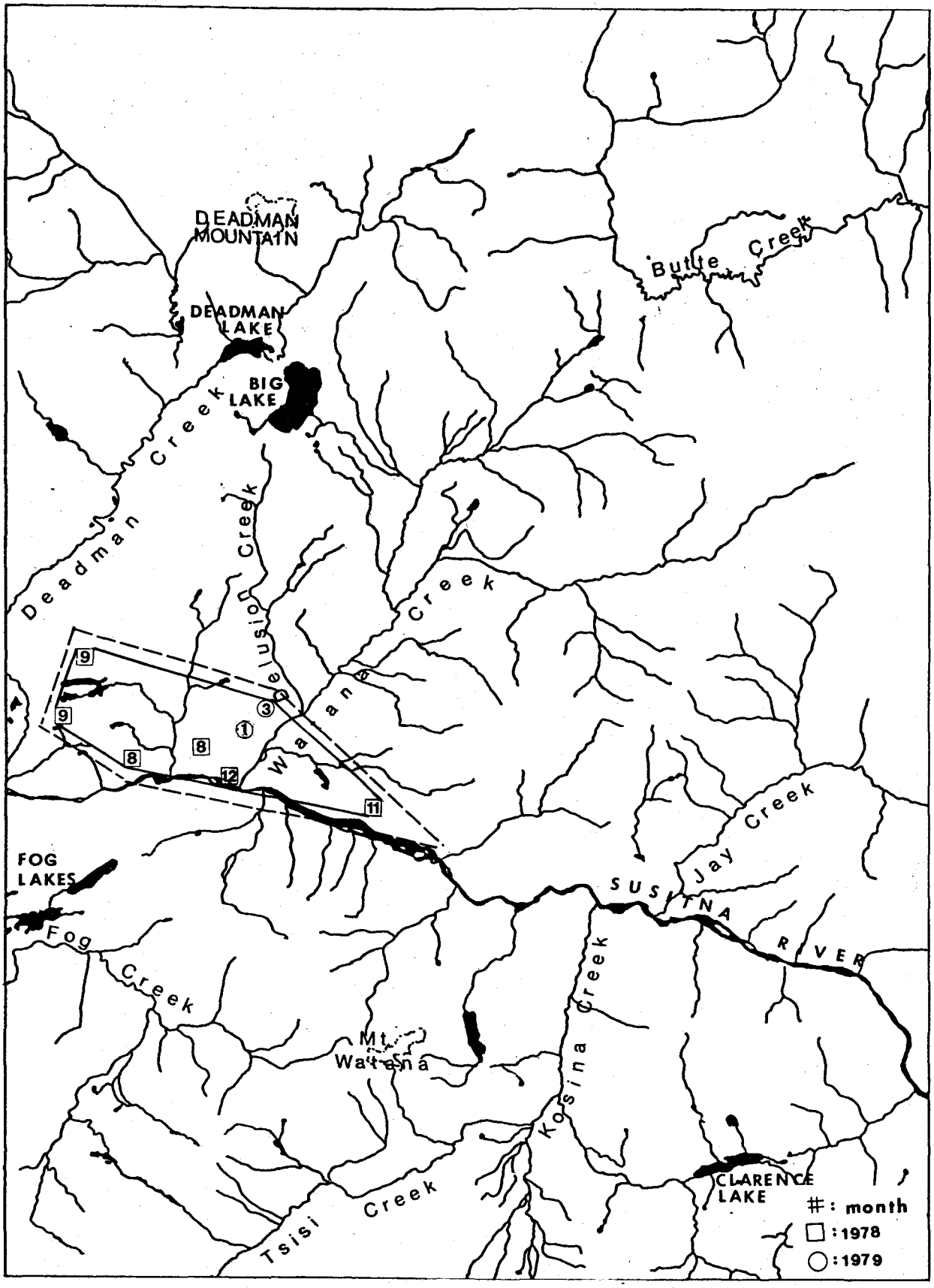


Fig. 40. Annual home range and monthly locations of moose 8040 II from August 1978 through March 1979 in the Susitna River Study Area.

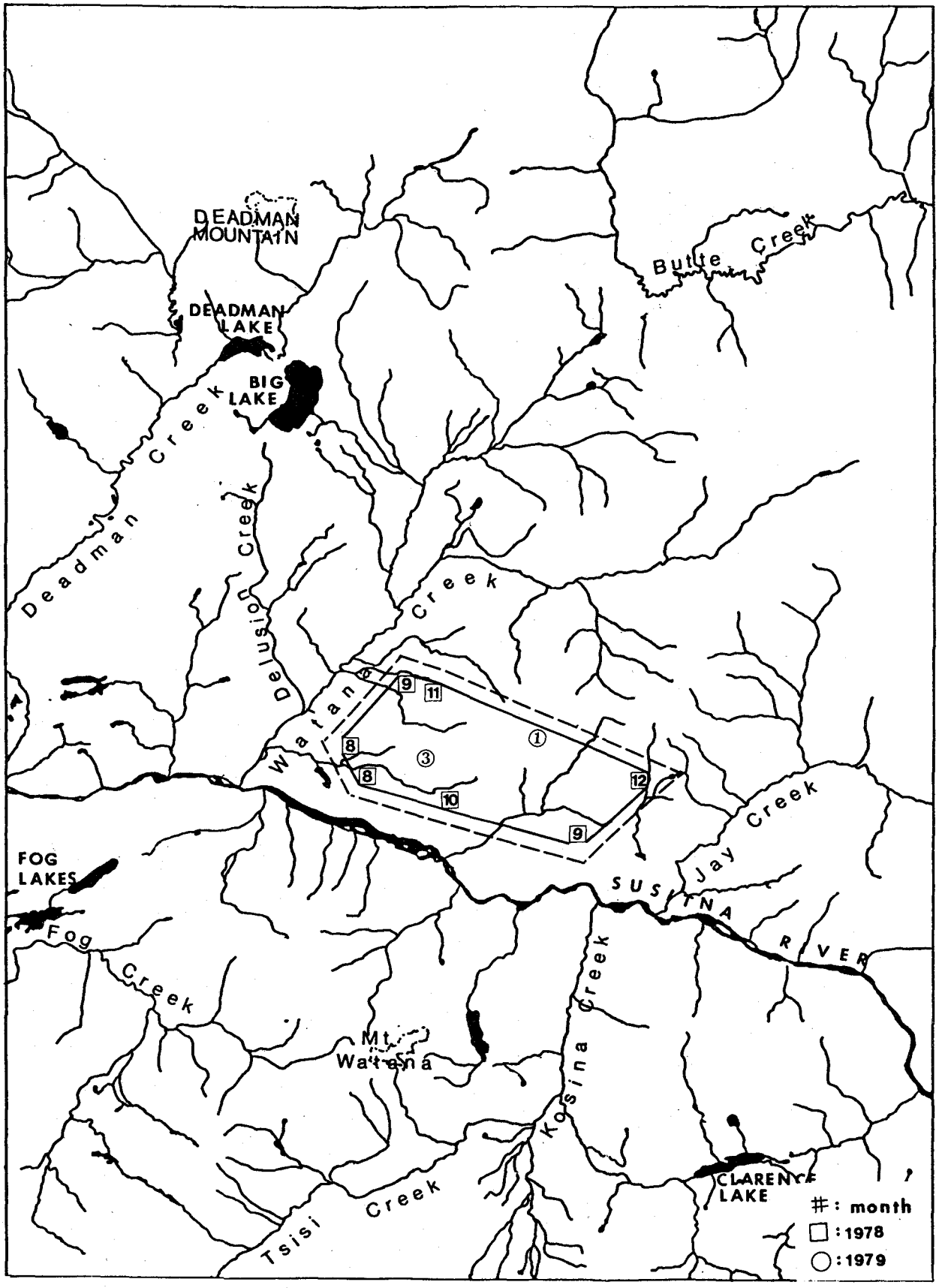


Fig. 41. Annual home range and monthly locations of moose 8588 II from August 1978 through March 1979 in the Susitna River Study Area.

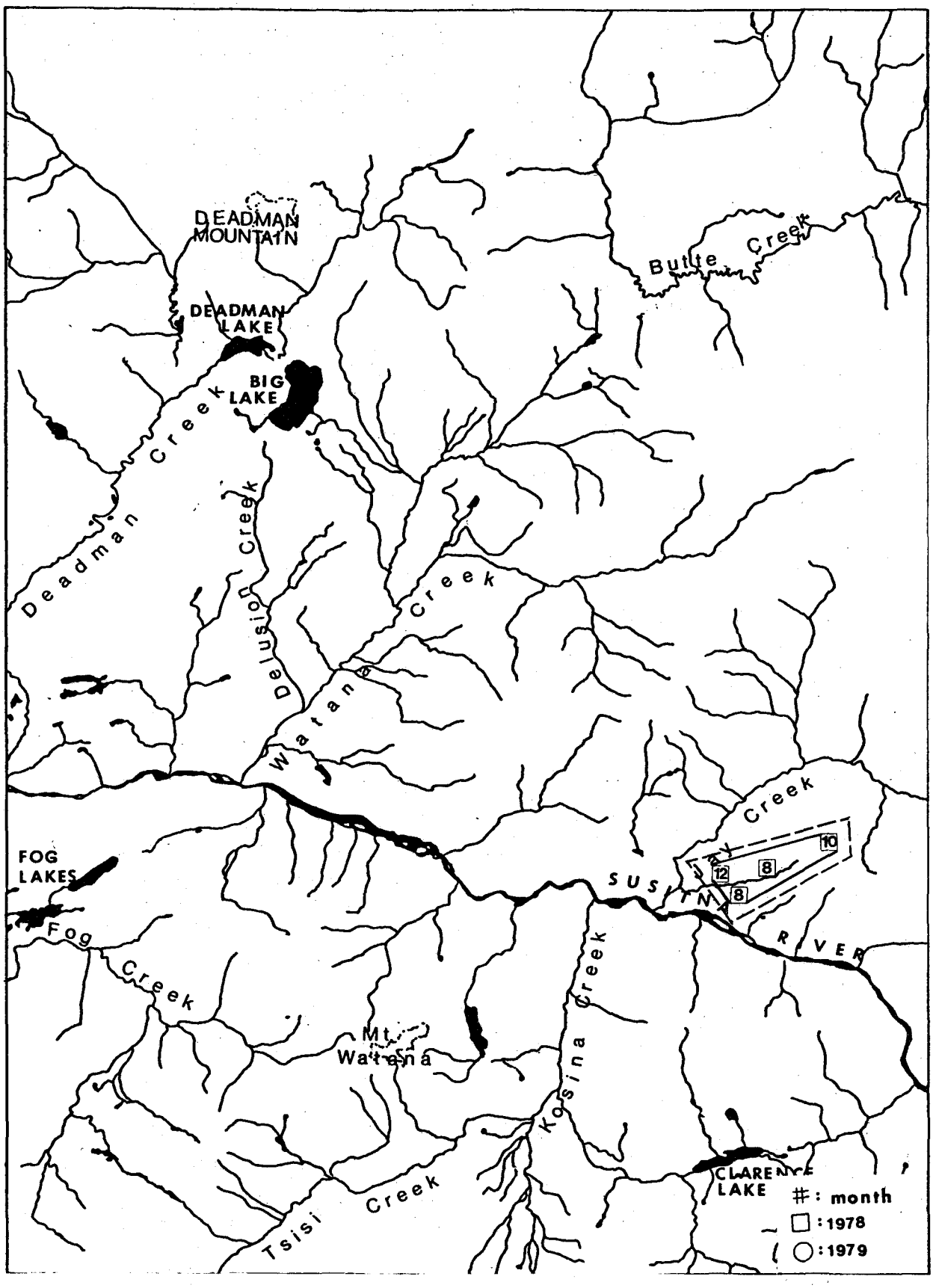


Fig. 42. Annual home range and monthly locations of moose 5527 from August 1978 through February 1979 in the Susitna River Study Area.

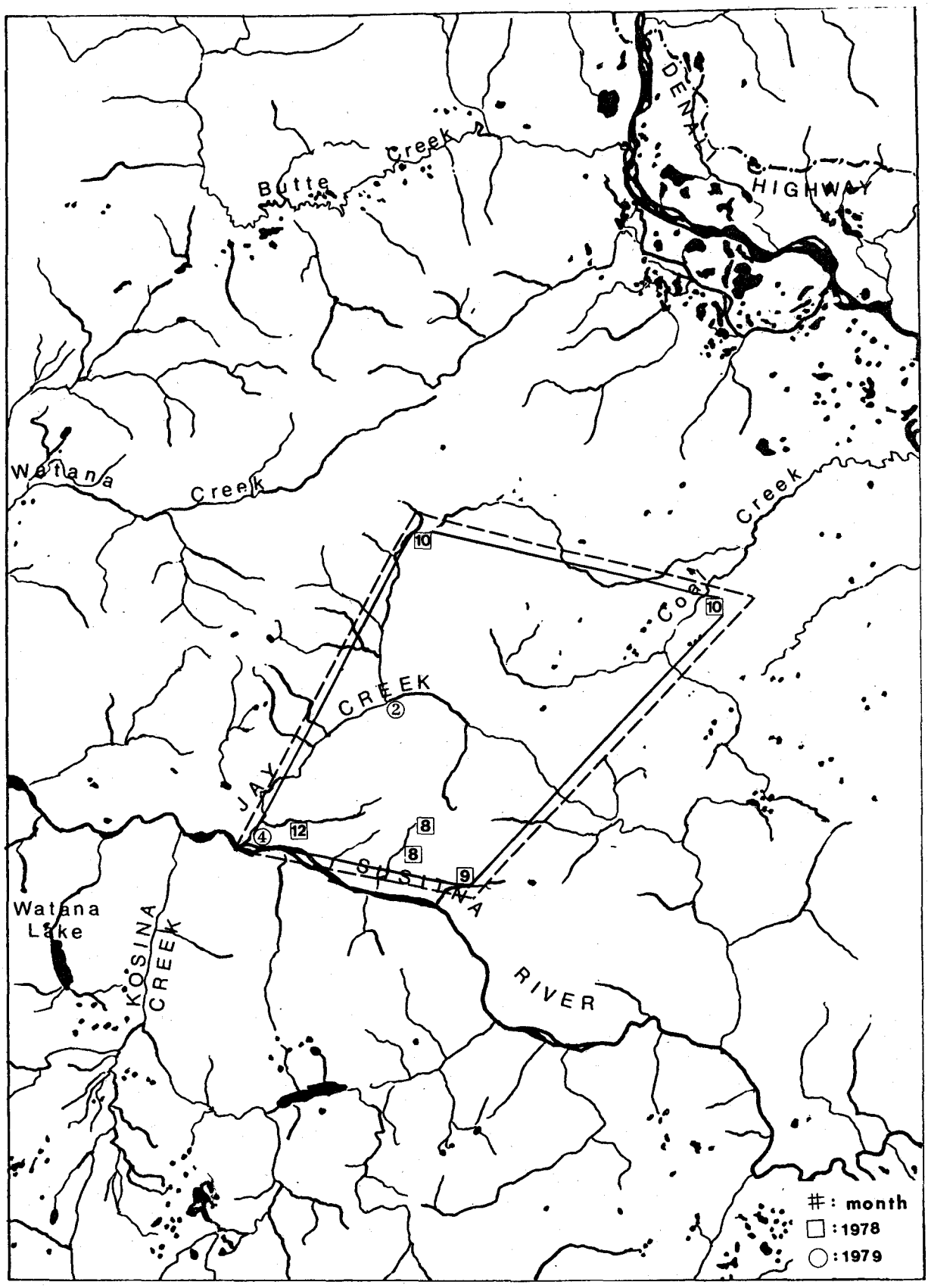


Fig. 43. Annual home range and monthly locations of moose 5540 from August 1978 through April 1979 in the Susitna River Study Area.

Coal Creek. By the end of October she had moved 16 km (10 mi) west to the headwaters of a Jay Creek tributary. She overwintered along Jay Creek and down to the Susitna River. She was last observed on 16 April 1979.

The 65 visually collared moose were observed on 151 occasions from October 1976 through December 1979. Ten (15%) were never observed during the study. Only 25 (39%) were observed more than twice. A fairly large proportion of the sightings were obtained during fall moose sex and age composition counts. These data may allow calculation of a crude population estimate based on mark:recapture ratios, however, this will not be done until the services of a biometrician are obtained.

Movement data from visual-collared moose generally reflected similar patterns of those obtained from radio-collared animals. However, had the study relied solely on visual collars, as was done on the Kenai Peninsula (Bailey et al. 1978), the scanty data would have been difficult, if not impossible, to interpret.

Our radio-collared moose exhibited all the types of movements described by LeResche (1974) for moose in North America. Most moose during this study were either somewhat sedentary, occupying the same drainages year-round with migration consisting primarily of elevational movements or highly migratory, moving from higher summer elevations to lower winter elevations with considerable distances in between.

Fall migration during 1977 and 1978 occurred primarily in November, but ranged from 5 October to 19 January (Table 3). Its occurrence appeared to be at least partially correlated with the first heavy snowfall of the year. Heavy snowfall came earlier in 1977 than in 1978 and probably accounted for the earlier dates of migration that year. LeResche (1974) stated that most investigators reported that weather, particularly snow conditions, was the mediating factor in moose migrations. Our tentative observations are supported by other studies in Alaska (Rausch 1958 and VanBallenberghe 1978a). Although most moose initiated fall migration at about the same time the speed at which individual moose moved to wintering sites was quite variable. Some moose arrived on wintering areas in mid-December while others continued to meander in a southerly direction until early spring.

Initiation of spring migration was not as clearly defined as was fall migration. Several moose began moving in April, arriving on summer range where calving took place in early May. Other moose remained close to the wintering site where some calved and then migrated in mid-July. Some of the summer migrators never reached the sites where they were originally tagged. These animals then turned around and began the migration to winter ranges in November. VanBallenberghe (1978a) reported that moose in the eastern portion of Unit 13 departed from their wintering areas between mid-April and mid-June. Once cow moose in the current study area began spring-summer migration, the movement to summer ranges usually took from 4-6 weeks.

Table 3. Minimum home ranges and dates of migration of 42 radio-collared moose observed from October 1976 through May 1979 in the Nelchina and upper Susitna River Basins of Southcentral Alaska.

Moose No.	Winter Home Range km² (mi²)	Summer Home Range km² (mi²)	Summer Home Range When With Calf km² (mi²)	Total Range km² (mi²)	Apprx. distance from summer range to possible rutting area km (mi)	Apprx. distance between summer and winter range km (mi)	Dates of migration to winter range	Dates of migration to summer range	Distance from winter range to calving area if different from summer range km (mi)	Longest distance moved between consecutive observations km (mi)
8017	220 (85)	210 (81)	- -	1373 (530)	0 (0)	52 (32)	11/2-11/22	7/7-7/23	26 (16)	47 (29)
8018	228 (88)	52 (20)	8 (3)	1334 (515)	0 (0)	52 (32)	12/3-12/24	6/10-7/12	19 (12)	50 (31)
8019	49 (19)	101 (39)	- -	205 (79)[2]	13 (8)	0 (0)	11/19-12/16[1]	-	N/A	34 (21)
8020	111 (43)	34 (13)	8 (3)	269 (104)	13 (8)	0 (0)	N/A	N/A	N/A	19 (12)
8021	114 (44)	70 (27)	10 (4)	293 (113)	19 (12)	0 (0)	N/A	N/A	N/A	19 (12)
8022	334 (129)	52 (20)	- -	350 (135)	0 (0)	0 (0)	N/A	N/A	N/A	21 (13)
8029	101 (39)	117 (45)	60 (23)	192 (74)	0 (0)	0 (0)	N/A	N/A	N/A	23 (14)
8030	207 (8)	78 (30)	60 (23)	666 (257)	44 (27)	44 (27)	8/30-10/5 9/18-9/22	11/19-4/22 11/22-3/31	N/A	44 (27)
8031	29 (11)	75 (29)	26 (10)	176 (68)	13 (8)	0 (0)	N/A	N/A	N/A	11 (7)
8032	23 (9)	86 (33)	- -	446 (175)	18 (11)	16 (10)	12/16-1/19 10/5-11/22	3/31-1/19	N/A	19 (12)
8033	34 (13)	13 (5)	- -	62 (24)	0 (0)	0 (0)	N/A	N/A	N/A	13 (8)
8034	155 (60)	145 (56)	3 (1)	399 (154)	21 (13)	0 (0)	N/A	N/A	N/A	19 (12)
8035	62 (24)	49 (19)	13 (5)	676 (261)	0 (0)	52 (32)	11/2-12/16 10/5-11/22 10/25-12/21	3/5-4/22 3/31-4/26	N/A	82 (51)
8036	49 (19)	80 (31)	13 (5)	148 (57)	11 (7)	0 (0)	N/A	N/A	N/A	19 (11)
8037	21 (8)	- -	355(137)	1137 (439)	40 (25)	55 (34)	10/28-11/22 8/18-11/22	6/15-7/12 6/19-7/7	N/A	52 (32)
8038	29 (11)	36 (14)	- -	83 (32)	0 (0)	0 (0)	N/A	N/A	N/A	10 (6)
8039	75 (29)	93 (36)	<3 (<1)	399 (154)	26 (16)	0 (0)	11/19-12/16	N/A	N/A	29 (18)
8040	26 (10)	8 (3)	- -	62 (24)	0 (0)	0 (0)	N/A	N/A	N/A	10 (6)
8042	36 (14)	36 (14)	- -	161 (62)	16 (10)	0 (0)	10/28-11/2	N/A	N/A	16 (10)
8044	86 (33)	130 (50)	- -	386 (149)	19 (12)	0 (0)	-	N/A	N/A	24 (15)
8570	225 (87)	119 (46)	10 (4)	557 (215)	13 (8)	19 (12)	-	5/10-5/25	N/A	24 (15)
8571	75 (29)	88 (34)	8 (3)	109 (42)	0 (0)	0 (0)	N/A	N/A	N/A	10 (6)
8572	95 (37)	47 (18)	- -	109 (42)	0 (0)	0 (0)	N/A	N/A	N/A	11 (7)
8573	54 (21)	36 (14)	5 (2)	73 (28)	0 (0)	0 (0)	N/A	N/A	N/A	11 (7)
8574	130 (50)	26 (10)	- -	181 (70)	10 (6)	0 (0)	10/5-10/30	-	N/A	19 (12)
8575	389 (150)	101 (39)	- -	1153 (445)	84 (52)	93 (58)	9/13-10/5 10/5-10/25	3/30-4/22 5/4-5/9	-	103 (64)
8576	34 (13)	29 (11)	- -	62 (24)	0 (0)	0 (0)	N/A	N/A	N/A	10 (6)

Table 3. (Continued).

Moose No.	Winter Home Range km² (mi²)	Summer Home Range km² (mi²)	Summer Home Range When With Calf km² (mi²)	Total Range km² (mi²)	Apprx. distance from summer range to possible rutting area km (mi)	Apprx. distance between summer and winter range km (mi)	Dates of migration to winter range	Dates of migration to summer range	Distance from winter range to calving area if different from summer range km (mi)	Longest dista moved betwee consecutive observation km (mi)
8577	241 (93)	88 (34)	18 (7)	277 (107)	16 (10)	0 (0)	N/A	N/A	N/A	26 (16)
8578	26 (10)	29 (11)	- -	62 (24)	0 (0)	0 (0)	N/A	N/A	N/A	177(110)
8579	161 (62)	199 (77)	- -	544 (214)	0 (0)	0 (0)	N/A	N/A	N/A	34 (21)
8581	60 (23)	161 (62)	<3 (<1)	244 (94)	0 (0)	0 (0)	N/A	N/A	N/A	26 (16)
8582	88 (34)	78 (30)	- -	168 (65)	0 (0)	0 (0)	N/A	N/A	N/A	13 (8)
8583	23 (9)	13 (5)	- -	44 (17)	0 (0)	0 (0)	N/A	N/A	N/A	9 (5)
8584	70 (27)	44 (17)	- -	122 (47)	0 (0)	0 (0)	N/A	N/A	N/A	16 (10)
8585	47 (18)	39 (15)	- -	67 (26)	0 (0)	0 (0)	N/A	N/A	N/A	8 (5)
8586	47 (18)	26 (10)	- -	80 (31)	0 (0)	0 (0)	N/A	N/A	N/A	11 (7)
8587	73 (28)	49 (19)	21 (8)	101 (39)	0 (0)	0 (0)	N/A	N/A	N/A	10 (6)
8588	65 (25)	39 (15)	- -	93 (36)	0 (0)	0 (0)	N/A	N/A	N/A	10 (6)
8040II	- -	- -	- -	36 (14)	- -	- -	N/A	N/A	N/A	15 (9)
8588II	- -	- -	- -	52 (20)	- -	- -	N/A	N/A	N/A	11 (7)
5527	- -	- -	- -	- -	- -	- -	N/A	N/A	N/A	- -
5540	- -	- -	- -	179 (69)	- -	- -	N/A	N/A	N/A	- -
N	38	37	17	41	38	38	N/A	N/A	N/A	40
Mean	102.4(37.6)	72.3(27.9)	36.7(14.1)	320.2(124)	9.9(6)	10.1(6)	N/A	N/A	N/A	27.9(17)
S.D.	89.5(34.2)	49.7(19.2)	83.9(32.4)	354.4(137)	16.8(10.5)	22.4(14)	N/A	N/A	N/A	31.3(20)

1/ After southerly movement of 37 km returned to summer range
2/ Above described movement excluded.

Although this study did not involve investigation of bull moose movements, it was evident that some cows were traveling to areas outside their normal winter and summer ranges for breeding purposes. Most, however, remained within or near their wintering areas. There did not appear to be any concentration areas except for those at the mouth of Valdez Creek and the Maclaren River side of the western Alphabet Hills. Both areas serve as rutting areas and thus should be protected as "critical" habitats.

Distances between summer and winter home ranges, for migratory moose in this study, ranged from 16 to 93 km (10-58 mi), averaging 48 km (30 mi). Similar movements of moose in other areas of North America range from 2 km (1 mi) in Minnesota (Berg 1971) up to perhaps 170 km (106 mi) in the Northwest Territories (Barry 1961). In southcentral Alaska, distances between ranges have varied from: 8 to 94 km (5-58 mi) in the eastern portion of Unit 13 (VanBallenberghe 1978a), from 2 to 60 km (1-37 mi) on the Kenai Peninsula (Bailey et al. 1978) and from 3 to 19 km (2-12 mi) in GMU 16 (Didrickson and Taylor 1978). The highly migratory nature of GMU 13 moose probably represents an adaptation for exploitation of marginal habitats resulting from excessive snow accumulation.

Irregular Movements

During this study we observed three moose whose movements did not fit typical migration patterns exhibited by others. One, which wore white visual collar number 80, was tagged just above the Susitna River west of Tsusena Creek on 18 March 1977. By 6 September she was observed east of Lone Butte near Sanona Creek, a straight line movement of 84 km (52 mi). This was the third longest movement recorded during this study and provided the only significant evidence of an east-west movement along the Susitna River.

The longest movement recorded during this study was by moose 8578 during summer 1978. She did not migrate during 1977-78, occupying a relatively small home range just south of the Susitna Bend. Some time in July 1978 she left the area and moved a straight line distance of 177 km (110 mi) southeast, reaching the Dadina River by mid-August 1978. The moose remained in this area through 1978-79 and was still present in January 1980.

The second longest movement occurred sometime during winter 1978-79 when moose 8035 left her traditional winter range of the previous two seasons and migrated an additional 82 km (51 mi) south to an area next to Mendeltna Creek, just south of the Glenn Highway. From her summer range the straight-line movement was 105 km (65 mi). By late spring she had returned to the summer range.

We were unable to explain the movements of moose numbers 80 and 8578 since they did not correspond with any other movement patterns nor with any noticeable change in environmental factors. This was not the case for moose 8035, however. Winter 1978-79, according to weather

records kept at Gulkana, was the second most severe in terms of total snowfall since 1952 when records were first kept. We suspect that moose 8035 moved south to an area of lower snow depths. Why other moose did not follow a similar pattern is unknown.

The movements exhibited by moose numbers 80 and 8578 may represent unusual random movements. Other moose researchers in Alaska have recorded similar percentages of animals making movements which are inexplicable (Schneider pers. comm.). Perhaps these apparently random movements aid moose in colonizing new habitats where moose are either absent or present in low densities.

Home Range

LeResche (1974) reported that seasonal home ranges of moose were consistently small regardless of how far a moose moved between seasons. Home ranges determined during this study were considerably larger than the 5-10 km^2 (2-4 mi^2) he reported (Table 3). Winter home ranges in this study ranged from 21 to 389 km^2 (8-150 mi^2), averaging 102 km (39 mi^2), while summer home ranges varied from 8-210 km^2 (3-81 mi^2) and averaged 72 km^2 (28 mi^2). Total area occupied by individual moose (migratory and sedentary) was quite large, ranging from 44 to 1373 km^2 (17-530 mi^2) and averaging 339 km^2 (131 mi^2). These latter figures compare favorably with the total range given by Peterson (1955) for Ontario moose, but were considerably larger than those reported for Kenai Peninsula moose (Bailey et al. 1978).

LeResche (1974) summarized studies indicating that cows with calves have smaller home ranges for a short time following parturition than do cows alone. This also appeared to be true for moose in this study. Radio-collared cows with calves had substantially smaller home ranges than lone cows, varying from 3 to 255 km^2 (1-137 mi^2), but averaging 37 km^2 (14 mi^2). By excluding data from one erratic migratory cow, however, the mean home range is dropped to 16.8 km^2 (6.5 mi^2) which is comparable with that reported by Berg (cited in LeResche 1974) in Minnesota, but larger than those reported in other studies (Table 4).

Moose throughout North America traditionally utilize the same home ranges each year. VanBallenberghe (1978b) found that moose returned to the same home ranges "even when environmental conditions broke the pattern of migration during one seasonal cycle." Our moose were also highly traditional, but did not always return to the same area. For the most part, fidelity to summer range was greater than to winter range.

Elevational and Habitat Usage

We classified habitat types on 719 occasions. Sixty-seven percent of the classifications were in spruce dominated habitats. Fifty-eight percent of the spruce classifications were of the medium spruce type (Table 5) which usually has considerable quantities of willow and birch understory.

Table 4. Comparison of home ranges of moose cows with calves (from LeResche 1975).

Locality	Time Interval	Home Range Area km^2	Home Range Area (mi^2)	Reference
Montana	6 July - 23 September	2.2	0.85	Knowlton, 1960
Wyoming	6 June - 15 September	5.1	1.97	McMillan, 1954
Ontario	15 August - 31 October	6.0	2.32	DeVos, 1956
Minnesota	11 June - 22 August	5.9	2.28	VanBallenberghe & Peek, 1971
Minnesota	15 May - 1 October	15.4	5.95	Berg, 1971
Minnesota	15 May - 1 October	16.9	6.53	Berg, 1971
Alaska	6 June - 31 October	8.4	3.24	LeResche, 1966
Alaska	24 May - 1 September	16.8	6.49	This study

Table 5. Habitat types utilized by radio-collared moose per month of observation for 1976-1979 in the Nelchina and upper Susitna River Basins, Alaska.

Habitat Classification	% Tall Spruce	% Medium Spruce	% Low Spruce	% Riparian Willow	% Marsh	% Alder	% Upland Willow &Brush	% Cottonwood or Aspen	Sample Size(n)
Month									
January	6	38	38	0	0	0	19	0	16
February	12	48	9	15	0	0	15	0	33
March	5	49	22	11	0	3	11	0	37
April	27	49	4	10	0	5	5	0	41
May	15	52	12	8	2	0	10	0	132
June	13	36	13	7	2	5	21	2	169
July	6	31	13	9	4	10	21	4	67
August	29	29	10	3	5	8	16	0	62
September	13	31	15	2	0	4	33	2	52
October	19	29	10	4	0	8	31	0	52
November	8	39	19	17	0	0	17	0	36
December	18	23	5	27	0	0	23	5	22
TOTALS	15	39	13	8	2	4	18	1	719

Habitat use percentages by month are listed in Table 5. Habitat classifications roughly corresponded with altitudinal movements depicted in Fig. 44. Medium spruce types were utilized more than any other type during all months except August, September, October and December. During three of these months (September, October and December) willow species were heavily utilized during the rut and early winter, respectively. Upland willow was heavily utilized during summer, and tall and medium spruce types were heavily utilized during parturition.

VanBallenberghe (1978a) summarized the altitudinal movements of Gakona and eastern Alphabet Hills moose from October 1974 through June 1977. During summer these moose occupied areas at about 762-914 m (2500-3000 ft) elevation, and during winter habitat types at the 548-671 m (1800-2200 ft) elevations were utilized. Moose in this study generally followed that pattern except that lower elevations were used more than reported by VanBallenberghe (1978a). During winter, Susitna Basin moose utilized areas with elevations ranging from 762-883 m (2500-2900 ft), while in summer 792-975 m (2800-3200 ft) elevations were used.

Calf Production and Survival

During spring 1977 tagging, it was determined that 14 of the radio-collared cows were pregnant. Subsequent observations in late spring and summer revealed that these animals only produced seven calves (Table 6). In contrast, 20 cows collared in the fall produced at least 23 calves. We did not know if the differences between the two groups reflected actual differences in production or survival. We compared numbers of calves produced from 1977 versus 1976 fall radio-collared cows in 1977 and 1978. Fall 1976 collared cows produced 1.0 calf per cow in both 1977 and 1978, while cows collared in spring 1977 produced only 0.39 calves in 1977. In 1978, however, the spring 1977 collared cows produced 1.06 calves/cow. The number of calves produced in 1977 by spring radio-collared cows was significantly different ($P<0.05$) from numbers produced in 1978 and also from fall collared cows in both 1977 and 1978. No significant differences ($P>0.05$) were detected between the mean number of calves per cow produced by fall collared cows in 1977 and 1978 and those produced by spring collared cows in 1978. Both Reynolds and VanBallenberghe (pers. comm.) suspect that either the drug (succinylcholine chloride) and/or rectal palpation may have been responsible for low calf production of their marked moose, however, no quantifiable data were available.

As in other moose studies utilizing succinylcholine chloride (Franzmann, Didrickson, Gasaway, etc., pers. comm.), we had difficulty determining drug dosages for individual moose. In several instances it was necessary to administer artificial respiration to prevent the moose from dying. Perhaps these animals and others which may have been oxygen-starved or stressed accounted for low calf production in 1977. We believe rectal palpation was not responsible for low calf production since it has little or no effect on domestic animal production (Franzmann and Tobey, pers. comm.). Moose rectally palpated, but immobilized with other drugs have had a disproportionately larger number of calves than

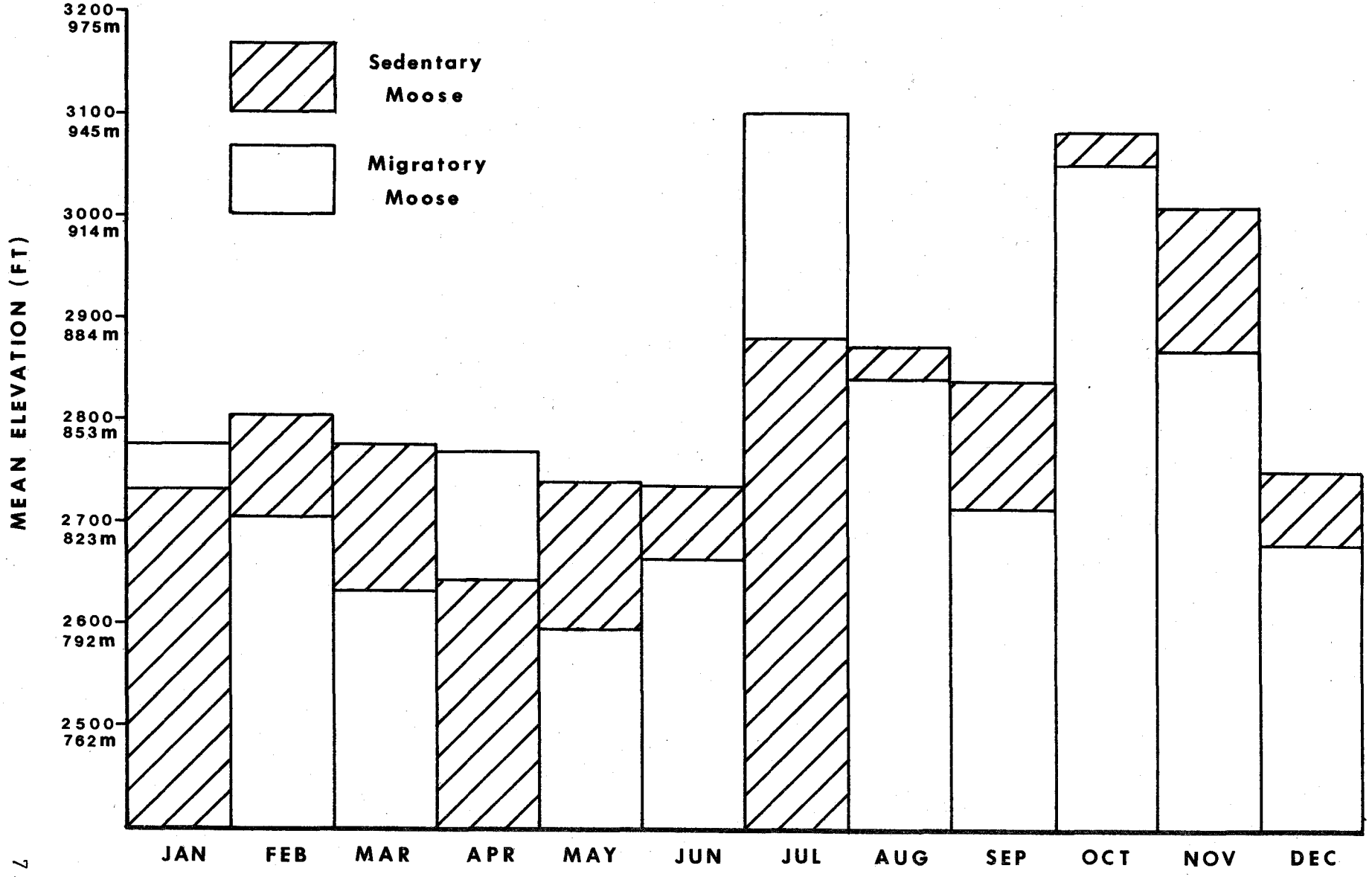


Fig. 44. Average monthly elevations occupied by radio-collared moose from October 1976 through May 1979 in the Nelchina and upper Susitna River Basins, Alaska.

Table 6. Comparison of observed calf production between radio-collared moose tagged in fall, 1976 versus those tagged in spring 1977 within or close to the Susitna River Study Area.

Fall Collared			Spring Collared			
Moose #	Observed calf production 1977	1978	Moose #	Pregnancy status	Observed calf production 1977	1978
8017	1	0	8570	Pregnant	1	1
8018	1	1	8571	Pregnant	1	1
8019	2	2	8572	Pregnant	0	1
8020	2	0	8573	Prenant	0	1
8021	1	1	8574	Pregnant	1	0
8022	0	1	8575	Pregnant	0	1
8029	2	2	8576	Unknown	0	1
8030	1	1	8577	Pregnant	0	1
8031	0	1	8578	Not pregnant	0	0
8032	1	1	8579	Pregnant	0	1
8033	2	N/A	8581	Pregnant	0	2
8034	1	2	8592	Pregnant	0	2
8035	0	1	8583	Not pregnant	0	2
8036	1	2	8584	Pregnant	2	2
8037	1	1	8585	Pregnant	0	0
8038	1	N/A	8586	Pregnant	1	0
8039	2	1	8587	Pregnant	1	0
8040	2	N/A	8588	Unknown	0	1
8042	1	0	8589	Not pregnant	0	2
8044	1	1				
Total No. 20	23	18	19		7	19
$\bar{x}$	1.00[1/]	1.00			0.39	1.06
S.D.	.69	.69			.61	.73

1/ Excludes moose 8033, 8038, and 8040.

uncollared moose (Smith and Franzmann 1977). We concluded from our comparison that use of succinylcholine chloride to immobilize moose in spring 1977 altered calf production that year, but did not alter it in 1978. We do not recommend use of this drug to immobilze potentially pregnant moose in spring. In addition, there are other economic and biological reasons for no longer using succinylcholine chloride (Gasaway et al. 1979).

Parturition was first observed for uncollared moose on 24 May in 1977 and 1978, and on 18 May in 1979 (Fig. 45). Radio-collared moose dropped their first calves by 25 May in 1977 and 1978. Sixty percent of the calves were born between 29 May and 3 June when parturition peaked. Parturition was nearly complete (95.5%) by 10 June of each year. Late calving was observed in 1978 when one calf was born sometime between 7 July and 17 August.

Information on status and reproductive history of visual-collared moose is stored in our Glennallen office. Of the 55 visually collared moose observed after tagging, at least 25 (64%) were known to have produced one or more calves from 1977 through 1979. These observations of calf production support those obtained on the radio-collared moose, indicating that adult cows were producing calves in sufficient quantities for the moose population to increase if calf survival improved.

Comparison of timing of mortality of uncollared calves of radio-collared adults to that of radio-collared calves is presented in Fig. 46 (from Ballard et al. In press). The loss pattern of the two groups of calves was very similar suggesting that the causes of mortality were also similar. Predation by brown bears was responsible for 79 percent of the natural mortality of radio-collared calves in 1977 and 1978. We also assumed that most of the uncollared calves of the radio-collared adults were also taken by brown bears. These data indicate that radio-collaring newborn moose calves did not predispose them to predation.

Approximately 94 percent and 82 percent, respectively, of the mortality to collared and uncollared calves occurred by 19 July of each year. Thereafter, most calves survived to 1 November of each year. Following this time period, no additional uncollared calf losses were noted in 1977-78 at least until April 1978 when cows and calves began separating. However, in 1978-79, a relatively severe winter, 7 of 17 surviving calves were lost in late winter, probably due to either starvation or predation (Ballard et al. In press).

Adult Cow Mortality

From October 1976 through approximately May 1979, we lost radio contact with 9 of 39 radio-collared moose. At least three of these were known to have died of unknown causes. Two others slipped their radio collars, but were subsequently observed in fall moose sex and age composition counts. The fate of the four remaining animals was unknown,

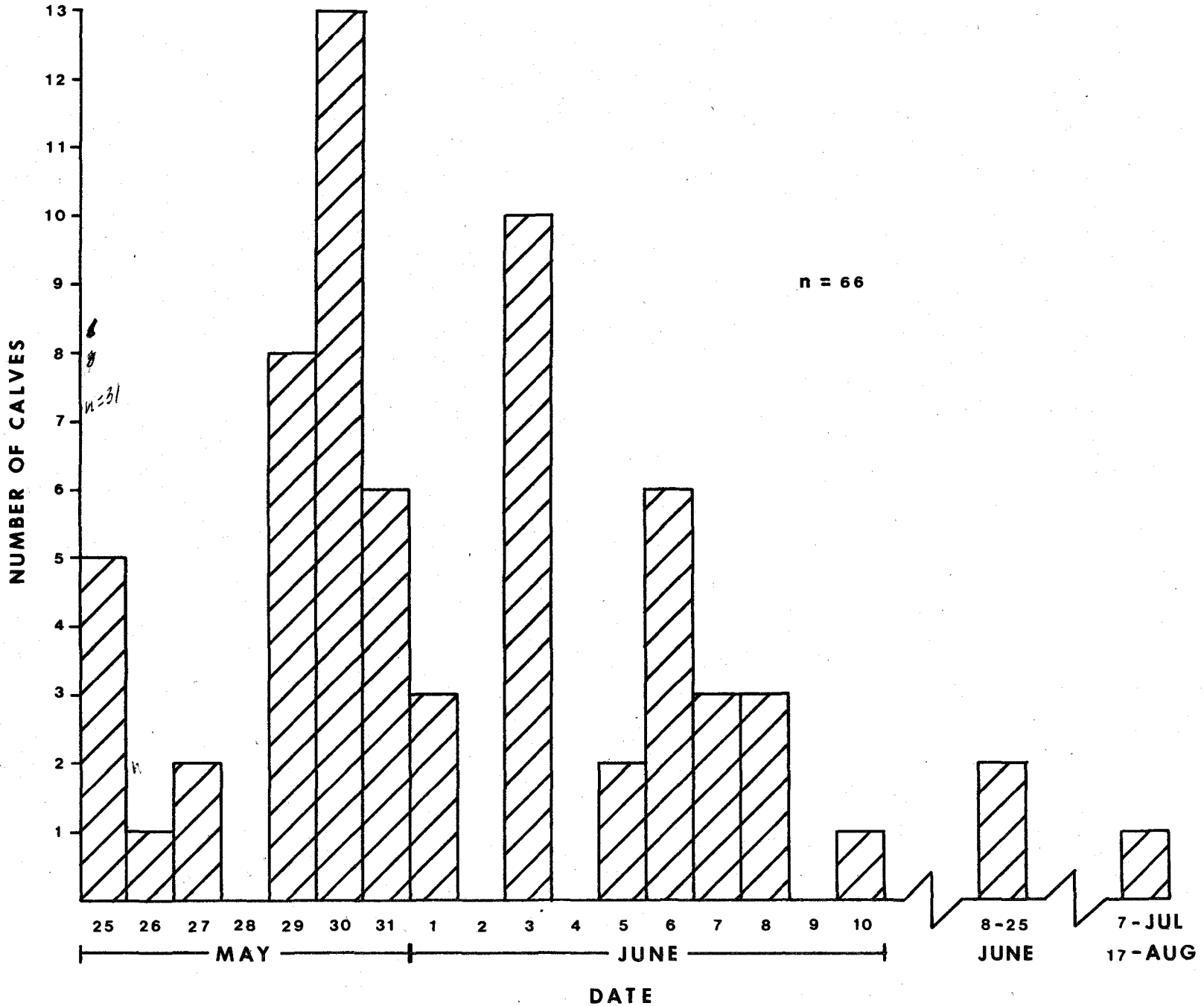


Fig. 45. Timing of moose parturition dates during 1977 and 1978 in Nelchina and upper Susitna River Basins, Alaska.

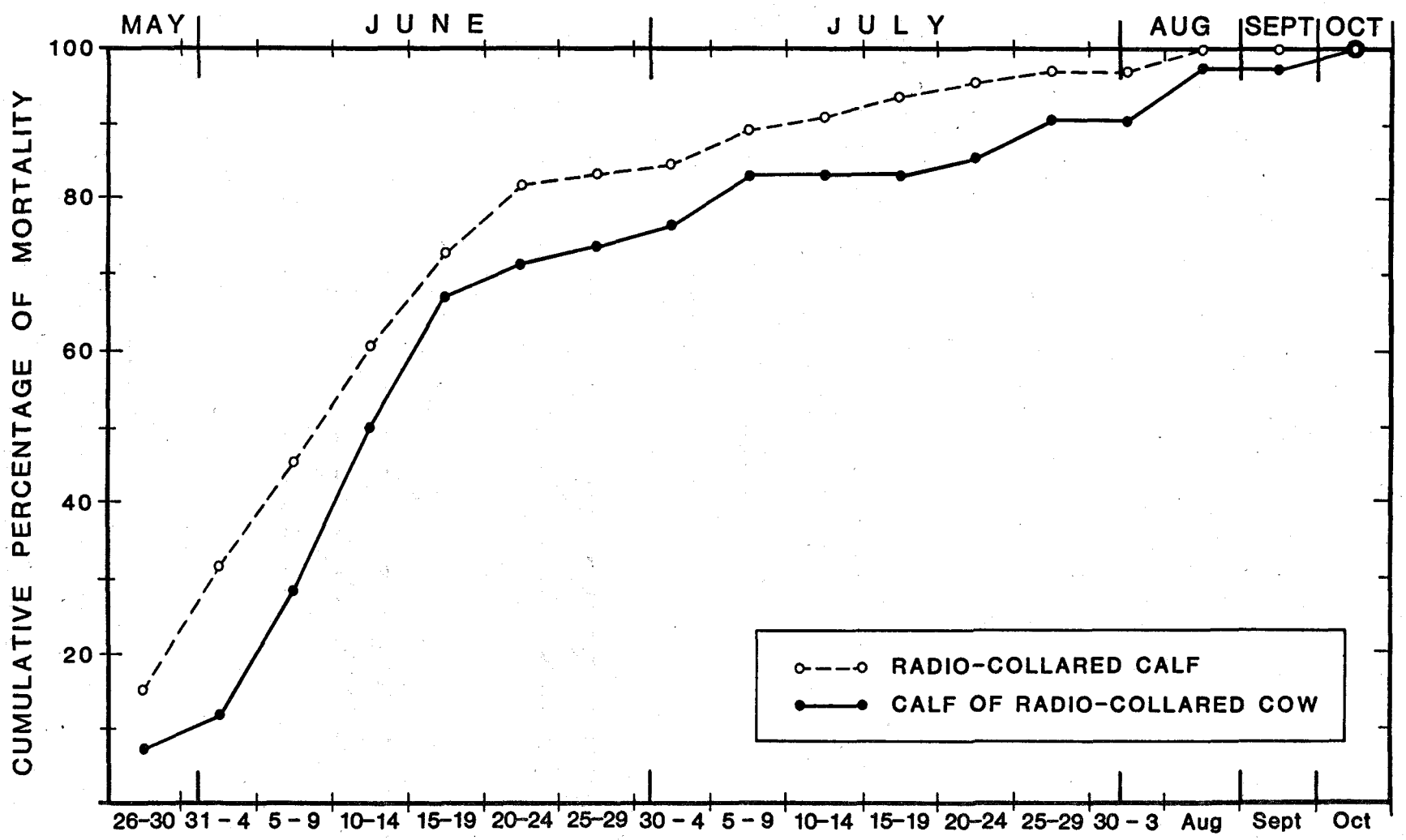


Fig. 46. Dates of mortalities of collared and uncollared moose calves during 1977 and 1978 in the Nelchina and upper Susitna River Basins, Alaska (from Ballard et al. 1980).

but for purposes of this discussion we considered them dead. Based upon these assumptions, from July through June of 1976-77, 1977-78 and 1978-79 we estimated annual adult cow mortality at 2.6 percent, 7.9 percent and 8.6 percent, respectively. These estimates should be viewed with caution because the study did not begin until October 1976 and ended in spring 1979. Overall, 17.9 percent of the radio-collared animals had either died or were missing by May 1979. Annually, adult cow mortality averaged 6.0 percent during the 3-year study.

Population Identity

Based upon movement patterns of radio-collared moose we identified four discrete populations of moose which doubtless are comprised of a number of subpopulations. These four identified populations were as follows:

Clearwater Mountains - Western Alphabet Hills Population - This population apparently consists of a highly migratory segment and a resident segment. Cows tagged in the Clearwater Mountains were extremely migratory. Most occupied the area only during late summer and fall. During November these animals migrated down the Maclaren River and Clearwater Creek to the bottomlands along the lower Maclaren River. Some moose wintered in the lower Maclaren area where they shared winter range with other moose which resided in the area year-round. Other Clearwater moose and some from the Maclaren River area continued migrating south. These moose either followed the Susitna River or traveled through the Alphabet Hills down Monsoon Lake Creek where they eventually wintered either in old spruce burns on the south side of the Alphabet Hills or at the mouths of the Oshetna and Tyone Rivers.

Upper Susitna River Population - Moose from this population generally were year-round residents of the east, middle, and west forks of the Susitna River. Most made relatively short movements, moving from higher elevations in summer to lower elevations in winter. The mouths of Valdez and Windy Creeks and the junction of the forks of the Susitna River received heavy moose usage through fall, winter and early spring. This population's movements appeared to correspond closely to the drainage patterns of the upper Susitna River.

Upper Nenana - Brushkana Population - Moose from this population appear to be comprised of animals residing in the tributary drainages of the Upper Nenana. These moose occupy the upper drainages in fall and summer but winter in lowland areas where they share winter range with year-round residents. Evidence suggests that some individuals may make extensive fall migrations down the Nenana River. There appeared to be a noticeable distinction between animals from this area and those utilizing the adjacent upper Susitna River drainages. Obviously, some exchange between these two populations occurs and, in fact, they may not be separate populations.

Susitna River Population - On the Susitna River from Butte Creek down to Devils Canyon most of the study animals exhibited relatively short movements and had small home ranges. Movements were mostly altitudinal

in nature with the exception of those cows tagged in upper Butte Creek. Those moose migrated down the Susitna River or Butte Creek where they wintered either at the mouth of Watana Creek or the vicinity of the Susitna Bend. There did not appear to be much interchange of animals in an east-west direction. Existing evidence indicates these resident moose share winter range with other highly migratory populations.

Comments Regarding Susitna Hydroelectric Project

Between October 1976 and June 1979, 18 radio-collared moose occupying areas near the two proposed impoundments crossed the Susitna River on at least 33 occasions. Ten (56%) of the 18 radio-collared moose crossed the river at least once. Tracks along the river during winter months indicate that moose commonly cross the river.

Two moose (8584 and 8586), originally collared in the Devil Mountain area, moved south of the Susitna River and did not return to the tagging site until winter 1978-79. Winter 1977-78 was relatively mild in terms of total snowfall which may account for these moose not returning to the tagging site. Winter 1978-79, however, was relatively severe in terms of total snowfall. Possibly the Devil Mountain area is only used by moose during relatively severe winters.

This radio-telemetry study focused exclusively on the north side of the Susitna River upstream from the proposed Devils Canyon dam site. Collection of moose movement information downstream and on the south side of the Susitna River was essential to evaluate the potential effects of this project on moose. To date, the entire analysis has been hampered by a lack of reliable moose population estimates for either side of the river.

Annual harvests within the immediate drainages of the upstream portion of the Susitna River have averaged 146 moose since 1974 (ADF&G, unpublished data). Approximately 475-500 sportsmen participate in moose hunts in this area each fall (Taylor and Ballard 1978). How significantly dam construction might reduce or increase the level of hunter participation is difficult to assess with the limited data available. Construction of an access road to the Watana site could substantially increase hunter pressure in the area, creating a corresponding increase in total man-days spent hunting. The quality of the hunting experience would probably decline, as well as the rate of hunter success. Dam construction and maintenance schedules are projected on the basis of a dam-life of 100 years. If project impacts reduced local moose populations by 50 percent this would amount to a harvest loss of 7,300 moose during the life of the dam. Loss of hunting opportunity downstream and loss of nonhunting wildlife values cannot be estimated on the basis of available information.

Construction of the Devils Canyon dam would flood a 45-km long portion of the Susitna River having a surface area of 7,500 acres. The riverbanks along this portion of the river are generally steep and provide marginal habitat for moose. The low density of moose tracks in

this area throughout the winter of 1977-78 indicates that little utilization occurs during winters of light of moderate snowfall. Since water levels in the Devils Canyon reservoir are expected to remain fairly constant, mortality rates associated with ice shelving and steep mud banks are expected to be low.

Construction of the Watana dam would inundate 43,000 acres along Watana Creek and the Susitna River. Approximately 35,000 of these acres sustain moderate to heavy utilization by moose during an average winter (USF&WS 1975). Doubtless, extremely heavy utilization occurs during severe winters. Much of this area supports moderate moose densities during the spring and summer season as well. Preliminary movement data gathered from radio-collared moose indicate that moose from several populations in surrounding areas of the Susitna Basin migrate across or utilize this portion of the river during some period of the year. The Alaska Department of Fish and Game observed 2,037 moose during their latest fall sex and age composition counts in these areas (ADF&G unpublished data). LeResche and Rausch (1974) concluded that an observer generally sights between 43 and 68 percent of the moose in an area during an aerial census. Using 50 percent for purposes of extrapolation, the resident moose population utilizing this portion of the basin can be estimated to be between 4,000 and 5,000 moose. Random stratified counts are needed to accurately assess numbers of moose in this area.

Effects of the Watana dam construction on these moose populations could be substantial. The resident nonmigratory segment of the population could be eliminated. The immediate loss of a major portion of the winter range along Watana Creek and parts of the Susitna River to flooding would effectively reduce the carrying capacity of the habitat at higher elevations used only during the warm seasons and mild winters. The Watana Reservoir would be 87 km long and may, during some seasons, prove to be an effective barrier to migrations. The resulting disruption of movements to traditional breeding grounds may adversely affect productivity. Increased mortality of neonates during post-calving movements might also occur. Since water levels are expected to fluctuate as much as 78 m, ice shelving behind the Watana dam could become a significant cause of mortality. Calving is a common occurrence in these portions of the study area. The loss of calving habitat notwithstanding, fluctuating water levels would change the timbered slopes from the Watana dam site to the Oshetna River to enormous mud banks. Calf mortality resulting from slipping on or getting stuck in this mud could become a common occurrence.

RECOMMENDATIONS

1. Succinylcholine chloride should not be used to immobilize moose during spring when normal calf production is desirable.

2. Due to fall migration being initiated by heavy snowfall it is recommended that fall sex and age composition counts be conducted as rapidly as possible following adequate snowfall preferably before mid-November.

3. Random stratified counts should be initiated to obtain reliable moose population estimates to aid in evaluating the effects of the Susitna Hydroelectric Project on moose.

4. Moose movements and population identity studies should be initiated south of the Susitna River and downstream to aid in assessing the effects of the hydroelectric project on moose.

ACKNOWLEDGEMENTS

A great number of individuals from the Alaska Department of Fish and Game participated in various aspects of the project and it would be difficult to give each recognition; A. Franzmann, T. Bailey, T. Spraker, and T. Balland participated in both tagging operations.

Al Franzmann, Kenai Moose Research Center, ADF&G, advised on various aspects of the project and assisted with interpreting the results from the blood tests.

Ted Spraker, ADF&G, assisted with monitoring moose movements. Artina Cunning and Tom Balland constructed maps for this report. Leon Metz assisted with data tabulations and constructed the final maps. Charles Lucier and his staff processed and aged moose teeth.

Karl Schneider and Don McKnight provided guidance during the program, reviewed the manuscript and made many helpful suggestions.

Vern Lofstedt, Kenai Air Service, continued to do an excellent job of piloting the helicopter. Mr. Kenneth Bunch, Sportsman Flying Service, Mr. Alfred Lee, Lee's Air Taxi Service, Mr. Kenneth Holland, Holland Air Service, Mr. Richard Halford, Susitna Flying Service and Doug Geeting all participated in monitoring radios.

We wish to thank ERA helicopters and the U.S. Army Corps of Engineers for their cooperation and assistance in radio-collaring moose during August 1978.

LITERATURE CITED

Bailey, T.N., A.W. Franzmann, P.D. Arneson and J.L. Davis. 1978. Kenai Peninsula moose population identity study. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. Final Report., W-17-3, 5, 6, 7, 8, and 9. 84pp.

Ballard, W.B. and K.P. Taylor. 1978. Upper Susitna River moose population study. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. Rept., W-17-9 and 10, Job 1.20R. 61pp.

_____, T.H. Spraker, and K.P. Taylor. In press. Causes of neonatal moose calf mortality in southcentral Alaska. J. Wildl. Manage.

Barry, T.W. 1961. Some observations of moose at Wood Bay and Bathurst Peninsula, N.W.T. Can. Filed. Nat. 75(3):164-165.

Berg, W.G. 1971. Habitat use, movements, and activity patterns of moose in northwestern Minnesota. 98pp. (Unpubl.)

Bishop, R.H. and R.A. Rausch. 1974. Moose population fluctuations in Alaska, 1950-1972. Naturaliste Can. 101:559-593.

Didrickson, J.C., D. Cornelius and J. Reynolds. 1977. Southcentral moose population studies. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. Rept. W-17-6, 7, and 8. Job 1.12R. 6pp.

_____, and K.P. Taylor. 1978. Lower Susitna Valley moose population identity study. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. Rept. W-17-8 and 9. Job 1.16R. Final Rept. 20pp.

Faro, J. and A.W. Franzmann. 1978. Productivity and physiology of moose on the Alaska Peninsula. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. Prog. Rept. W-17-9 and 10. Job 1.22R. 29pp.

Franzmann, A.W. and P.D. Arneson. 1973. Moose Research Center Studies. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. Prog. Rept., W-17-5. 60pp (multilith).

_____, P.D. Arneson, R.E. LeResche and J.L. Davis. 1974. Development and testing of new techniques for moose management. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. Final Rept., W-17-2, 3, 4, 5, and 6. 54pp.

_____, A. Flynn and P.D. Arneson. 1975. Levels of some mineral elements in Alaskan moose hair. J. Wildl. Manage. 39(2):374-378.

_____, R.E. LeResche, P.D. Arneson and J.L. Davis. 1976. Moose productivity and physiology. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. Final Rept., W-17-2, 3, 4, 5, 6 and 7. 87pp.

_____, and R.E. LeResche. 1978. Alaskan moose blood studies with emphasis on condition evaluation. J. Wildl. Manage. 42:344-351.

Gasaway, W.C., A.W. Franzmann and J.B. Faro. 1979. Immobilization of free ranging moose with a mixture of etrophine (M-99) and xylazine hydrochloride (ROMPUN). J. Wildl. Manage.

Greer, K.R. and W.W. Hawkins. 1967. Determining pregnancy in elk by rectal palpation. J. Wildl. Manage. 31(1):145-149.

LeResche, R.E. 1974. Moose migrations in North America. Naturaliste Can. 101:393-415.

_____, and R.A. Rausch. 1974. Accuracy and precision of aerial moose censusing. J. Wildl. Manage. 38(2):175-182.

Markgren, G. 1969. Reproduction of moose in Sweden. Viltrevy. G(3):1-299.

McIlroy, C. 1974. Moose survey-inventory progress report - 1972, Game Management Unit 13. 66-74pp. In McKnight, D.E. (Ed). 1974. Annual report of survey-inventory activities, Part II. Moose, caribou, marine mammals and goat. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Rep., Proj. W-17-5. 269pp.

Mech, L.D. 1974. Current techniques in the study of elusive wilderness carnivores. Proc. of XI. Internat. Congress of Game Biol. 315-322pp.

Nielson, A.E. and W.M. Shaw. 1967. A helicopter dart technique for capturing moose. Proc. West. Assoc. Game and Fish Comm. 47:182-199.

Peterson, R.L. 1955. North American moose. Univ. Toronto Press. 280pp.

Rausch, R.A. 1958. Moose management studies. Alaska Game Comm. Fed. Aid in Wildl. Rest. Job Completion Rept. Vol. 12, Proj. W-3-R-12. Juneau. 138pp.

_____. 1967. Report on 1965-1966 moose studies. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-15-R-1, Juneau, 129pp.

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

Skoog, R.O. 1968. Ecology of caribou (*Rangifer tarandus granti*) in Alaska. PhD. Thesis, Univ. of California, Berkeley, California. 699pp.

Smith, C.A. and A.W. Franzmann. 1979. Productivity and physiology of Yakutat Forelands moose. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. Final Rept., W-17-10 and 11. Job 1.25R. 18pp.

Taylor, K.P. and W.B. Ballard. In press. Moose movements and habitat use along the Susitna River near Devil's Canyon, Alaska. North Am. Moose Conf. Workshop, Kenai, Alaska.

U.S. Fish and Wildlife Service. 1975. Southcentral railbelt area upper Susitna River Basin hydroelectric project two dam plan. U.S. Dept. Interior, Anchorage, Ak. 25pp.

VanBallenberghe, V. 1978a. Migratory behavior of moose in southcentral Alaska. Proc. 13th Int. Conf. Game Biol., Atlanta, Georgia. 12pp.

_____. 1978b. Final report on the effects of the Trans-Alaska Pipeline on moose movements. Alaska Dept. Fish and Game. 44pp.

Yankee Jr., W.H. 1974. Annual population and employment projections, 1961-1980. Alaska Dept. of Labor, Juneau. 10pp.

PREPARED BY:

Warren B. Ballard
Game Biologist

APPROVED BY:

Ronald J. Somerville
Director, Division of Game

SUBMITTED BY:

Karl Schneider
Regional Research Coordinator

Donald E. McKnight
Research Chief, Division of Game

Appendix I. Location, physical measurements, ages, and statistics associated with capturing and marking of 44 adult cow moose in the Susitna River Study area from 21 through 28 October 1976.

Moose #	Date	Location	Collar color-#	L. ear tag color and #	R. ear tag color and #	Age (months)	Measurements (CM) Total length	Hind foot	Shoulder height	Heart girth	Cond. index	Heart Rate (BAM)	Body Temp. (°F)	Drug dosage (mg)	Drug reaction time	Drug placement
8017	10/27/76	S. McClaren Bend	Radio-Yellow	G16258	G16259	77	-	-	-	-	7	-	-	30	7 min	left leg
8018	10/27/76	Butte Creed	Radio-Green	B16240	B16237	17	270	79	-	184	6	-	100.4	29	7 min	lower leg
8019	10/21/76	Gracious House	Radio-Black	G16228	G16229	77	325	89	-	-	8	-	-	-	-	left rump
8020	10/22/76	Gracious House	Radio-Yellow	B16222	G16221	113	319	-	-	198	8	96	103.4	27	6 min	right rump
8021	10/22/76	Brushkana Crk.	Radio-Red	16252	16253	-	-	-	-	-	-	-	-	28	12 min	left hip
8022	10/28/76	Upper Watana	Radio-Red	W16285	W16284	101	299	81	-	214	7	-	-	29	6 min	-
8029	10/26/76	S. McClaren S.E. knob	Radio-Red	G16255	G16256	-	-	79	-	-	8	-	-	30	16 min	-
8030	10/22/76	Across from Ballard Lk. at 3400'	Radio-Black	B16202	B16201	77	306	80	-	46	6	116	100.8	25	9 min	leg
8031	10/22/76	South Bend Susitna	Radio and Blue 3	B16223	B16224	41	280	79	-	198	7	88	101.2	27	3 min	-
8032	10/23/76	Upper Clear-water Crk.	Radio-Red	G16233	G16234	89	318	81	-	266	8	-	101.8	28	10 min	top rump
8033	10/28/76	Valdez Crk.	Radio-Green	B16299	B16254	65	315	78	-	214	8	88	103.2	30	-	left flank
8034	10/23/76	Brushkana Crk.	Radio-Yellow	G10673	G10673	41	296	79	-	196	7	-	-	29	13 min	top back
8035	10/27/76	S. McClaren Flats	Radio-Blue	W16066	W16067	-	290	-	-	203	7	-	-	-	5 min	lower left hip
8036	10/28/76	West Fork Glacier	Radio-Blue	B16266	B16265	77	302	77	-	183	-	-	-	29	5 min	high left hip
8037	10/28/76	Just below West Fork Glacier	Radio-Blue	W16243	W16244	77	308	-	-	193	7	-	-	27	9 min	left hip
8038	10/27/76	Watana Creek	Radio-Red	G16239	G16263	101	303	-	-	193	-	-	-	-	-	-

Appendix I. (Continued).

8039	10/28/76	West Fork Glacier	Radio-Yellow	B16298	B16296	77	-	-	-	-	-	-	-	30	-	top left rump
8040	10/28/76	Upper Watana Creek	Radio-Green	W16061	W16062	-	305	-	-	193	7	-	-	29	9 min	-
8042	10/28/76	West Fork Susitna	Radio-Blue	16241	W16242	53	305	-	-	203	-	-	-	29	10 min	left flank
8044	10/23/76	Upper Little Clearwater	Radio-Black	G16074	G16075	41	302	81	-	-	8	-	102.6	29	-	high tail
1	10/21/76	Gracious House	Blue 1	Y16232	Y16231	149	300	74	-	183	-	-	102.2	-	-	left rump
2	10/22/76	South Bend	Blue 2	G16248	G16247	101	297	68	-	193	-	-	-	-	6 min	-
4	10/22/76	across from Spraker Lake	Blue 4	G16250	G16249	53	312	-	-	193	-	-	-	-	-	high on left hip
5	10/22/76	across from Spraker Lake el 3400'	Blue 5	B16206	B15205	65	176	81	-	118	7	88	102.2	27	10 min	left hind
6	10/22/76	across from Spraker Lake el 3400'	Blue 6	B16277	B162776	65	317	-	-	213	-	-	-	27	4 min	left hip
7	10/22/76	Sue R - S of Coal River	Blue 7	G16226	G16227	53	-	-	-	-	-	-	-	25	9 min	left hind quarters.
8	10/27/76	South McClaren SE Knob	Blue 8	W16216	W16217	161	291	72	-	200	6	-	-	30	5 min	left hip
9	10/27/76	Butte Creek	Blue 9	G16262	G16275	65	287	79	175	206	6	120	102.2	27	-	left rump
10	10/27/76	Butte Creek	Blue 10	G16281	G16279	89	301	82	-	188	-	-	-	27	12 min	rump-left leg
11	10/27/76	South McClaren Flats	Blue 11	G16260	G16273	77	305	-	-	204	6	-	-	31	5 min	top left rump
12	10/23/76	Brushkana Creek	Blue 12	G16070	G16071	41	-	-	-	-	7	-	-	27	-	-
14	10/23/76	Brushkana Creek	Blue 14	16235	16236	41	311	-	-	-	8	-	104	29	-	inside rear left leg
15	-	West Fork G1	Blue 15	B16269	B16267	113	301	-	-	206	-	-	-	29	10 min	high left leg
16	10/23/76	Valdez Creek	Blue 16	G16068	G16069	-	-	-	-	-	-	-	-	28	6 min	tail
17	10/21/76	Gracious House	Blue 17	Y16246	16245	173	320	74	-	224	6	78	101.1	27	5 min	low left hip
18	10/22/76	Gracous House	Blue 18	G16219	G16207	137	190	-	-	-	7	-	-	-	7 min	top of rump
19	10/27/76	Butte Creek	Blue 19	W16055	W16054	89	310	83	-	226	-	-	-	27	20 min	top rump

Appendix I. (Continued).

25	10/27/76	Butte Creek	Blue 25	W16053	W16052	125	308	88	-	210	7	-	102.8	30	7 min	lower leg
38	10/28/76	West Fork McClaren	Blue 38	B15282	B16283	173	-	-	-	-	6	-	-	29	5 min	-
42	10/28/76	West Fork Gl.	Blue 42	W16063	W16064	17	267	77	-	180	6	-	-	29	10 min	left flank
1-71	10/28/76	Upper Watana	Blue 71	B16270	B16271	41	-	-	-	-	-	-	-	29	11 min	left side rump
M-1	10/27/76	Butte	-	-	-	65	-	-	-	-	-	-	-	27	12 min	flank
M-2	10/27/76	Butte	-	-	-	137	298	84	186	212	-	-	-	27	5 min	left low leg
M-3	10/27/76	Watana	-	-	-	101	274	81	-	118	7	-	-	29-3day 30	10 min	genitals
Totals	-	Mean ($\bar{x}$)				83.46	294.4	79.39	180.50	190.45	6.7	96.29	102.15	28.3	8.4	
		Standard Deviation (S.A.)				40.16	31.47	4.66	7.78	31.21	1.35	15.77	1.07	1.45	3.64	
		Sample size (n)				39	34	23	2	31	27	7	13	37	34	

Appendix II. Location, physical measurements, ages, pregnancy status, and statistics associated with capturing and marking 73 adult cow moose in the Susitna River Study area from 18 through 23 March 1977 and August 1978.

Moose #	Date	Location	Collar color and #	L. ear tag color and #	R. ear tag color and #	Age (months)	Pregnancy status	Measurements (cm) Total length	Hind foot	Heart girth	Cond. index	Drug dosage (mg)	Drug reaction time (min)	Drug placement
Spring Collared														
8570	3/20/77	Lower Brushkana	Radio-Orange 12	W-15904	W-15903	82	yes	302	-	193	6	28	-	tail (genitals)
8571	3/20/77	opposite & above Spraker Lake	Radio-Blue 62	W-15910	W-15909	46	yes	292	-	183	6	25 plus & 1/2 dose	9 min	tail
8572	3/22/77	Lower McClaren	Radio-Orange 2	16124	16125	142	yes	-	-	-	7	27	10 min	left hip
8573	3/19/77	Lower Susitna near Watana	Radio-Orange 5	-	-		yes	295	-	203	7	27	26 min	tail
8574	3/20/77	between east & middle fork of Sue River	Radio-Orange 15	O-15920	O-15921	34	yes	284	-	193	6	28	6 min	lower flank
8575	3/21/77	Lower McClaren	Radio-Orange 3	G-16095	G-16096	154	yes	310	-	229	7	27	5 min	left leg
8576	3/19/77	between Sue and Watana Creek	Radio-Orange 6	G-16030	G-16029	94	-	293	-	218	7	28	9 min	top rump
8577	3/20/77	opposite & above Spraker Lake	Radio-Orange 8	O-16045	O-16045	154	yes	282	-	198	6	27	4 min	flank
8578	3/20/77	Sue Bend	Radio-Orange 10	W-15912	W-15905	46	no	262	-	168	5	27	-	-
8579	3/20/77	Sue Bend	Radio-Orange 14	O-16099	O-16100	22	yes	257	-	168	6	25	-	inside leg
8580	3/18/77	Devil Mountain	Radio-No collar	-	-		-	-	-	-	-	23	-	top hip
8581	3/18/77	mouth Valdez Crk.	Radio-Blue 13	-	-		yes	298	-	193	7	-	12 min	left leg
8582	3/22/77	Lower McClaren	Radio-Orange 4	G-16122	G-16123	82	yes	-	-	-	7	27	-	high left leg
8583	3/18/77	E. Devil Mountain	Radio-Orange 7	R-16293	R-16294	46	no	258	-	188	6	27	7 min	rib cage

Appendix II. (Continued).

8584	3/18/77	E. Devil Mountain	Radio-Orange 9	W-16003	W-16004	130	yes	290	-	198	6	25	-	top rump
8585	3/22/77	lower McClaren	Radio-Orange 1	G-16079	O-16080		yes	305	-	206	7	27 plus & 1/3 dose	18 min 5 min	left hip
8586	3/18/77	Devil Mountain	Radio-Orange 11	W-16001	W-16002	118	yes	309	80	198	4	23	10 min	top loin
8587	3/20/77	lower Brushkana	Radio-Orange 13	O-15917	O-15916	34	yes	290	-	183	5	27	9 min	top rump
8588	3/19/77	upper Jay Creek	Radio-Orange 16	-	-	94	-	274	-	208	7	29	12 min	tail
8589	3/18/77	E. Devil Mountain	Radio-White 82	R-16028	R-16027	154	no	-	-	-	-	27	-	top rump
20	3/18/77	mouth Valdez Crk	Blue 20	R-16005	R-16006		yes	-	-	-	6	27	-	top rump
21	3/20/77	between east and middle fork of Sue	Blue 21	O-15918	O-15919	46	yes	310	-	193	6	28	-	rump
22	3/23/77	Valdez Creek	Blue 22	16187	16186	82	yes	274	-	-	7	27	-	left leg
23	3/20/77	between east and middle fork of Sue	Blue 23	G-16035	G-16034	22	yes	259	-	183	-	28	10 min	lower flank
27	3/20/77	upper Brushkana	Blue 27	R-16042	R-16041	34	no	-	-	-	-	27	7 min	rump
28	3/20/77	between east and middle fork of Sue	Blue 28	G-16037	G-16036	46	yes	-	-	-	-	28	9 min	-
30	3/23/77	upper Sue	Blue 30	O-16126	O-16127	94	yes	320	-	208	7	-	4 min	-
31	3/23/77	upper Sue	Blue 31	-	-		yes	-	-	-	7	27	-	lower right leg
32	3/23/77	upper Sue	Blue 32	O-R-16128	O-R-16129		yes	-	-	-	7	27	-	left leg
33	3/23/77	upper Sue	Blue 33	R-16199	16200	22	yes	244	-	-	5	25	8 min	left hip
34	3/23/77	upper Sue	Blue 34	-	-		-	-	-	-	7	27	-	left high
35	3/23/77	upper Sue	Blue 35	O-16132	O-16133	34	yes	-	-	-	6	27	-	left hip
36	3/23/77	upper Sue	Blue 36	R-16180	R-16181	70	yes	279	-	-	-	-	-	-
37	3/23/77	middle fork	Blue 37	Y-16176	Y-16177	34	yes	-	-	-	-	27	6 min	left lower leg
39	3/20/77	lower Brushkana	Blue 39	R-16038	R-16039	34	yes	264	-	188	-	28	9 min	top rump
40	3/23/77	Valdez Creek	Blue 40	O-15875	W-15874	94	no	284	-	208	-	27	-	left rump
44	3/23/77	Valdez Creek	Blue 44	B-16192	B-16193		yes	-	-	-	-	25	-	rump
45	3/23/77	Valdez Creek	Blue 45	W-16147	W-16148	94	yes	302	-	208	6	27	-	left rump
46	3/23/77	Valdez Creek	Blue 46	O-16191	O-16190	34	yes	-	-	-	5	27	7 min	right rump
47	3/23/77	Valdez Creek	Blue 47	W-16149	W-16150	94	yes	297	-	193	7	27	-	-
48	3/23/77	Valdez Creek	Blue 48	W-15851	W-15852	154	yes	318	-	206	7	27	-	left leg

Appendix II. (Continued).

49	3/23/77	Valdez Creek	Blue 49	O-15872	W-15873	154	yes	-	-	-	6	27	-	-
50	3/22/77	lower McClaren	Blue 50	G-16120	G-16125	94	yes	-	-	-	6	27	-	left rump side
51	3/22/77	lower McClaren	Blue 51	G-16118	G-16119	34	yes	-	-	-	6	25	-	left rump
52	3/22/77	lower McClaren	Blue 52	G-16093	G-16094	82	yes	290	-	188	7	27	14 min	high on butt near spine
53	3/22/77	lower McClaren	Blue 53	16102	16103		yes	-	-	-	6	27	-	high left
54	3/22/77	lower McClaren	Blue 54	W-16116	W-16117	46	yes	-	-	-	-	25	8 min	left rear
55	3/23/77	upper Sue	Blue 55	-	-		-	-	-	-	-	27	13 min	left leg
56	3/22/77	lower McClaren	Blue 56	G-16081	G-16082	82	yes	292	-	193	7	27	5 min	left leg rear
57	3/23/77	upper Sue	Blue 57	B-15188	B-16189		yes	-	-	-	8.0	27	17 min	left rump
58	3/22/77	lower McClaren	Blue 58	G-16091	G-16092	142	yes	287	-	-	6	27	-	left leg
60	3/20/77	across from Spraker Lake	Blue 60	-	-	154	-	-	-	-	-	28	21 min	left tail
61	3/20/77	opposite & above Spraker Lake	Blue 61	W-15907	W-15908		yes	295	-	193	7	25	-	center of rump
63	3/20/77	Sue Bend	Blue 63	W-15913	W-15914	58	yes	290	-	193	7	27	7 min	flank
64	3/20/77	Sue Bend	Blue 64	O-16097	O-16098	130	yes	305	-	183	7	27	13 min	middle back
66	3/23/77	Sue River below	Blue 66	R-16088	R-16089	94	yes	302	-	198	6	27	6 min	-
67	3/23/77	SE Sue Lodge (5 mi on road)	Blue 67	G-15853	G-15854	-	-	-	-	-	6	27	15 min	ribs
68	3/23/77	Hatchet Lake	Blue 68	R-16085	R-16086	154	no	-	-	-	-	25	-	rectum
70	3/23/77	Hatchet Lake	Blue 70	-	-		no	-	-	-	-	27	10 min	left hip
75	3/19/77	between Jay and Watana	White 75	G-16033	G-16032		yes	-	-	-	-	28	-	hind end tail
79	3/19/77	between Jay and Watana Creek	White 79	R-15922	R-15923		-	-	-	-	-	1/2/of 25 28	20 min	right hind qrts.
80	3/18/77	E. Devil Mountain	White 80	R-16286	R-16287	46	yes	274	-	188	-	25	-	top of rump
81	3/18/77	E. Devil Mountain	White 81	-	-		yes	-	-	-	7	27	-	left rump
84	3/23/77	Hatchet Lake	White 84	-	-	-	-	-	-	-	-	27	-	top leg left
M-1	3/20/77	between East & Middle Fork Sue	-	-	-	70	yes	283	-	183	-	1/3/of 27	-	top of back
M-2	3/20/77	lower Brushkana	-	-	-	154	yes	310	-	203	5	28	10 min	high left rump
M-3	3/20/77	opposite Spraker Lk.	-	-	-		yes	284	84	208	8	27	19 min	left rump
M-4	3/23/77	upper Sue	-	-	-	84	yes	-	-	-	-	1/3 25 27	6 min 4 min	left hip
M-5	3/23/77	-	-	-	-	22	-	-	-	-	-	-	-	-
Total -	Mean ($\bar{x}$)					82.00		288.53	82.00	195.41	6.38	26.77	10.69	
	Standard Deviation (SD)					45.30		18.00	2.83	12.72	.82	1.14	5.34	
	Sample size (n)					49		38	2	34	47	65	36	

Appendix II. (Continued).

August 1978

8040II	14/8/78	Watana Creek& Susitna River	Blue 43	B-16200	R-16007	192	N/A	-	-	-	-	29	6 min	-
8588II	14/8/78	Watana Creek& Susitna River	Blue 26	W-15954	Y-15906	72	N/A	-	-	-	-	29	8 min	-
5527	14/8/78	Jay Creek& Susitna River	Blue 24	G-15969	G-15970	8	N/A	-	-	-	-	29	7 min	-
5540	14/8/78	Jay Creek&	Blue 29	G-15963	G-15965	84	N/A	-	-	-	-	29	-	-

Appendix III. Blood values from adult cow moose by tagging site in the Upper Susitna River Basin, October 1978.

	Hemoglobin g/100 ml	Packed Cell Volume %	Calcium mg/100 ml	Phosphorus mg/100 ml	Glucose mg/100 ml	B.U.N. mg/100 ml	Uric Acid mg/100 ml	Cholesterol mg/100 ml	Bilirubin mg/100 ml	Ak. Phos. mg/100 ml	L.D.H. mu/100 ml	S.G.O.T. mu/100 ml	Total Protein g/100 ml	Albumin %	Globulin %	Alpha 1 %	Alpha 2 %	Beta %	Gamma %	A/G Ratio
Susitna River Bend																				
n	8	4	3	3	3	3	-	3	3	3	3	3	3	3	3	3	3	3	3	3
$\bar{x}$	20+	52.75	12.27	5.00	166.67	3.0	-	84.67	.17	50.0	313.67	91.0	8.00	5.19	2.81	.41	.48	.88	1.04	1.85
S.D.	N/A	2.06	1.14	1.00	38.21	1.0	-	9.81	.06	2.65	20.31	18.68	.50	.32	.21	.03	.02	.03	.11	.09
Susitna Glacier																				
n	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4
$\bar{x}$	20+	54.00	11.4	4.73	171.71	2.75	.07	107.00	.20	55.25	325.25	98.25	7.63	4.72	3.15	.30	.56	.91	1.14	1.64
S.D.	N/A	2.83	.95	.56	25.33	.96	.06	17.57	0.0	9.43	39.92	26.46	.32	.15	.72	.08	.14	.11	.24	.11
Maclaren River																				
n	5	5	5	5	5	5	1	5	5	5	5	5	5	5	5	5	5	5	5	5
$\bar{x}$	20+	53.20	10.94	6.18	189.2	4.4	0.2	85.8	.22	53.2	249.8	128.8	8.1	4.81	3.29	.34	.60	.87	1.36	1.49
S.D.	N/A	9.58	.83	.68	20.62	1.14	0.0	7.33	.04	13.66	53.55	78.19	.33	.49	.42	.13	.29	.12	.35	.30
Valdez Creek																				
n	2	1	1	1	1	1	-	1	1	1	1	1	1	-	-	-	-	-	-	-
$\bar{x}$	20+	56.00	10.40	4.2	185	3.00	-	82	.1	70.0	259	84	7.7	-	-	-	-	-	-	-
S.D.	N/A	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	-	-	-	-
Brushkana Creek																				
n	4	4	4	4	4	4	-	4	4	4	4	4	4	4	4	4	4	4	4	4
$\bar{x}$	20+	55.50	11.25	5.35	184.75	3.5	-	89.25	.23	56.5	316.25	112.0	8.2	5.06	3.4	.26	.55	.93	1.41	1.63
S.D.	N/A	4.04	.97	.76	34.45	1.0	-	11.3	.1	17.62	43.45	35.62	.88	.42	1.01	.03	.20	.28	.28	.18
Watana Creek																				
n	7	5	5	5	5	5	2	5	5	5	5	5	5	5	5	5	5	5	5	5
$\bar{x}$	20+	53.40	11.26	5.44	228.6	3.6	.15	46.05	.22	53.6	258	103.8	8.24	5.27	5.63	.28	.59	.93	1.18	1.78
S.D.	N/A	4.93	.92	.77	64.38	.55	.07	85.63	.11	9.07	32.88	49.71	.38	.47	3.4	.07	.2	.16	.18	.23
Middle Susitna River																				
n	10	10	11	11	11	10	4	11	10	11	11	11	11	11	11	11	11	11	11	11
$\bar{x}$	20+	51.40	12.02	4.54	153.0	2.91	.25	96.45	.29	58.82	290.55	110.2	7.91	4.86	3.05	.31	.46	1.02	1.26	1.63
S.D.	N/A	2.91	1.39	.88	29.03	.94	.06	19.85	.22	14.32	52.44	73.03	.78	.74	.43	.11	.15	.38	.47	.39

Appendix III. Blood values from adult cow moose by tagging site in the Upper Susitna River Basin, October 1976.

	Hemoglobin g/100 ml	Packed Cell Volume %	Calcium mg/100 ml	Phosphorus mg/100 ml	Glucose mg/100 ml	B.U.N. mu/100 ml	Uric Acid mg/100 ml	Cholesterol mg/100 ml	Bilirubin mg/100 ml	Ak. Phos. mg/100 ml	L.D.H. mu/100 ml	S.G.O.T. mu/100 ml	Total Protein g/100 ml	Albumin %	Globulin %	Alpha 1 %	Alpha 2 %	Beta %	Gamma %	A/G Ratio
Susitna River Bend																				
n	8	4	3	3	3	3	-	3	3	3	3	3	3	3	3	3	3	3	3	3
$\bar{x}$	20+	52.75	12.27	5.00	166.67	3.0	-	84.67	.17	50.0	313.67	91.0	8.00	5.19	2.81	.41	.48	.88	1.04	1.85
S.D.	N/A	2.06	1.14	1.00	38.21	1.0	-	9.81	.06	2.65	20.31	18.68	.50	.32	.21	.03	.02	.03	.11	.09
Susitna Glacier																				
n	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4
$\bar{x}$	20+	54.00	11.4	4.73	171.71	2.75	.07	107.00	.20	55.25	325.25	98.25	7.63	4.72	3.15	.30	.56	.91	1.14	1.64
S.D.	N/A	2.83	.95	.56	25.33	.96	.06	17.57	0.0	9.43	39.92	26.46	.32	.15	.72	.08	.14	.11	.24	.11
Maclaren River																				
n	5	5	5	5	5	5	1	5	5	5	5	5	5	5	5	5	5	5	5	5
$\bar{x}$	20+	53.20	10.94	6.18	189.2	4.4	0.2	85.8	.22	53.2	249.8	128.8	8.1	4.81	3.29	.34	.60	.87	1.36	1.49
S.D.	N/A	9.58	.83	.68	20.62	1.14	0.0	7.33	.04	13.66	53.55	78.19	.33	.49	.42	.13	.29	.12	.35	.30
Valdez Creek																				
n	2	1	1	1	1	1	-	1	1	1	1	1	1	-	-	-	-	-	-	-
$\bar{x}$	20+	56.00	10.40	4.2	185	3.00	-	82	.1	70.0	259	84	7.7	-	-	-	-	-	-	-
S.D.	N/A	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	-	-	-	-
Brushkana Creek																				
n	4	4	4	4	4	4	-	4	4	4	4	4	4	4	4	4	4	4	4	4
$\bar{x}$	20+	55.50	11.25	5.35	184.75	3.5	-	89.25	.23	56.5	316.25	112.0	8.2	5.06	3.4	.26	.55	.93	1.41	1.63
S.D.	N/A	4.04	.97	.76	34.45	1.0	-	11.3	.1	17.62	43.45	35.62	.88	.42	1.01	.03	.20	.28	.28	.18
Watana Creek																				
n	7	5	5	5	5	5	2	5	5	5	5	5	5	5	5	5	5	5	5	5
$\bar{x}$	20+	53.40	11.26	5.44	228.6	3.6	.15	46.05	.22	53.6	258	103.8	8.24	5.27	5.63	.28	.59	.93	1.18	1.78
S.D.	N/A	4.93	.92	.77	64.38	.55	.07	85.63	.11	9.07	32.88	49.71	.38	.47	3.4	.07	.2	.16	.18	.23
Middle Susitna River																				
n	10	10	11	11	11	10	4	11	10	11	11	11	11	11	11	11	11	11	11	11
$\bar{x}$	20+	51.40	12.02	4.54	153.0	2.91	.25	96.45	.29	58.82	290.55	110.2	7.91	4.86	3.05	.31	.46	1.02	1.26	1.63
S.D.	N/A	2.91	1.39	.88	29.03	.94	.06	19.85	.22	14.32	52.44	73.03	.78	.74	.43	.11	.15	.38	.47	.39

Appendix III. Blood values from adult cow moose by tagging site in the Upper Susitna River Basin, October 1976.

		Hemoglobin g/100 ml	Packed Cell Volume %	Calcium mg/100 ml	Phosphorus mg/100 ml	Glucose mg/100 ml	B.U.N. mu/100 ml	Uric Acid mg/100 ml	Cholesterol mg/100 ml	Bilirubin mg/100 ml	Ak. Phos. mg/100 ml	L.D.H. mu/100 ml	S.G.O.T. mu/100 ml	Total Protein g/100 ml	Albumin %	Globulin %	Alpha 1 %	Alpha 2 %	Beta %	Gamma %	A/G Ratio
Clearwater Creek	n	6	5	4	4	4	4	1	4	4	4	4	4	4	4	4	4	4	4	4	4
	x̄	20+	54.60	10.63	5.0	195.75	3.5	.2	80.25	.23	52.5	271	86.5	7.9	5.03	2.87	.32	.47	.91	1.21	1.79
	S.D.	N/A	1.67	.33	1.32	56.17	1.0	0.0	10.72	.05	7.0	33.68	39.23	.22	.44	.38	.08	.09	.22	.11	.43
Totals	n	46	38	37	37	37	37	11	37	37	37	37	37	36	36	36	36	36	36	36	36
	x̄	20+	53.29	11.33	5.07	180.3	3.32	.15	90.41	.23	55.62	286.08	134.64	7.98	4.96	3.08	.31	.52	.94	1.24	1.67
	S.D.	N/A	4.39	1.01	.96	43.64	1.0	.11	15.46	.13	11.78	47.85	27.9	.57	.53	.50	.09	.17	.25	.32	.30

Appendix IV. Blood values from adult cow moose by tagging site in the Upper Susitna River Basin, March 1977.

	Hemoglobin g/100 ml	Packed Cell Volume %	Calcium mg/100 ml	Phosphorus mg/100 ml	Glucose mg/100 ml	B.U.N. mu/100 ml	Uric Acid mg/100 ml	Cholesterol mg/100 ml	Bilirubin mg/100 ml	Ak. Phos. mg/100 ml	L.D.H. mu/100 ml	S.G.O.T. mu/100 ml	Total Protein g/100 ml	Albumin %	Globulin %	Alpha 1 %	Alpha 2 %	Beta %	Gamma %	A/G Ratio
Susitna River Bend																				
n	5	5	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
$\bar{x}$	18.52	49.60	11.04	4.44	153.50	2.25	.21	83.5	.10	70.4	260.1	72	6.99	5.0	1.99	.29	.35	.64	.70	2.71
S.D.	1.29	2.07	.58	.58	30.38	1.58	.10	4.93	.06	19.93	45.54	21.08	.70	.54	.38	.05	.07	.21	.20	.72
Susitna Glacier																				
n	5	13	10	10	10	10	10	10	10	10	10	10	11	11	11	11	11	11	11	10
$\bar{x}$	19.70	51.23	11.45	4.78	155.3	1.7	.21	90.6	.19	59.5	211.4	71.9	7.25	5.24	2.01	.28	.39	.86	.49	3.09
S.D.	.33	2.80	.59	.90	19.18	.48	.13	11.89	.07	16.06	32.35	19.18	.68	.85	.52	.07	.20	.34	.25	.68
Maclaren River																				
n	1	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
$\bar{x}$	19.50	50.90	10.8	4.9	150.1	1.4	2.4	77.4	.25	66	234	77.78	6.95	4.67	2.28	.29	.35	.85	.78	2.24
S.D.	N/A	3.45	.31	.76	27.46	.52	.52	12.4	.18	18.18	22.95	25.44	.48	.55	.58	.14	.13	.33	.28	.88
Valdez Creek																				
n	0	8	8	8	8	8	8	8	8	8	8	8	9	9	9	9	9	9	9	9
$\bar{x}$	0	51.25	12.09	3.55	140.5	1.5	.25	89.0	.24	71.0	224.25	82.13	7.29	4.93	2.35	.31	.41	.92	.71	2.44
S.D.	N/A	2.60	1.02	.78	28.73	.53	.05	10.45	.09	14.01	24.69	40.41	.67	.51	.36	.10	.12	.25	.26	.62
Brushkana Creek																				
n	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
$\bar{x}$	19.22	49.20	10.6	4.36	165.2	1.6	.14	91.0	.12	72	277.6	100.8	7.28	5.02	2.26	.32	.37	.92	.64	2.23
S.D.	.74	1.79	.86	1.96	25.81	.89	.13	16.54	.04	23.55	73.66	71.55	.7	.56	.18	.06	.10	.26	.19	.2
Watana Creek																				
n	4	4	2	2	2	2	2	2	2	2	2	2	4	4	4	4	4	4	4	4
$\bar{x}$	19.25	49.50	11.45	4.85	135.00	4.5	.3	76.0	.2	62.0	251.5	97.5	7.25	5.29	1.97	.23	.32	.67	.75	2.74
S.D.	1.37	4.12	.07	.49	48.08	.71	.14	7.07	0	21.21	78.49	30.41	.82	.65	.34	.07	.09	.26	.20	.52
Middle Susitna River																				
n	0	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
$\bar{x}$	0	51	11.5	4.25	162	3.5	.2	82.0	.2	53.0	229.5	61.5	7.3	4.9	2.4	.27	.52	.99	.63	2.05
S.D.	N/A	N/A	.42	.07	28.28	2.12	0	1.41	0	2.83	48.79	7.78	.42	.24	.18	0	.16	.04	.02	.05

Appendix IV. Blood values from adult cow moose by tagging site in the Upper Susitna River Basin, March 1977.(continued)

Devil Mth.	Hemoglobin g/100 ml	Packed Cell Volume %	Calcium mg/100 ml	Phosphours mg/100 ml	Glucose mg/100 ml	B.U.N. mu/100 ml	Uric Acid mg/100 ml	Cholesterol mg/100 ml	Bilirubin mg/100 ml	Ak. Phos. mg/100 ml	L.D.H. mu/100 ml	S.G.O.T. mu/100 ml	Total Protein g/100 ml	Albumin %	Globulin %	Alpha 1 %	Alpha 2 %	Beta %	Gamma %	A/G Ratio
n	5	5	4	4	4	4	4	4	4	4	4	2	5	5	5	5	5	5	5	4
x̄	17.00	46.40	10.95	4.7	160.75	7.5	.3	95.5	.45	76	309.5	152.5	6.94	4.38	2.55	.28	.25	1.3	.73	1.68
S.D.	1.41	6.43	.6	1.41	29.92	2.52	.08	17.45	.31	26.5	26.29	96.87	.68	.5	.61	.15	.15	.63	.58	.53
Totals																				
n	25	51	49	49	49	49	49	49	49	49	49	47	54	54	54	54	54	54	54	52
x̄	18.75	50.20	11.23	4.48	152.43	2.35	.32	85.98	.21	70.94	243.2	82.15	7.14	4.94	2.2	.29	.37	.87	.67	2.5
S.D.	1.38	3.48	.80	1.03	26.6	2.0	.47	12.45	.15	18.26	46.86	39.13	.63	.64	.47	.09	.14	.35	.29	.74

Appendix V. Abstract of a paper presented at 15th North American Moose Conference and Workshop at Kenai, Alaska.

MOOSE MOVEMENTS AND HABITAT USE ALONG THE SUSITNA RIVER NEAR DEVILS CANYON

KENTON P. TAYLOR, Alaska Department of Fish and Game, Talkeetna, Alaska 99676

WARREN B. BALLARD, Alaska Department of Fish and Game Glennallen, Alaska 99588

ABSTRACT: From October 1976 through January 1979 a moose movements and population study was conducted along the Susitna River in southcentral Alaska to aid in assessing the potential impacts of hydroelectric power development on moose (*Alces alces*). Twenty-two radio collars and 21 visual collars were placed on adult cow moose during the study. Radio-collared moose were located on 567 occasions while visual-collared moose were observed 43 times. Annual home ranges of moose are calculated and compared between drainages and to those from other studies in North America. Movement patterns, fidelity to summer and winter ranges and habitat utilization are discussed. Areas of high moose concentrations are identified. Proposed hydroelectric developments are described and their potential impacts on moose are considered.

Appendix VI. Tagging location, collar number and color, dates of sightings and reproductive status of adult cow moose tagged with visual collars in 1976-77 in the Susitna River Study Area.

Yellow Number on Blue Collar

Bl. #1 Gracious House	Bl. #2 Sue River	Bl. #4 Low. Sue
10/21/76	10/22/76	10/22/76
11/04/76 w/calf	11/02/76	11/11/76
3/19/77 w/calf	11/03/77	12/09/76
		11/04/79
Bl. #5 Low. Sue	**Bl. #6 Low. Sue**	**Bl #7 Coal Ck.**
10/22/76	10/22/76	10/22/76
11/03/77	11/04/78 w/calf	11/04/78 w/calf
Bl #8 S. Maclaren	**Bl. #9 Butte Ck.**	**Bl #10 Butte Ck.**
10/27/76	10/22/76	10/27/76
11/04/77	2/07/77 w/calf	11/04/76 w/calf
	5/28/77 w/calf	8/05/77
	10/30/77 w/calf	
	9/27/78 w/calf	
Bl. #11 S. Maclaren	**Bl. #12 Brushkana**	
10/27/76	10/23/76	
Bl. #14 Brushkana	**Bl. #15 W.F.Gl.**	**Bl. #16 Valdez Ck.**
10/23/76	10/27/76	10/23/76
	?	11/11/76
	9/18/77	10/05/77
	5/31/77	11/01/77
	10/31/77	9/18/78
		9/27/78
Bl #17 Gracious House	**Bl. #18 Gracious House**	**Bl. #19 Butte Ck.**
10/21/76	10/22/76	10/27/76
11/09/76 w/calf	11/02/76 w/calf	6/16/77 w/calf
	11/04/76 w/calf	
	5/10/77	
	5/29/77	
	10/30/77 w/twins	
	5/27/78 w/1 yrl.	
	11/01/78	

Appendix VI. (Continued).

Bl. #20 Valdez Ck.

3/18/77 w/calf
5/27/77
9/18/77
6/03/77 w/calf
5/27/78 w/1 yrl.
11/27/79 w/twins

Bl. #21 Mid. Fork

3/20/77 w/calf
6/11/77
8/06/77 w/twins
10/05/77 ?
5/31/77 w/twins
5/28/77 w/twins
5/29/77 w/twins
11/08/78

Bl. #22 Valdez Ck.

3/23/77
5/10/77
9/18/77
10/31/77
5/27/78
11/07/78 w/twins

Bl. #23 Middle Sue

3/20/77 w/calf
3/31/77 w/calf
8/05/77 w/1 yrl.
10/05/77
6/07/77
11/01/77
11/07/78 w/calf

Bl. #27 Brushkana

3/20/77 w/calf

Bl. #28 Mid. Fork

3/20/77
10/05/77 w/calf
10/31/77 w/calf
11/29/79 w/calf

Bl. #30 Upper Sue

3/23/77
6/03/77
10/31/77
11/08/78 w/calf

Bl. #31 Upper Sue

3/23/77
6/04/77
10/03/77
11/08/78
11/30/79 w/calf

Bl. #32 Upper Sue

3/23/77
10/31/77
11/08/78 w/calf
11/27/79

Bl. #33 Upper Sue

3/23/77
11/01/77
11/08/78

Bl. #34 Upper Sue

3/23/77
6/07/77 w/calf
10/31/77
10/27/78
11/08/78

Bl. #35 Upper Sue

3/23/77
6/11/77 w/calf
11/08/78

Bl. #36 Upper Sue

3/23/77
10/31/77
11/08/79

Bl. #37 Upper Sue

3/23/77
10/31/77
6/ /78 w/calf

Bl. #38 W.E. Maclaren

10/28/76
11/06/76
11/23/76
11/02/77
11/04/77
11/04/78 w/calf

Appendix VI. (Continued).

Bl. #39 Brushkana

3/20/77

Bl. #40 Valdez Ck.

3/23/77
5/10/77
5/25/77
11/01/77
11/08/78 w/calf

Bl. #42 W.F.Gl.

10/28/76
11/04/76
5/10/77
5/31/77
11/01/77

Bl. #44 Valdez Ck.

3/28/77 w/calf
5/28/77 w/twins
11/01/77
3/27/78
11/07/78 w/calf
4/14/79 Dead

Bl. #45 Valdez Ck.

3/23/77 w/calf
6/07/77 w/calf
6/25/77
8/05/77
9/18/77
6/25/78 w/calf
9/27/78

Bl. #46 Valdez Ck.

3/23/77
11/07/78 w/calf

Bl. #47 Valdez Ck.

3/23/77
5/25/77
9/18/77
9/27/78

Bl. #51 low MacClaren

3/22/77 w/calf
11/01/77

Bl. #52 low MacClaren

3/22/77
2/08/78 w/calf
10/05/78 w/calf

Bl. #53 low MacClaren

3/22/77
11/03/77

Bl. #54 low MacClaren

3/22/77 w/calf
5/29/77 w/calf
11/02/77

Bl. #55 Upper Sue

3/23/77

Bl. #56 low MacClaren

3/22/77

Bl. #57 Upper Sue

3/23/77
8/05/77
11/01/77

Bl. #58 low MacClaren

3/22/77

Bl. #60 low Sue

3/20/77
8/06/77

Bl. #61 low Sue

3/20/77
11/03/77 w/calf

Appendix VI. (Continued).

Bl. #63 Sue Nipp.

3/20/77

Bl. #64 Sue Nipp.

3/20/77
5/31/77 w/calf
11/03/77
11/04/78 w/calf

Bl. #66 Mid. Sue

3/23/77
11/04/78

Bl. 67 Sue Lod.

3/23/77
5/28/77
11/03/77
11/04/78

Bl. #68 Hatchet Lk.

3/23/77
9/06/78 Dead

Bl. #70 Hatchet Lk.

3/23/77 w/calf
11/01/77
2/09/78 w/calf
11/01/78
3/15/79

Bl. #71 Watana

10/28/76
11/07/76

Black Number on White Collar

W. #75 Jay Ck.

3/19/77
6/16/77
8/05/77

W. #79 Jay Ck.

3/19/77
6/16/77 w/calf
10/31/77
6/23/78 w/calf

W. #80 Devil Mt.

3/18/77 w/calf
9/06/77

W. #81 Devil Mt.

3/18/77

W. #84 Hatchet Lk.

3/23/77
11/01/77
11/04/78