ACBERT

SUSITNA HYDROELECTRIC PROJECT

PHASE I FINAL REPORT

BIG GAME STUDIES

Volume III MOOSE - UPSTREAM

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ALASKA DEPARTMENT OF FISH AND GAME
Submitted to the Alaska Power Authority
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PREFACE

In early 1980, the Alaska Department of Fish and Game contracted with the Alaska Power Authority to collect information useful in assessing the impacts of the proposed Susitna Hydroelectric Project on moose, caribou, wolf, wolverine, black bear, brown bear and Dall sheep. This information, along with information on furbearers, small mammals, birds, and plant ecology collected by the University of Alaska, is to be used by Terrestrial Environmental Specialists, Inc. of Phoenix, New York, in preparation of exhibits for the Alaska Power Authority's application for a Federal Energy Regulatory Commission license to construct the project.

The studies were broken into phases which conformed to the anticipated licensing schedule. Phase I studies, January 1, 1980 to June 30, 1982, were intended to provide information needed to support a FERC license application. If the decision is made to submit the application, studies will continue into Phase II to provide additional information during the anticipated 2 to 3 year period between application and final FERC approval of the license.

Wildlife studies did not fit well into this schedule. Data collection could not start until early spring 1980, and had to be terminated during fall 1981 to allow for analysis and report writing. (Data continued to be collected during winter 1981-82, but could not be included in the Phase I report.) The design of the hydroelectric project had not been determined. Little data was available on wildlife use of the immediate project area, although some species had been intensively studied nearby. Consequently, it was necessary to start with fairly general studies of wildlife populations to determine how each species used the area and identify potential impact mechanisms. This was the thrust of the Phase I Big Game Studies. During Phase II, we expect to narrow the focus of our studies to evaluate specific impact mechanisms, quantify impacts and evaluate mitigation measures.

Therefore, the Final Phase I Report is not intended as a complete assessment of the impacts of the Susitna Hydroelectric Project on big game.

The reports are organized into the following eight volumes:

Volume I.	Big Game Summary Report
Volume II.	Moose - Downstream
Volume III.	Moose - Upstream
Volume IV.	Caribou
Volume V.	Wolf
Volume VI.	Black Bear and Brown Bear
Volume VII.	Wolverine
Volume VIII.	Dall Sheep

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SUMMARY

During April 1980, and March and May 1981, 58 adult and 16 calf moose were captured by darting from helicopter and radio-collared. Biological specimens and measurements were collected to evaluate physical condition, age and reproductive status of each moose. Average age of adult cow moose captured in 1980 was 9.4 years, which was significantly older than moose captured in 1977 and older than other Alaskan moose populations. Sixty-two percent of the moose were 10 years old or older. At least 73 percent of the cow moose examined were pregnant. This pregnancy rate was lower than that found in other moose studies but this may have been due to errors in pregnancy determination.

Blood parameters indicated that calves sampled in 1981 were in better physical condition than those from 1979 when animals were suffering from nutritional stress during a severe winter. Adult moose captured in 1979-1980 were in poorer condition than those sampled in earlier Susitna studies and other Alaskan moose populations. This suggested that range conditions have deteriorated in the upper Susitna Basin since 1977. However, twinning and natality rates remain high. Earlier studies had indicated that this moose population was not at range carrying capacity and that predation was limiting recruitment.

Data obtained from earlier moose studies in the Susitna Basin were combined with similar data from this project to evaluate movements and home range sizes. Between October 1976 and mid-August 1981, more than 2,700 locations were obtained on 207 moose of both sexes and all age classes. Moose were subjectively classified as migratory or nonmigratory. Migratory moose occurred in areas east of Watana and Kosina Creeks. Most moose located west of these areas were nonmigratory. Several migratory travel routes were identified. Most movements followed drainage patterns of creeks and tributaries and, thus, were in a north-south direction.

During this study, moose generally moved to lower elevations during late spring and early summer. As summer progressed, moose generally moved to higher elevations. Winter elevations were significantly higher than summer elevations. Observation of moose at relatively high elevations during winter was attributed to mild winters during most of the study period.

Ninety-one percent of radio-collared moose observations were located on flat or gentle slopes. Flat and southerly exposures composed 54 percent of the observations.

Monthly habitat utilization data by radio-collared moose as determined from aircraft were presented and discussed. Fifty-nine percent of the basin was covered by conifer and shrubland habitat types but these two types constituted over 90 percent of the moose observations. Use of willow habitat types corresponded with observed altitudinal movements. Reasons for non-use of other habitat types were discussed. Problems associated with determining habitat use by moose with the methods used were reviewed.

From October 1976 through December 1981, 33 radio-collared moose crossed the Susitna River a minimum of 73 occasions. During 1980 and 1981, all documented crossings occurred from May through November. Track sightings suggested that crossings also occur during other months. River crossings appeared concentrated in the following areas: mouth of Fog Creek to area opposite Stephan Lake, mouth of Deadman Creek upstream for approximately 5 miles, Watana to Jay Creek, and from Goose Creek to Clearwater Creek.

Data describing the distribution of radio-collared moose during the rut and parturition were presented. Apparent breeding and calving areas were identified.

A winter census of the two impoundments was conducted in March 1981. A total of 28 moose were counted in the Devil Canyon impoundment while 42 moose were counted within the Watana impoundment. Mild winter conditions probably contributed to the low count.

Sex and age composition surveys and a random stratified census were conducted in the study area during November 1980. It was estimated that 2,046 ± 382 moose occupied the areas north and south of the proposed Watana impoundment. A crude population estimate of 1,151 moose was made for the project area lying west of Kosina and Watana Creek. The entire upper Susitna Basin above Devils Canyon and excluding Lake Louise Flats and the areas south of the Maclaren River was estimated to contain 4500 moose in fall, 1980.

Moose parturition from 1977 through 1981 generally occurred from 15 May to 15 June of each year peaking between 25 May to 2 June. Rates of calf production have been quite high, however, mortality during the first 6 weeks of life has also been high. Earlier studies documented the importance of brown bear predation to calf survival.

Based upon movement studies conducted from 1976 through 1981, 13 moose subpopulations were identified which could be impacted by the construction and operation of the two impoundments. Each subpopulation was briefly described. Several significant dispersals of moose from the impoundment areas were described.

Seasonal and total home range sizes were determined for 162 radio-collared moose. Total home ranges ranged from 3.8 to 2911 km^2 and averaged 224.2 km^2. Home range sizes of Susitna moose were relatively large in relation to those reported elsewhere from North America.

Proposed project impacts partially included the following: loss of habitat and mortality of moose occupying the impoundment areas, decreased range carrying capacity of adjacent areas due to overstocking by displaced moose, increased vulnerability to predation, disruption and perhaps prevention of both sedentary and migratory moose from crossing the river, alteration of weather patterns causing increased mortality and decreased productivity, and an increase in accidental deaths. It was suggested that the Watana impoundment would have a larger impact on moose than the Devil Canyon impoundment. Impacts on moose could possibly be reduced by lowering the normal pool elevation and by stabilizing water levels.

Average maximum length of moose home ranges was 28.7 km. This area was used to identify an area of impact around the two impoundments. Numbers of moose occurring in the impact area were extrapolated from census and stratification data and from numbers of radio-collared moose home ranges overlapping the census area boundaries. An estimated 3,040 moose would be moderately impacted by the proposed project. Of that total an estimated 2,400 moose are expected to be severely impacted.

Additional data needs and proposals for Phase II studies were briefly described and discussed.

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INTRODUCTION

The Susitna River Basin is a rugged wilderness area of high esthetic appeal and an important habitat to a wide variety of wildlife species (Taylor and Ballard 1979). A variety of hydroelectric proposals seemed to pose threats to wildlife in this area. Moose (*Alces alces*) which are one of the most important species to humans seemed likely to be impacted. Consequently, some very general population assessment work was begun in 1974 (USFWS 1975). This study was funded for 1 year and consisted of a series of reconnaissance flights to identify moose concentration areas. In 1976 limited funds became available to begin gathering baseline data on moose movements and habitat use for areas which could be impacted by the Corp of Engineers two dam proposal (Ballard and Taylor 1980). These initial studies focused on areas lying north of the Susitna River and were conducted from March 1977 through spring 1978 with limited follow-up work from spring 1978 through spring 1979 (op. cit.). Results of these preliminary studies identified some potential problem areas and data gaps for better assessing the impacts of the two dam system on moose.

The most significant data gaps identified in the preliminary moose movements study were the lack of moose movement data for areas lying south of the Susitna River and accurate moose population estimates for the entire project area (Ballard and Taylor 1980). Funding for the original project terminated in spring 1979 and little work was conducted until 1 January 1980 when the Alaska Power Authority contracted the Alaska Department of Fish and Game to conduct the present study. The purpose of this report is to present our preliminary findings on moose movements, habitat use and size and trend of moose populations inhabiting areas which could be impacted by the two dam system. Although this study was funded from 1 January 1980 through 31 December 1981, in depth field studies could not be initiated until March 1980 when radio telemetry equipment was received. Also because of time lags between data entry and output only data up to

September 1981 were included in this report. For purposes of home range determination, habitat utilization, elevational use and movement patterns, data from moose captured and studied in other areas of Game Management Unit 13 adjacent to the Susitna Hydroelectric study area from 1976 to 1980 were included. Details of these other studies were provided by Ballard and Taylor (1978; 1980), Ballard and Gardner (1980), Ballard et al. (in press), and Taylor and Ballard (1979).

Objectives of the upstream moose studies during the first year of study were:

To identify moose subpopulations using habitat that will be inundated by proposed impoundments.

To determine the seasonal distribution, movement patterns, size and trends of those subpopulations.

To determine the timing and degree of dependency of those subpopulations on habitat to be impacted by the Susitna Hydroelectric Project.

METHODOLOGY

Adult moose (2 year old) were captured with the aid of a helicopter by darting with 10 cc aluminum darts fired from a Cap-Chur gun (Nielson and Shaw 1967) with a combination of either 9 or 11 cc etorphine (1 mg/cc M-99, D-M Pharmaceuticals, Inc., Rockville, MD) and 1 or 2 cc xylazine hydrochloride (100 mg/cc, Rompun, Haver-Lockhart, Shawnee, KS) (Ballard and Gardner 1980). Calves (short yearlings-10 mo. old) were immobilized with 5cc M-99 with no Rompun. After each moose was processed an equivalent cc dosage of the antagonist diprenorphine (2 mg/cc M 50-50, D-M Pharmaceuticals, Inc., Rockville, MD) was injected into either the radial or jugular vein to reverse immobilization and permit the moose to escape.

Captured moose were equipped with a radio collar which allowed each moose to be located from fixed-wing aircraft when desired. Visual collars, similar to those described by Franzmann et al. (1974) were riveted to each radio collar to aid observation from aircraft and to insure individual recognition. Radio collars, manufactured by Telonics (Mesa, AZ), were constructed of two layers (black urethane over butyl rubber) and had an inner circumference of 140 cm. Calf collars were similar to those used on adults except that each was lined with foam rubber to permit growth (Ballard and Gardner 1980; Ballard et al. in press). Each radio collar was equipped with a dipole antenna which was partially enclosed between the urethane and butyl rubber layers with 22 cm of antenna protruding from the side and back of the collar. The entire unit with visual collar weighed 1,380 g. Twelve radio collars were also equipped with experimental air temperature sensors in an effort to relate moose movements to ambient air temperature. The latter transmitters were tried on an experimental basis during 1980. Although the pulse widths did in fact vary with air temperatures the resulting termperature conversions were not accurate and thus this portion of the study was terminated.

Each moose was ear tagged with a numbered, monel metal tag. Tags were affixed to the middle of the ear. When possible a lower incisor tooth from each adult animal was extracted for determining 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. Three ml samples were later sent to Pathologists Central Laboratories, Seattle, Washington for blood chemistry analysis (Technical Autoanalyzer SMA-12) and protein electrophoresis (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-Adams Company, Parsippany, N.J.). Remaining sera were stored for possible future analyses.

Physical measurements taken included total length, head length, heart girth, neck circumference 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). Each adult cow moose was rectally palpated (Greer and Hawkins 1967) to determine pregnancy. Data from individual moose were placed on numbered tagging cards and each moose was assigned an individual accession number (Fig. 1).

Radio signals were received from a 4,000 channel portable programmable scanning receiver manufactured by Telonics (Mesa, AZ). Ambient air temperatures for those moose collars equipped with air temperature sensors were collected on the same flights made to locate moose. Pulse widths of the air temperature sensors were recorded from a portable digital data processor (Telonics TDP-1, Mesa, AZ) which was connected to the receiver.

MOOSE TAGGING RECORD

Moose No._______________ Location___________________

Sex______ Age_______ Date_____________________

Collar Color____________ Ear Tag No(s) & Color(s)

Number______________ Radio Frequency ________ LE______________________

Metal Tag No.___________ RE______________________

Year Born______________ W/Calf_____ Operators__________________

Blood: Yes___ No___ Tooth: Yes___ No___ Hair: Yes___ No___

Measurements: T.L.____ H.F.____ H.S.____ Girth____ Head_____ Neck____

Excit.____ Cond.____ H.R.____ Temp.____ Amb. Temp._______

Antler Spread________ Antler Base________ Weight_________ PG Yes__No__

Remarks:____

____

Calf Tagged: Yes___ No___ Accession No.______________

DARTS:

No. 1				No. 2			
Time	Hour	Min.	Sec.	Time	Hour	Min.	Sec.
Hit	:	:		Hit	:	:	
Down	:	:		Down	:	:	
M50-50	:			M50-50	:	:	
Up	:	:		Up	:	:	

Hit Location:_________________ Hit Location:_________________

Drug/Dosage:_________________ Drug/Dosage:_________________

Figure 1. Moose tagging record for moose immobilized in April 1980 in the upper Susitna River Basin above Devil Canyon.

Radio-collared moose were relocated from both 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), except that our right-left switch box allowed us to listen to both antennas simultaneously. This feature often allowed us to detect and locate signals much sooner than if we had just listened to one antenna.

An attempt was made to locate each moose a minimum of twice per month. From mid-May through mid-July of 1977, 1978 and 1980 each moose which had been diagnosed as pregnant was located at 3-5 day intervals to obtain data on calf parturition and survival (Ballard et al. 1981). When radio-collared moose were found, their locations were recorded on U.S.G.S. maps (scale of 1:63,000) along with information pertaining to sex, age and numbers of associated moose and other wildlife, activity, and environmental parameters (Fig. 2).

General habitat type at each moose location was also classified from fixed-wing aircraft. A number of serious problems exist with attempts to classify moose habitat from fixed-wing aircraft. Often the observer is only able to identify overstory vegetation. In many cases the overstory vegetation may have little relevance to why an animal has selected an area because understory vegetation varies significantly, often in association with density of overstory.

Therefore, any habitat classification made from fixed-wing aircraft may not provide a meaningful index of the types preferred by moose. In 1977 an aerial moose habitat classification system based on overstory vegetation was used for describing habitat utilized by radio-collared moose (Table 1). Although the system has many shortcomings it was used for this study because we were most familiar with it, thus insuring collection of data which could be compared with earlier studies. We attempted to develop a system to transform these classifications to Viereck and Dyrness's (1980) system down to their level 3 classifications

Date ______________ Start ______________

Survey type ______________ Pilot ______________ Stop ______________

Observer ______________ Keypunched /__/ Duration ______________

Frequency (153.)							
Strong Frequency							
Collar number							
Sex and age							
Location							
Visual obs.							
Habitat							
Time							
Activity							
# of young							
Group size							
# of ♂							
# of ♀							
# of calves							
Elevation							
Slope							
Aspect							
Antlers							
Wind dir.							
Wind speed							
Cloud cover							
Temperature							
Snow depth							
Snow cover							
Remarks							

Figure 2. Moose radio-tracking flight record for moose located for Susitna studies from April through December 1980.

Table 1. Habitat classifications utilized to classify moose habitat usage from fixed-wing aircraft from 1977 through mid-August 1981 in the Susitna River Basin of south-central Alaska. [1]

Classification	Habitat Description
Tall Spruce [2] (TW)	Usually white spruce (*Picea glauca*), with a height of more than 20 feet. Usually riparian.
Moderate spruce [2] (MS)	Both black (*Picea mariana*) and white spruce, with heights ranging from appoximately 10 to 25 feet. Probably the most common habitat type in the basin.
Short spruce [2] (SS)	Less than 10 feet in height. Usually approaching a subalpine situation or a very boggy wet area.
Willow (P)	Mostly upland willow (*Salix* spp.) species which may or may not include varying sparse densities of spruce or hardwoods or shrub birch (*Betula glandulosa*). May also include riparian willow.
Cottonwood/ aspen (C/A)	Cottonwood (*Populus trichocarpa*) or other hardwoods and some spruce usually found in riparian situations. Aspen often on hillsides in isolated clumps.
Marsh (M)	No running water, open water in middle with edges consisting of sedges, grass, willow and birch.
Alder (E)	Usually found at high elevations approaching subalpine tundra usually in continuous stands.
Spruce/hardwood (U/H)	Conifer-deciduous mixture often includes mixture of spruce, paper birch, cottonwood, or balsam poplar. Usually located on well drained slopes often with an alder understory.
Unidentified hardwood (D)	

[1] Modified from Ballard and Taylor (1980).
[2] Spruce densities also classified as high, medium or low.

which we thought probably was the most accurate classification obtainable from aircraft. The attempted transformation of aerial habitat classifications to those of Viereck and Dyrness (1980) is presented in Table 1A. Comparison of the two classification systems suggests the two systems are not compatible at the level necessary to make realistic comparisons between moose usage and availability of habitat types. Therefore, the aerial classifications were presented independently. An additional approach has been designed which involved overlaying moose locations on the vegetation maps but that analysis was incomplete.

In cooperation with R & M Consultants and the U.S. Soil Conservation Service, eight snow depth transects were established at key areas to measure snow depths on a monthly basis (Fig. 3). Location and descriptions of each marker were provided in Table 2 and Fig. 4. November snow depths are provided in Table 3. Unfortunately bears (*Ursus* sp.) and porcupines (*Erethizon epixanthus*) damaged over half of the markers in 1980 and consequently, this portion of the study was terminated due to lack of both maintenance funding and manpower.

Winter distribution of moose in the project area was determined in March 1980. Linear transects spaced at ¼ to ½ mile were flown on flat terrain. In mountainous areas, parallel contour intervals in combination with a series of circles were flown. All flights were performed with a Piper PA-18 Super Cub at 300 to 500 foot elevations. Numbers, sex and age of moose were plotted on 1:63,000 scale U.S.G.S. maps. Moose were classified as adult or calf based on size and appearance. Sex could not be identified on most adult moose because bulls did not possess antlers.

Moose sex and age composition counts have been conducted in the vicinity of Watana impoundment since 1955. Only one such survey has been conducted in the vicinity of the Devil canyon impoundment. These surveys were conducted by methods described for winter distribution surveys except for the following: Transects are flown closer together and more intensively (narrower search

Table 1A. Comparison between aerial habitat classifications and those of Viereck and Dyness (1980) used to classify observations of radio-collared moose in the Nelchina and Susitna River Basins of southcentral Alaska from 1977 through mid-August 1981.

Aerial Habitat Classifications	Equivalent Classification from Viereck and Dyness (1980)
Dense tall spruce (white or unknown)	open white spruce
Medium density, tall height spruce (white or unknown)	open white spruce, open mixed forest, closed mixed forest
Sparsely dense tall spruce (white or unknown)	Woodland white spruce, open mixed forest, closed mixed forest
Dense medium height spruce (white, black or unk.)	open black spruce
Medium density, medium height spruce (white, black or unk).	open black spruce, open mixed forest, closed mixed forest
Sparsely dense, medium height spruce (white, bl. or unk.)	woodland white spruce, open mixed forest, closed mixed forest
Medium density, short spruce (bk. or unk.)	open black spruce, open mixed forest, closed mixed forest
Sparsely dense short spruce	woodland black spruce, open mixed forest, closed mixed forest
Riparian willow	willow shrub, wet sedge grass tundra
Upland willow & brush	willow shrub, sedge shrub tundra mixed low shrub
Aspen	closed balsam popular
Riparian hardwood or unidentified	open birch forest, closed birch forest
Alder	closed tall shrub, open tall shrub, willow shrub
Rock/ice	rock/ice

Figure 3. Illustration of aerial snow marker erected at 33 locations within the Susitna River study area.

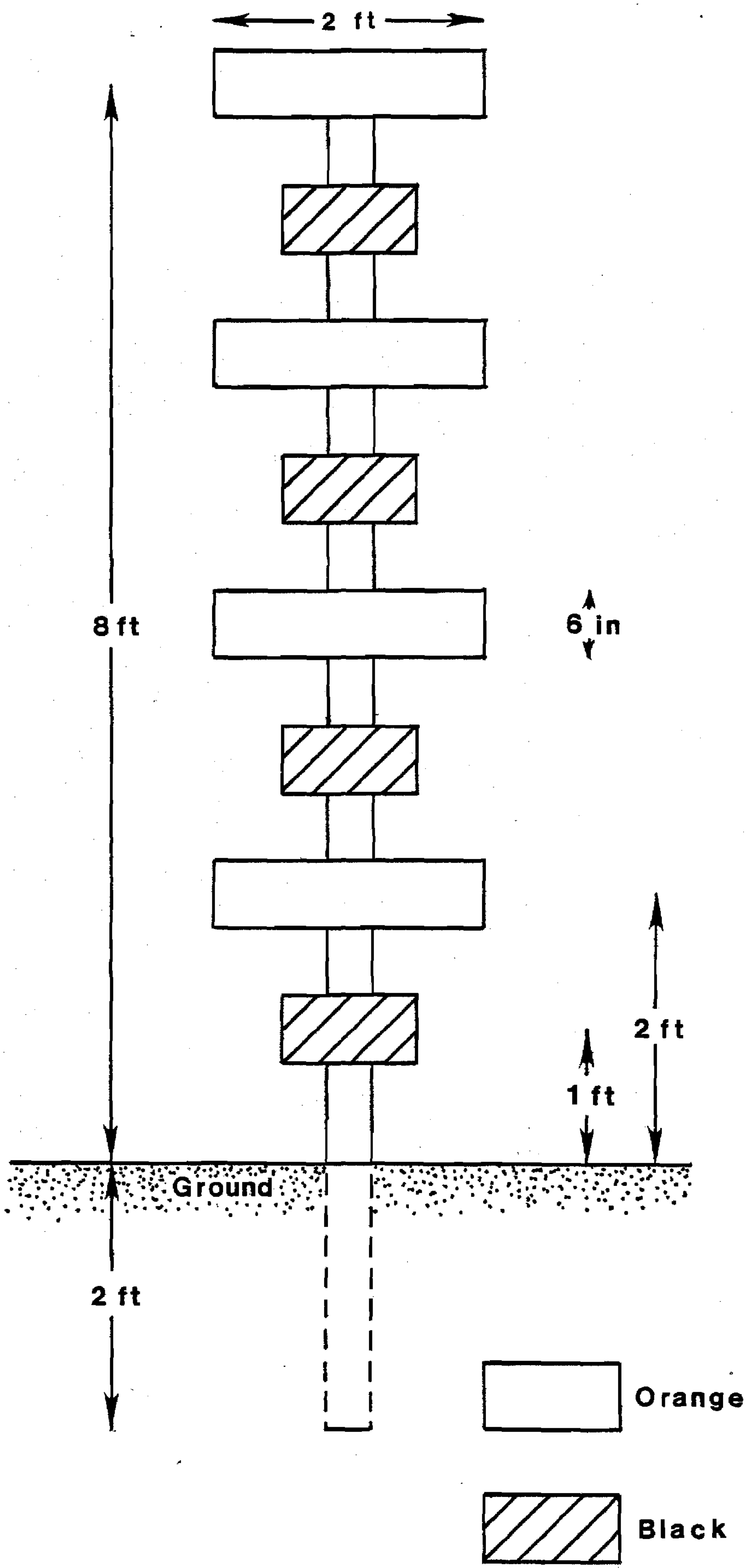


Table 2. Location and description of 33 snow depth markers erected for Susitna moose studies in the Susitna River Basin of southcentral Alaska.

Snow Course Number	Marker Number	Location	Elevation Ft.	Aspect	Habitat Classification and Description
1	A	Devil Mt. - island in Susitna River	1250	N	Medium density tall conifer-deciduous mixture. Medium density mixture of tall spruce (*Picea glauca*), tall birch (*Betula papyrifera*), and tall cottonwood (*Populus* spp.). Ground cover: tall grass, many down trees. Sandy soil.
1	B	Devil Mountain	2050	WSW	Medium density tall conifer-deciduous mixture. Medium density mixture tall spruce (*Picea glauca*) with clumps of alders (*Alnus* spp.) and few tall birch (*Betula papyrifera*). Ground cover: dwarf birch (*Betula* spp.) and blueberry (*Vaccinium* spp.). Muck.
1	C	Devil Mountain	2450	WSW	Upland tundra. Upland tundra with low blueberries (*Vaccinium* spp.), dwarf birch (*Betula* spp.) and mosses (Sphagnum) with a few alder (*Alnus* spp.) Thickets. Humus.
1	D	Devil Mountain	3000	SSW	Upland tundra. Upland tundra with low grasses, tall mosses (Sphagnum), lichens. Humus.
2	A	Fog Creek - mouth	1400	S	Medium density tall conifer-deciduous mixture. Medium density tall spruce (*Picea glauca*) and birch (*Betula papyrifera*). Ground cover - grasses. Sandy soil with small rock substrate.

Table 2 (cont.). Location and description of 33 snow depth markers erected for Susitna moose studies in the Susitna River Basin of southcentral Alaska.

Snow Course Number	Marker Number	Location	Elevation Ft.	Aspect	Habitat Classification and Description
2	B	Fog Creek - lower	2000	W	Medium density tall spruce. Medium density tall spruce (*Picea glauca*) with understory of blueberry (*Vaccinium* spp.), wild rose (*Rosa* spp.), scattered willows (*Salix* spp.). Gravel soil.
2	C	Fog Creek - upper	2500	N	Medium density tall spruce. Medium density tall spruce (*Picea glauca*) with low willows (*Salix* spp.) in clearing. Clay soil.
2	D	Fog Creek-hillside to northeast	3000	NW	Medium density medium spruce. Medium density medium spruce (*Picea glauca*) with abundant willow (*Salix* spp.). Humus and sandy soil.
3	A	Watana Creek - mouth	1550	S	Medium density tall spruce. Medium density tall spruce (*Picea glauca*) with blueberry (*Vaccinium* spp.) dominated understory. Sandy soil.
3	B	Watana Creek, lower	1650	SSW	Medium density medium conifer-deciduous mixture. Medium density medium spruce (*Picea glauca*) and cottonwood (*Populus* spp.) with willow (*Salix* spp.) and blueberry (*Vaccinium* spp.) dominated understory. Sandy soil.

Table 2 (cont.). Location and description of 33 snow depth markers erected for Susitna moose studies in the Susitna River Basin of southcentral Alaska.

Snow Course Number	Marker Number	Location	Elevation Ft.	Aspect	Habitat Classification and Description
3	C	Watana Creek - ridge southeast of of mouth Delusion Creek	2100	NW	Sparse medium spruce. Low density medium spruce (*Picea* spp.) with dwarf birch (*Betula* spp.) dominated understory. Small rock and sandy soil.
3	D	Watana Valley - eastern lower Watana Valley	2400	W	Medium density medium spruce. Medium density medium spruce (*Picea* spp.) with willow (*Salix* spp.) dominated understory. Loam and gravel soil.
3	E	Watana Valley - upper drainage to east of Watana Valley	3100	W	Upland willow. Low willow (*Salix* spp.) adjacent to alder (*Alnus* spp.) thickets. Loam and gravel soil.
3	F	Watana Creek - mouth east Fork	2100	S	Medium density tall spruce. Medium density tall spruce with mixed low willow (*Salix* spp.) (*Picea glauca*), blueberry (*Vaccinium* spp.) and dwarf birch (*Betula* spp.) understory. Sandy soil.
3	G	Big Lake outlet - stream draining Big Lake	2500	ESE	Medium density tall spruce. Medium density tall spruce (*Picea glauca*). Tall willow (*Salix* spp.) understory. Rock and sandy soil.

Table 2 (cont.). Location and description of 33 snow depth markers erected for Susitna moose studies in the Susitna River Basin of southcentral Alaska.

Snow Course Number	Marker Number	Location	Elevation Ft.	Aspect	Habitat Classification and Description
4	A	Kosina Creek - lower	2000	N	Low density tall conifer-deciduous mixture. Low density tall spruce (*Picea glauca*) and medium birch (*Betula papyrifera*) with understory of alder (*Alnus* spp.), low willow (*Salix* spp.), shrubby cinquefoil (*Potentilla fruticosa*) and grass. Loam and sandy soil.
4	B	Kosina Creek - mouth of Gilbert Creek	2400	N	Medium density medium spruce. Medium density medium spruce (*Picea glauca*) with understory of dwarf birch (*Betula* spp.) and a few blueberries (*Vaccinium* spp.). Sandy soil.
4	C	Kosina Creek - above Terrace Creek	3000	E	Riparian willow. Low willows (*Salix* spp.). Rock and fine sand soil.
4	D	Kosina Creek - above Terrace Creek - bench to west	3350	E	Upland brush. Low willows (*Salix* spp.), low dwarf birch (*Betula* spp.) and equisetum. Loam covering large rocks.
5	A	Jay Creek - mouth	1800	S	Medium density tall conifer-deciduous mixture. Medium density tall spruce (*Picea glauca*) and birch (*Betula papyrifera*). Sandy soil.

Table 2 (cont.). Location and description of 33 snow depth markers erected for Susitna moose studies in the Susitna River Basin of southcentral Alaska.

Snow Course Number	Marker Number	Location	Elevation Ft.	Aspect	Habitat Classification and Description
5	B	Jay Creek - bench to NW	2500	SSE	Low density tall spruce. Low density tall spruce (*Picea* spp.) with understory of low willows (*Salix* spp.), dwarf birch (*Betula* spp.), blueberry (*Vaccinium* spp.), and labrador tea (*Ledum palustra*). Loam.
5	C	Jay Creek, Valley to west of lower Jay Creek	2850	SSW	Medium density medium spruce. Medium density medium spruce (*Picea* spp.) with dwarf birch (*Betula* spp.) understory. Sandy soil.
5	D	Jay Creek - upper portion of valley to west of lower Jay Creek	3200	SSW	Riparian willow. Medium height willow (*Salix* spp.) dwarf birch (*Betula* spp.), shrubby cinquefoil (*Potentilla fruticosa*). Loam.
6	A	Gaging Station Creek - mouth	2050	SSW	Medium density tall conifer-deciduous mixture. Medium density tall spruce (*Picea glauca*) and birch (*Betula papyrifera*) with grass understory. Muck and rock soil.
6	B	Gaging Station Creek - lower	2500	S	High density tall spruce. High density tall spruce (*Picea glauca*) interspersed with medium height willow (*Salix* spp.). Gravel.

Table 2 (cont.). Location and description of 33 snow depth markers erected for Susitna moose studies in the Susitna River Basin of southcentral Alaska.

Snow Course Number	Marker Number	Location	Elevation Ft.	Aspect	Habitat Classification and Description
6	C	Gaging Station Creek - East Fork	3000	W	Riparian willow. Mixed species of medium height willow (*Salix* spp.), dwarf birch (*Betula* spp.). Muck and rock soil.
6	D	Gaging Station Creek - upper East Fork	3500	SW	Riparian willow. Medium height willow (*Salix* spp.) and grasses. Mud, water and large rocks.
7	A	Coal Creek - Coal Lake	2600	S	Medium density tall spruce. Medium density tall spruce (*Picea glauca*) with willow (*Salix* spp.) understory. Sandy soil.
7	B	Coal Creek - mouth of East Fork	2900	N	Upland brush. Mixture of dwarf birch (*Betula* spp.) with clumps of alders (*Alnus* spp.). Grass understory. Muck.
8	A	Goose Creek - mouth	2050	SE	Medium density medium spruce. Medium density medium spruce (*Picea glauca*) with low willow (*Salix* spp.) and dwarf birch (*Betula* spp.) understory. Wet clay and sandy soil.

Table 2 (cont.). Location and description of 33 snow depth markers erected for Susitna moose studies in the Susitna River Basin of southcentral Alaska.

Snow Course Number	Marker Number	Location	Elevation Ft.	Aspect	Habitat Classification and Description
8	B	Goose Creek - lower	2500	NNE	Medium density tall spruce. Medium density tall spruce (*Picea glauca*) with moss (Sphagnum) and scatterd willow (*Salix* spp.) understory. Gravel and small rock soil.
8	C	Goose Creek - mid	2900	N	Riparian willow. Low willows (*Salix* spp.) interspersed with blueberry (*Vaccinium* spp.) and grasses. Sandy soil.
8	D	Goose Creek - mouth Busch Creek	3400	E	Riparian willow. Low willow (*Salix* spp.) mixed with dwarf birch (*Betula* spp.) shrubby cinquefoil (*Potentilla fruticosa*). Sand and rock soil.

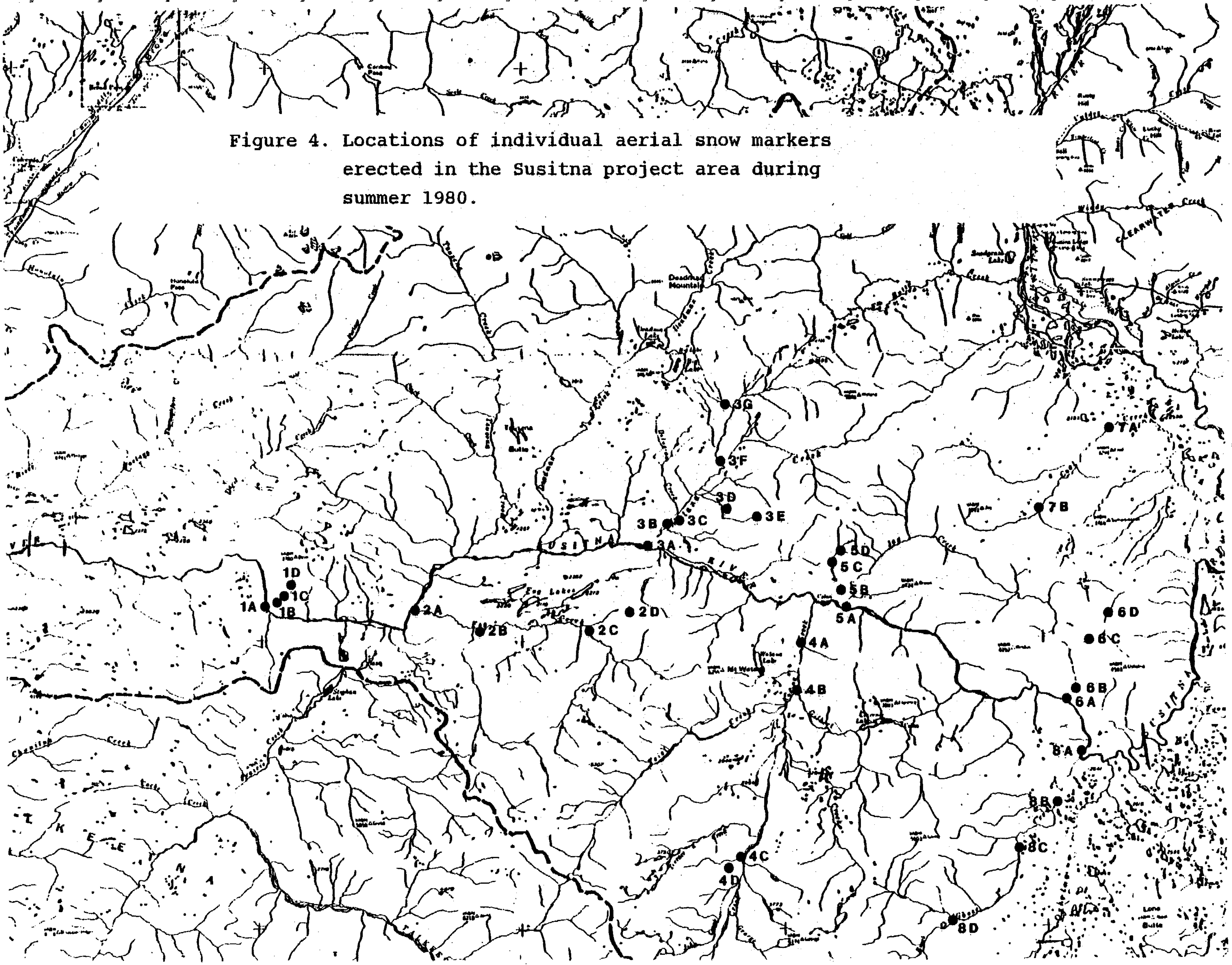


Figure 4. Locations of individual aerial snow markers erected in the Susitna project area during summer 1980.

Table 3. Listing of observed snow depths at 33 snow markers located in the Susitna Hydro Project study area on 9 November 1980.

Course Number	Marker Designation	General Location	Elevation of Marker	Snow Depth (Inches)	Remarks
1	A	Devil Mt. - Island	1250'	3	
1	B	Devil Mt.	2050'	7	
1	C	Devil Mt.	2450'	1	Wind blown
1	D	Devil Mt.	3000'	0	Wind blown
2	A	Fog Creek mouth	1400'	2	
2	B	Fog Creek lower	2000'	-	Missing crossmembers
2	C	Fog Creek upper	2500'	3	Missing crossmembers
2	D	Fog Creek - Mt. to NE	3000'	5	Missing crossmembers
3	A	Watana Creek - mouth	1550'	4	Missing crossmembers
3	B	Watana Creek lower	1650'	3	
3	C	Watana Creek - ridge to east	2100'	4	
3	D	Watana Valley - east	2400'	-	Could not locate
3	E	Watana Valley - Mt. to E	3100'	6	
3	F	Watana Creek - mouth of east fork	2100'	5	
3	G	Big Lake outlet	2500'	-	Missing crossmembers
4	A	Kosina Creek - lower	2000'	4	
4	B	Kosina Creek - mouth Gilbert Creek	2400'	3	
4	C	Kosina Creek - above Terrace Creek	3000'	3	
4	D	Kosina Creek - bench to west	3350'	3	
5	A	Jay Creek - mouth	1800'	3	
5	B	Jay Creek - bench to west	2500'	3	Missing crossmembers
5	C	Jay Creek - valley to west	2850'	6	Missing crossmembers
5	D	Jay Creek - upper valley	3200'	6	
6	A	Gaging Station creek mouth	2050'	4	

Table 3 (cont.). Listing of observed snow depths at 33 snow markers located in the Susitna Hydro Project study area on 9 November 1980.

Course Number	Marker Designation	General Location	Elevation of Marker	Snow Depth (Inches)	Remarks
6	B	Gaging Station Creek - lower	2500'	5	
6	C	Gaging Station Creek - east fork	3000'	6	
6	D	Gaging Station Creek - upper east fork	3500'	6	Missing crossmembers
7	A	Coal Creek - Coal Lk.	2600'	-	Could not locate
7	B	Coal Creek - mouth east fork	2900'	5	
8	A	Goose Creek - mouth	2050'	-	Laying on side
8	B	Goose Creek - lower	2500'	4	
8	C	Goose Creek - mid	2900'	6	
8	D	Goose Creek - mouth Busch Creek	3400'	8	
		Square Lake		12	11/20

strips), surveys are conducted annually in late October or early November depending on snow conditions, attempts are made to survey each area with the same pilot and observer to minimize the differences between observers (LeResche and Rausch 1974), and more detailed sex and age composition data are collected.

Boundaries of three composition count areas (CA's) used for this study are depicted in Fig. 5. CA 6 was surveyed because earlier studies had identified a migratory subpopulation of moose which used portions of the Watana impoundment area during winter (Ballard and Taylor 1980).

Moose populations within the study area were censused in early November using quadrat sampling techniques developed by Gasaway (1978), Gasaway et al. (1979), and Gasaway and Dubois (unpub. report). The census was conducted immediately following moose sex and age composition surveys. Due to deteriorating snow conditions only CA's 7 and 14 were censused to provide an estimate of the numbers of moose which could potentially be influenced by the Watana impoundment. No census was conducted for areas outside of CA's 7 and 14; however, remaining potential impact areas were stratified into high, medium and low densities.

The density classifications were based upon numbers of moose observed, continuity of moose habitat, and moose tracks observed during a cursory aerial survey similar to that performed in CA's 7 and 14 before they were censused. This stratification procedure allowed gross estimation of population numbers in uncensused areas by applying density estimates from areas which were censused and similarly stratified.

For the purposes of this report, we utilized the home range definition provided by LeResche (1974): "the area in which the individual accomplishes its normal activities during a given period of time." According to this definition" local movements occur within a home range, home ranges may shift seasonally, and individuals may occupy more than one home range in a year." In

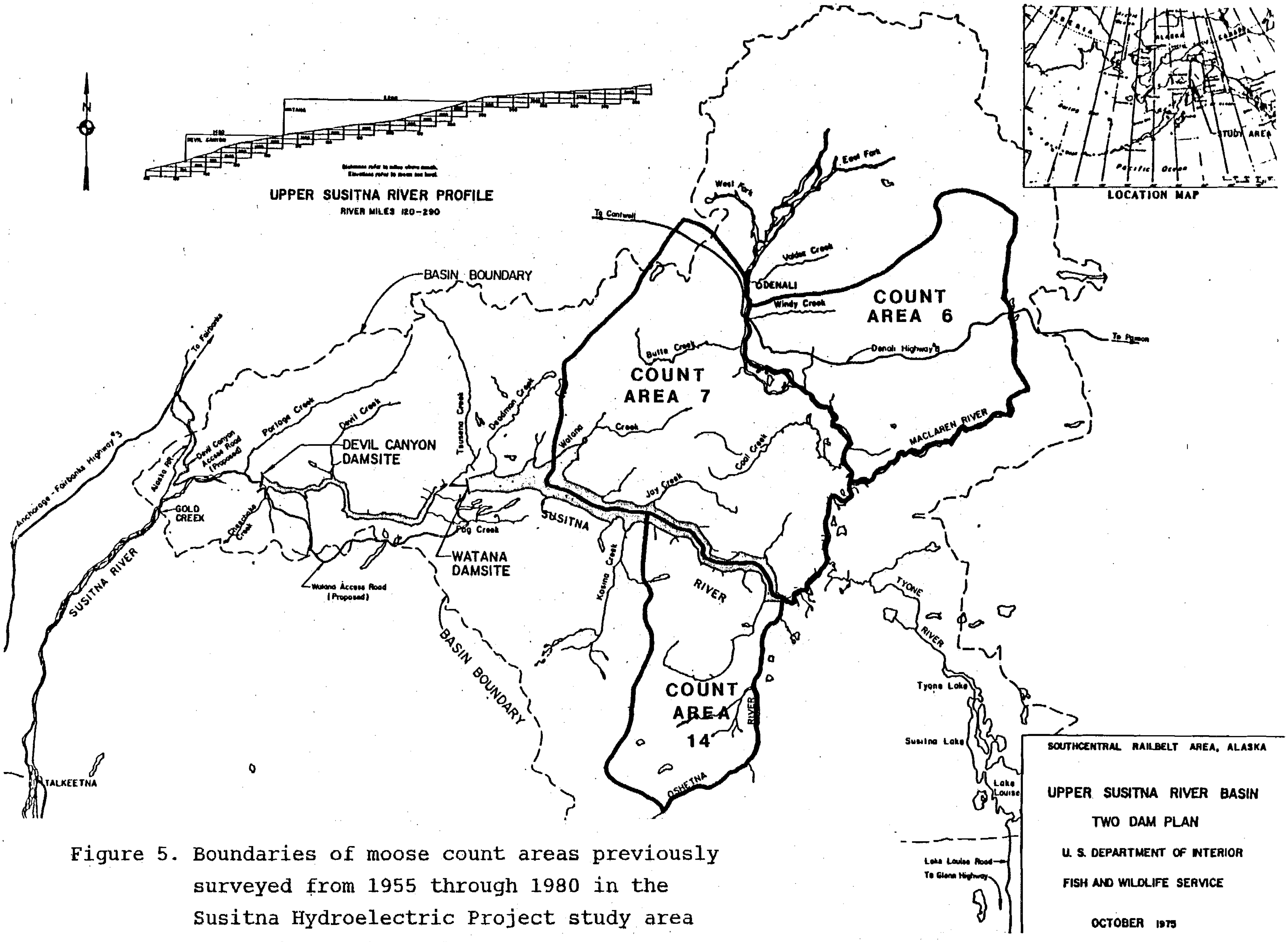


Figure 5. Boundaries of moose count areas previously surveyed from 1955 through 1980 in the Susitna Hydroelectric Project study area of southcentral Alaska.

this study home ranges were computed by connecting outer location sightings of each animal and then computing the area. Unless otherwise stated total home ranges were divided into summer and winter with summer consisting of the months of April, May, June, July, August and September and winter consisting of the remaining 6 months.

STUDY AREA

The study area included the suspected year-round ranges of sub-populations of moose that may encounter proposed impoundments regularly. Moose sex-age composition counts, winter distribution surveys and preliminary moose movement studies (Ballard and Taylor 1980; Ballard and Gardner 1980) were used to delineate the area. The boundaries of this area (Fig. 6) are as follows: The Denali Highway on the north to its confluence with the Maclaren River on the east, the Maclaren River to its confluence with the first unnamed creek in R4E, T13N (Gulkana Quad) upstream to Monsoon Lake, then a straight line to Tyone Village continuing up Lake Louise to the Lake Louise Road to its intersection with the Glenn Highway, on the south the Glenn Highway to the Little Nelchina River, then upstream to the peak of the Talkeetna Mountains, on the west the upper elevations of the Talkeetna Mountains to the confluence of the upper north and south forks of the Talkeetna River, then northwest to the mouth of Portage Creek, then upstream of Portage Creek to its headwaters to the headwaters of Brushkana Creek to its confluence with the Denali Highway.

Vegetation, topography and general climate of the area were described by Skoog (1968), Bishop and Rausch (1974), Ballard and Taylor (1980), and Ballard (1981). Also vegetation studies conducted under Subtask 7.12 provide a thorough description of vegetation in the impoundment areas.

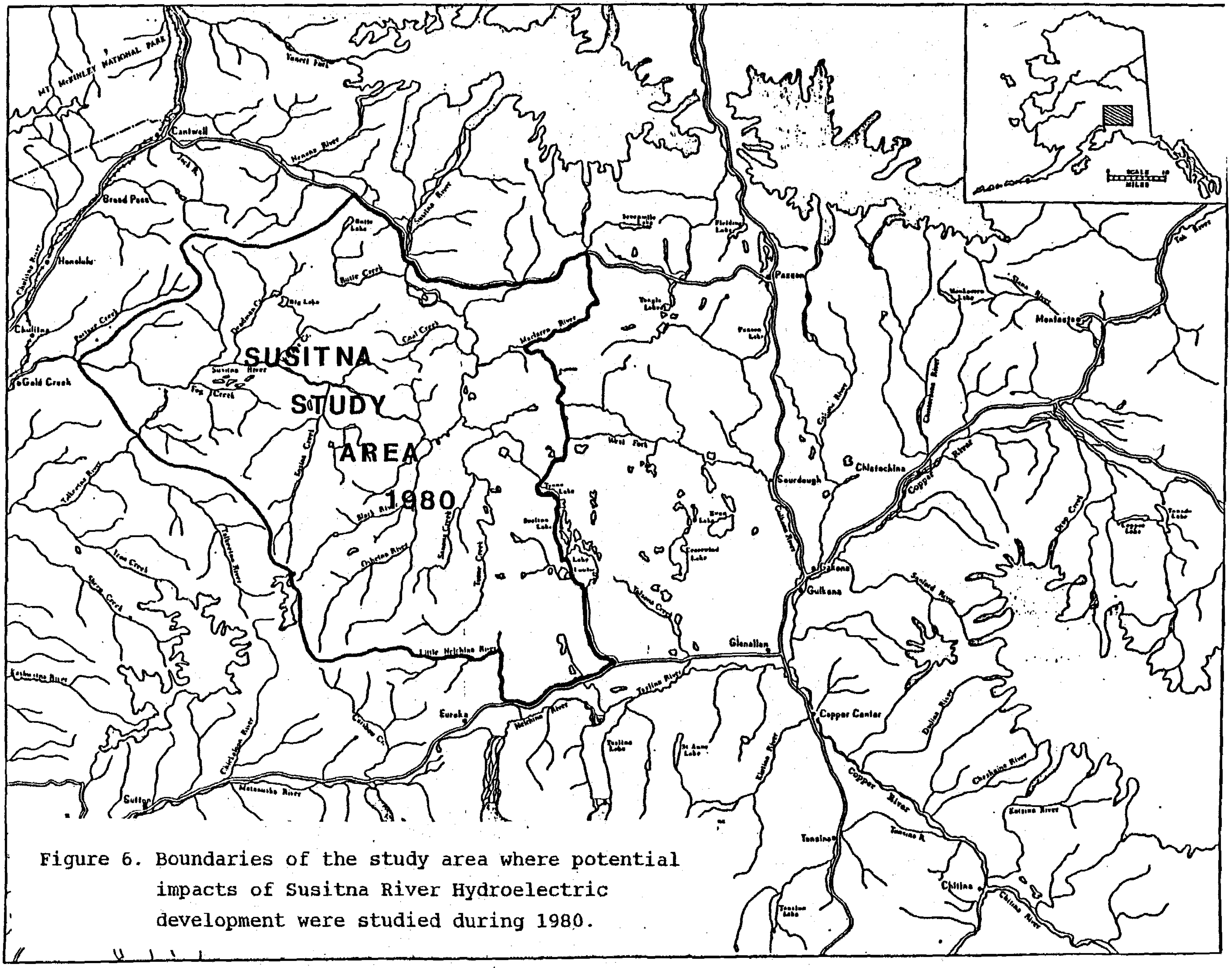


Figure 6. Boundaries of the study area where potential impacts of Susitna River Hydroelectric development were studied during 1980.

RESULTS AND DISCUSSION

From 11 through 23 April 1980 40 adult moose (37 females and 3 males) were captured and radio-collared in the Susitna moose study area. Three of these moose had been previously radio-collared from previous studies and were recaptured. A summary of tagging location, reproductive status, age and physical measurements of the 1980 captured moose are presented in Table 4. Collaring locations are visually depicted in Fig. 7. Collaring locations for all moose captured from October 1976 through 1981 which were used for evaluation of moose movements are depicted in Fig. 8.

From 7 through 9 March and May 1981 an additional 34 moose (18 adults and 16 calves) were captured and radio-collared in the Susitna study area in an effort to provide additional movement information in areas not adequately sampled in 1980. Also an attempt was made to capture and radio-collar the calves of radio-collared adults to begin gathering data on dispersal of subadult moose from the study area. A summary of tagging statistics for these moose is presented in Table 5.

Mean induction time for adult moose captured in spring 1980 was 16.4 minutes (S.D. = 10.5) ranging from 5 to 52 minutes. In 1981, the average induction times were less (11.8 minutes, S.D.=2.83) due to the slightly larger dosages of etorphine. Induction times for 10 month old calves averaged 9.9 minutes (S.D.=4.3). Longer induction times were due to either the moose not responding to the first dart and/or the dart malfunctioned. In such cases, a second injection of from 2 to 4 cc's etorphine was administered.

Two cow moose (#'s 620 and 646) were known to have died in 1980, apparently as a result of capture activities resulting in a 5 percent mortality rate for 1980. No capture related mortalities occurred in 1981. The 1980 mortality rate is comparable with mortality rates reported in other Alaska moose studies where M-99

Table 4. Location, age, reproductive status, physical measurements, and statistics associated with capture and handling of 40 adult moose in the Susitna River Study Area from 11 through 23 April 1980.

Moose Number	Sex	Date of Capture	Location	Radio Collar Number	Visual Collar* Color and No.	Metal Ear Tag No. L.	Metal Ear Tag No. R.	(6/1/80) Age (Yrs.)	w/Calf Yes/No	Diagnosed Pregnant Yes/No	Total Length	Measurements Inches (cm) Hind Foot	Measurements Inches (cm) Heart Girth	Measurements Inches (cm) Head Length	Measurements Inches (cm) Neck Circum.	Body Cond. Index	Drug Dosage	Drug Reaction Time (Min.)	Drug Placement
120617	F	04/11/80	3.25 mi east of mouth of Tsusena Creek N. side of Susitna R.	6406 *ATS	Black	15877	15876		Yes-1	Yes	124.5 3162	35.0 889	78.0 1981	30.0 762	36.0 914	6	M-99:9cc Rompun:1cc	8 min	Left leg
120618	F	04/11/80	6 mi east of mouth Watana Ck.-N. side of Susitna River	6402 *ATS	Black	15836	15837	13	Yes-1	No	113.0 2870	32.0 813	64.0 1625	32.0 813	28.0 711	9	M-99:9cc Rompun:1cc	-	-
120619	F	04/11/80	1.25 mi NW of mouth Deadman Creek. N. side Susitna River.	6399 *ATS	Black	15834	15835	9	Yes-1	No	109.8 2787	29.8 756	82.0 2083	27.5 699	34.8 883	8	M-99:9cc Rompun:1cc	11 min	Left rump
120620	F	04/11/80	0.5 mi N of Gauging Station N side of Susitna River	6404 *ATS	Black	16030	16029	12	Yes-2	Yes	118.5 3010	31.1 791	76.0 1931	30.8 781	32.5 825	-	M-99:9cc Rompun:1cc	11 min	Top back
120621	F	04/11/80	2.75 mi E of mouth Tsusena Creek, N. side Susitna River	6400 *ATS	Black	15832	15833	11	No	Yes	117.0 2972	-	86.0 2184	33.0 838	38.0 965	Excelnt	M-99:14cc Rompun:1cc	32 min	Top back
120622	F	04/11/80	0.8 mi NW of mouth Deadman Creek N. side Susitna River	6407 *ATS	Black	none	none	12	Yes-1	Yes	116.0 2946	30.5 775	74.0 1880	33.0 838	33.0 838	-	M-99:9cc Rompun:1cc	12 min	Left rump
120623	F	04/11/80	2.2 mi NE of mouth of Watana Creek, N side of Susitna River	6405 *ATS	Yellow 40	16252	16253	8	Yes-1	Yes	112.0 2844	34.0 863	68.0 1727	29.0 737	35.0 889	7	M-99:9cc Rompun:1cc	-	-

Table 4 (cont.). Location, age, reproductive status, physical measurements, and statistics associated with capture and handling of 40 adult moose in the Susitna River Study Area from 11 through 23 April 1980.

Moose Number	Sex	Date of Capture	Location	Radio Collar Number	Visual Collar Color and No.	Metal Ear Tag No. L.	Metal Ear Tag No. R.	(6/1/80) Age (Yrs.)	w/Calf Yes/No	Diagnosed Pregnant Yes/No	Total Length	Measurements Inches (cm) Hind Foot	Heart Girth	Head Length	Neck Circum.	Body Cond. Index	Drug Dosage	Drug Reaction Time (Min.)	Drug Placement
120624	F	04/13/80	2.4 mi E of mouth of E fork Watana Creek N. side of Susitna R.	6398 *ATS	Black	16922	16923	10	No	Yes	114.8 2914	30.9 785	- -	29.8 756	32.5 825	6	M-99:9cc Rompun:1cc	11 min	Left rump
120625	F	04/13/80	2.3 mi E of mouth E Fork of Watana Ck. N. side of Susitna River	6409 *ATS	Black	16921	16920	13	No	No	108.0 2743	- -	78.0 1981	29.0 737	31.0 787	6	M-99:9cc Rompun:1cc	20 min	Left rump
120626	M	04/13/80	Fog Creek 2.5 mi SE of southeastern-most Fog Lake S side of Susitna River.	6401 *ATS	Black	15843	15842	5	-	-	112.1 (2848)	31.5 (800)	78.0 (1981)	- -	30.9 785	8	M-99:9cc Rompun:1cc	-	Top rump
120627	M	04/13/80	Fog Creek 2.9 mi SE of southeastern-most Fog Lake S side of Susitna River	6408 *ATS	Black	16916	16917	4	-	-	115.0 2921	30.8 781	79.0 2006	30.5 775	35.0 889	6.5	M-99:9cc Rompun:1cc	10 min	Top rump
120628	F	04/13/80	Fog Creek 2.6 mi SE of southeastern-most Fog Lake S. side of Susitna River	6403 *ATS	Black	15827	15828	12	No	Yes	-	-	84.0 2133	32.0 813	33.0 838	-	M-99:9cc Rompun:1cc	7 min	Left rump
120629	F	04/18/80	3.3 mi S of Stephan Lake S. side of Susitna River	6434 36	Orange	16907	16906	3	No	No-?	109.0 2768	35.0 889	68.0 1727	29.0 737	26.0 660	5	M-99:9cc Rompun:1cc	16 min	Left rump

Table 4 (cont.). Location, age, reproductive status, physical measurements, and statistics associated with capture and handling of 40 adult moose in the Susitna River Study Area from 11 through 23 April 1980.

Moose Number	Sex	Date of Capture	Location	Radio Collar Number	Visual Collar Color and No.	Metal Ear Tag No. L.	Metal Ear Tag No. R.	(6/1/80) Age (Yrs.)	w/Calf Yes/No	Diagnosed Pregnant Yes/No	Total Length	Measurements Inches (cm) Hind Foot	Heart Girth	Head Length	Neck Circum.	Body Cond. Index	Drug Dosage	Drug Reaction Time (Min.)	Drug Placement
120630	F	04/18/80	2.8 mi NW of mouth of Tsusena Creek N. side of Susitna R.	6438	Orange 40	16108	16109	6	No	No	115.0 2921	35.5 902	84.0 2133	31.0 787	39.0 991	8	M-99:9cc Rompun:1cc	11 min	Top back
120631	F	04/18/80	Devil Mountain 2.8 mi SSW of VABM Devil N. side of Susitna River	6435	Orange 37	16157	16158	10	No	No	116.0 2946	35.0 889	89.0 2260	34.0 863	35.5 902	8	M-99:9cc Rompun:1cc	14 min	Left hind leg
120632	F	04/18/80	Devil Mountain 2.7 mi SSW of VABM Devil N side of Susitna River.	6432	Orange 34	16115	16114	11	Yes-1	Yes	114.0 2895	32.0 813	80.0 2032	30.0 762	32.0 813	8	M-99:9cc Rompun:1cc	18	Left rump
120633	F	04/18/80	Devil Creek 6.4 mi N of VABM Devil N side of Susitna River	6431	Orange 33	16155	16156	2	No	No	89.0 2260	30.0 762	66.0 1677	26.5 673	34.0 863	7	M-99:9cc Rompun:1cc	9 min	Left leg
120634	F	04/18/80	3.3 mi SSW of Stephan Lake S. side of Susitna River	6436	Orange 38	16912	16913	12	No	Yes	115.0 2921	30.6 778	82.0 2083	29.8 756	30.1 765	7	M-99:9cc Rompun:1cc	12 min	Right rump
120635	F	04/19/80	2.2 mi E of mouth of Deadman Creek N. side of Susitna River	6433	Orange 35	16162	16161	-	Yes-1	Yes-?	120.0 3048	32.0 813	78.0 1981	31.5 800	33.0 838	8.5	M-99:9cc Rompun:1cc	9 min	-

Table 4 (cont.). Location, age, reproductive status, physical measurements, and statistics associated with capture and handling of 40 adult moose in the Susitna River Study Area from 11 through 23 April 1980.

Moose Number	Sex	Date of Capture	Location	Radio Collar Number	Visual Collar Color and No.	Metal Ear Tag No. L.	Metal Ear Tag No. R.	(6/1/80) Age (Yrs.)	w/Calf Yes/No	Diagnosed Pregnant Yes/No	Total Length	Measurements Inches (cm) Hind Foot	Heart Girth	Head Length	Neck Circum.	Body Cond. Index	Drug Dosage	Drug Reaction Time (Min.)	Drug Placement
120636	F	04/19/80	1.0 mi SSW of mouth of Terrace Creek S. side of Susitna R.	6448	Orange 50	16165	16166	4	No	No	107.0 2717	31.5 800	68.0 1727	28.0 711	31.5 800	7	M-99:9cc Rompun:1cc	7 min	Left rump
120637	F	04/19/80	2 mi NNW of mouth of Terrace Creek S. side of Susitna River	6437	Orange 39	16170	16169	-	No	Yes	110.3 2800	29.9 760	75.2 1910	31.5 800	-	7	M-99:9cc Rompun:1cc	8 min	Left side
120638	F	04/19/80	1 mi SSW of mouth of Terrace Creek S side of Susitna River.	6446	Orange 48	16164	16163	16 est.	No	No	107.0 2717	33.0 838	80.0 2032	30.8 781	-	6	M-99:9cc Rompun:1cc	7	Left rump
120639	F	04/19/80	1.3 mi E of Watana Lake S side of Susitna River	6444	Orange 46	None	None	4	No	Yes	115.0 2921	30.8 781	80.0 2032	29.8 756	31.5 800	6.5	M-99:11cc Rompun:1cc	12 min	Rump
120640	F	04/19/80	1.9 mi N of mouth of Terrace Creek S. side of Susitna River	6440	Orange 42	16160	16159	5	Yes-1	Yes	110.5 2807		92.0 2337	28.3 718	34.8 883	6	M-99: Rompun:1cc	16 min	Right rump Top rump
120641	F	04/20/80	1.8 mi SE of mouth of Watana Creek S. side of Susitna River	6442	Orange 44	15942	15943	12	No	Yes	114.2 2900	31.5 800	79.5 2020	29.3 745	33.9 860	7	M-99:9cc Rompun:1cc	8 min	Left leg

Table 4 (cont.). Location, age, reproductive status, physical measurements, and statistics associated with capture and handling of 40 adult moose in the Susitna River Study Area from 11 through 23 April 1980.

Moose Number	Sex	Date of Capture	Location	Radio Collar Number	Visual Collar Color and No.	Metal Ear Tag No. L.	Metal Ear Tag No. R.	(6/1/80) Age (Yrs.)	w/Calf Yes/No	Diagnosed Pregnant Yes/No	Total Length	Measurements Inches (cm) Hind Foot	Heart Girth	Head Length	Neck Circum.	Body Cond. Index	Drug Dosage	Drug Reaction Time (Min.)	Drug Placement
120642	M	04/20/80	1.8 mi SE of mouth of Watana Creek S. side of Susitna River	6445	Orange 47	15915	16903	4	-	-	109.5 2781	35.0 889	70.0 1778	29.0 787	33.5 851	-	M-99:17cc Rompun:1cc	34 min	Left leg Left rump Left side
120643	F	04/20/80	1.1 mi WSW of southeastern-most Fog Lake S. side of Susitna River	6447	Orange 49	16918	16919	-	No	Yes	115.0 2921	31.5 800	79.0 2006	31.0 787	26.8 680	6	-	-	Left rump(2x) Right rump
120644	F	04/20/80	1.1 mi WSW of southeastern-most Fog Lake S. side of Susitna R.	6452	Orange 54	15947	15946	-	No	No	111.0 2819	35.0 889	72.0 1829	28.0 711	30.0 762	6		18 min	Left side Back
120645	F	04/20/80	1.7 mi N of mouth of Watana Creek N. side of Susitna River	6451	Orange 53	15945	15944	10	No	Yes	124.0 3149	29.8 756	84.0 2133	30.3 770	32.0 813	6	M-99:11cc Rompun:1cc	25 min	Left hip
120646	F	04/20/80	1.7 mi N of mouth of Watana Creek, N side of Susitna River.	6441	Orange 43	16914	16915	11	No	Yes	117.3 2978	30.5 775	86.0 2184	31.0 787	34.8 883	6.5	M-99:9cc Rompun:1cc	5	Tail
120647	F	04/22/80	0.4 mi S of mouth of creek draining easterly from Clarence Lake area S side of Susitna River	6443	Orange 45	16924	16925	13	No	Yes	-	29.5 750	85.9 2180	31.2 792	-	8	-	36 min	Left rump

Table 4 (cont.). Location, age, reproductive status, physical measurements, and statistics associated with capture and handling of 40 adult moose in the Susitna River Study Area from 11 through 23 April 1980.

Moose Number	Sex	Date of Capture	Location	Radio Collar Number	Visual Collar Color and No.	Metal Ear Tag No. L.	Metal Ear Tag No. R.	(6/1/80) Age (Yrs.)	w/Calf Yes/No	Diagnosed Pregnant Yes/No	Total Length	Measurements Inches (cm) Hind Foot	Heart Girth	Head Length	Neck Circum.	Body Cond. Index	Drug Dosage	Drug Reaction Time (Min.)	Drug Placement
120648	F	04/22/80	0.8 mi N of mouth of Jay Creek N. side of Susitna River	6462	Yellow 65	15940	15941	4	No	No	116.4 2956	31.5 800	75.2 1910	30.3 770	38.2 970	6	M-99:15cc Rompun:1cc	52 min	Left back ?
120649	F	04/22/80	0.5 mi S of mouth of creek flowing easterly out of Clarence Lake area S. side of Susitna River	6463	Yellow 66	16172	16171	-	No	Yes	115.8 2940	31.9 810	82.7 2100	30.1 765	33.5 850	5	M-99:9cc Rompun:1cc	25	Left rump
120650	F	04/22/80	0.9 mi N of mouth of Jay Creek N. side of Susitna R.	6467	Yellow 70	15827	15826	4	No	Yes	119.3 3030	30.8 783	82.0 2083	27.8 705	31.9 810	5	M-99:9cc Rompun:1cc	14 min	Left rump
120651	F	04/22/80	2.0 mi WNW of mouth of Kosina Creek N. side of Susitna River	6449	Orange 51	15954	15956	15 est.	No	No	112.6 2860	32.3 820	75.6 1920	30.5 775	32.5 825	5	M-99:9cc Rompun:1cc	15 min	Left rump
120652	F	04/23/80	Gauging Station 1.8 mi SE of VABM Windus N side of Susitna River.	6464	Yellow 67	16152	16151	13	No	Yes	115.8 2940	-	85.1 2160	31.5 800	35.0 890	6	M-99:9cc Rompun:1cc	17	Left rump

Table 4 (cont.). Location, age, reproductive status, physical measurements, and statistics associated with capture and handling of 40 adult moose in the Susitna River Study Area from 11 through 23 April 1980.

Moose Number	Sex	Date of Capture	Location	Radio Collar Number	Visual Collar Color and No.	Metal Ear Tag No. L.	Metal Ear Tag No. R.	(6/1/80) Age (Yrs.)	w/Calf Yes/No	Diagnosed Pregnant Yes/No	Total Length	Measurements Inches (cm) Hind Foot	Heart Girth	Head Length	Neck Circum.	Body Cond. Index	Drug Dosage	Drug Reaction Time (Min.)	Drug Placement
120653	F	04/23/80	2.5 mi SSE of mouth of creek flowing easterly out of Clarence Lake area S side of Susitna River	6450	Orange 52	16105	16104	13	No	Yes?	-	-	-	-	-	7	M-99:12cc Rompun:1cc	35	Left rump(2x)
120654	F	04/23/80	2.5 mi SSE of mouth of creek flowing easterly out of Clarence Lake area S. side of Susitna River	6400	Black	16841	16842	9	No	No	111.5 2832	31.3 794	- -	29.0 737	33.5 851	7	M-99:9cc Rompun:1cc	12	Left side
120655	F	04/23/80	Gauging Station 1.8 mi SE of VABM Windus N. side of Susitna R.	6404	Black	16652	16653	16	?	No	112.0 2845	32.0 813	83.0 2108	28.8 730	33.3 845	5	M-99:9cc Rompun:1cc	7 min	Left rump
120656	F	04/23/80	Gauging Station 1.8 mi SE of VABM Windus N. side of Susitna River	6465	Yellow 68	16816	16815	13	No	Yes	116.3 2953	31.3 794	-	28.0 711	-	6	M-99:12cc Rompun:1cc	27 min	Left rump(2x)

*ATS = Air Temp Sensing.

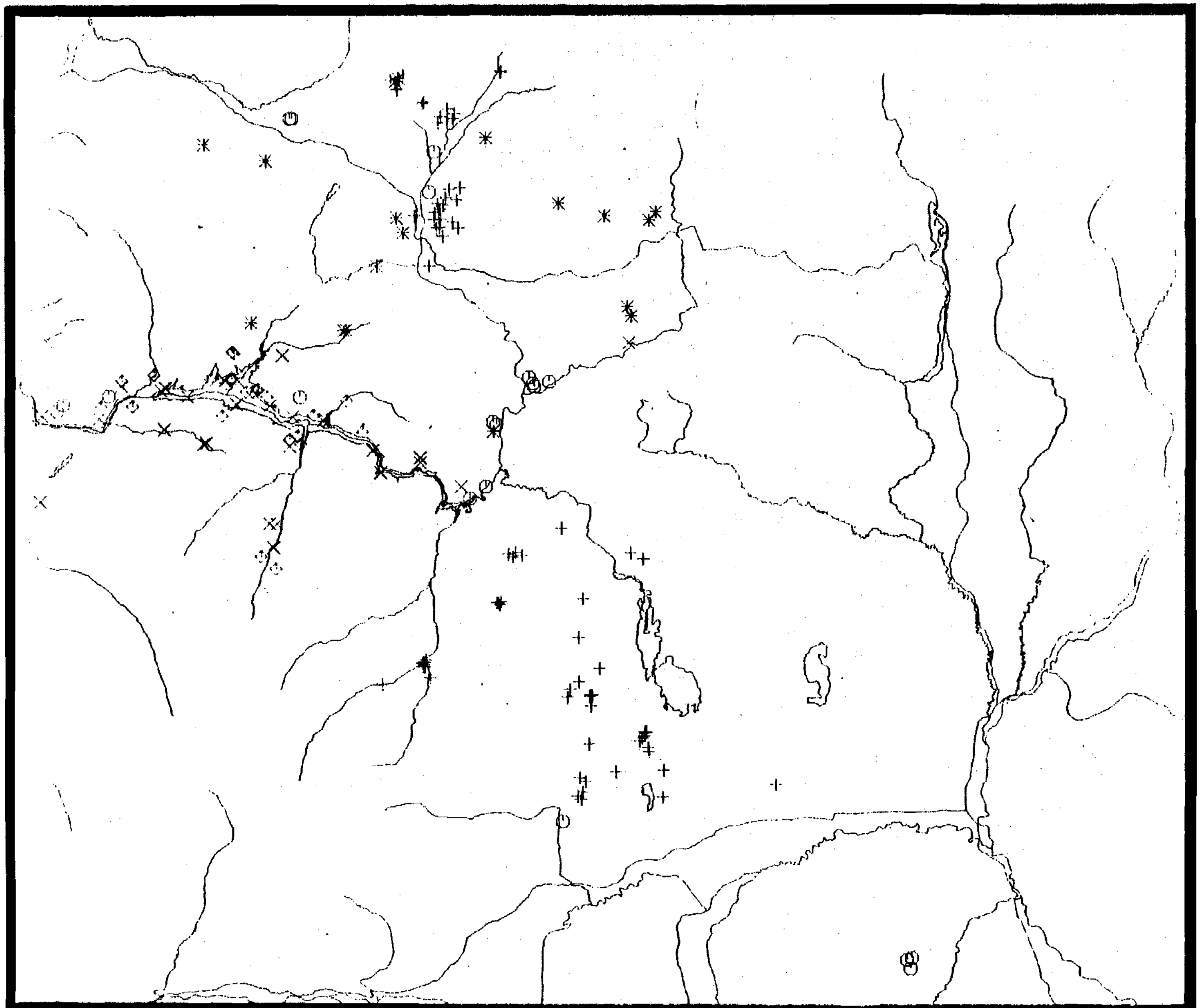


Figure 8. Collaring locations of calf (≥6 mo.) and adult moose captured for movement and mortality studies from October 1976 through 1981 in the Nelchina and upper Susitna River Basins of Southcentral Alaska. (scale: 1 cm = 12500 meters)

Table 5. Location, age, reproductive status, physical measurements and statistics associated with the capture and handling of adult and calf moose in the Susitna Hydroelectric Project Study Area during spring, 1981.

Acc. # 120-	Sex	Date of Capture	Location	Radio Collar #	Visual Collar Color & #	Metal Ear Tag R.	Metal Ear Tag L.	Age 6/1/81 yrs. (mos.)	w/calf & #	preg- nant	# ob- served calves	Tot. length (cm)	Hind foot (cm)	Heart girth (cm)	Head length (cm)	Neck circum. (cm)	Cond.	Drug Dosage	Place- ment Induc- tion time (min.)
662	F	5-9-81	N. of Susitna R., opposite Fog Crk	8583	Black			8(96)	Y(1)	Y	0	257	79	198	67			11mg M99 200mg Rompun	10
663	F	5-9-81		8031	White			8(96)	w/yrlg(1)	Y	0							11mg M99 100 mg Rompun	L. shldr. 7
666	F	3-5-81	Delusion Crk	6416	Yellow 83			9(106)	Y(1)	Y	1	294	103	211			6	9mg+2.5mg M99 100 mg Rompun	L. Rr. 19
667	M	3-5-81	Delusion Crk	6455	Yellow 87		16562	2(22)				264	78	158)	62	75		9mg M99 100mg Rompun	13
668	F	3-5-81	Watana Crk	6496	Yellow 73		16564	8(94)	N	Y	0	297	85	206	79			9mg M99 100mg Rompun	13
669	F	3-5-81	2 miles E. of Watana Crk	7154	Black	16435		0(10)				206	69	154				5mg+2.5 mg M99	17
670	M	3-5-81	Delusion Crk	7155	Black		16905	0(10)				229	73	173	53	69		5mg M99	L. hip 11
671	F	3-5-81	Delusion Crk	6454	Yellow 86		16826	4(46)	Y(1)	Y	0	277	86	183	70			9mg M99 100mg Rompun	9
672	M	3-7-81	E. of Watana Crk	7158	Black			0(10)									6	5mg M99	L. rump 9
673	F	3-7-81	E. bank of Watana Crk	6495	Orange 72			Adult	Y(1)			300	83	206	78	82	7	10mg+5mg M99	L.shldr.&back 13
674	M	3-7-81	E. bank of Watana Crk	7150	Black			0(10)				230	74	175	60			5mg M99	R. rump 8
675	M	3-7-81	On Mountain E. of Watana Crk	7151	Black	16375		0(10)				218	75	168	55	64	5	5mg M99	9
676	M	3-7-81		7141	Black	16567		0(10)										5mg M99	L. back 6
677	M	3-7-81	Upper Kosina Crk	7145	Black			0(10)				203						5mg M99	mid-back 13
678	F	3-7-81	opposite Kosina Crk	7146	Black			0(10)									4.5	5mg M99	L. rump 6
679	F	3-7-81	E. of Fog L	7144	Black			0(10)										5mg M99	Loin 9
680	F	3-8-81	Tsusena Crk	7142	Black	16612		2(22)		N	0							10mg M99	Rump 15

Table 5. (cont.d).

Acc. # 120-	Sex	Date of Capture	Location	Radio Collar #	Visual Collar Color & #	Metal Ear Tag R.	L.	Age 6/1/81 yrs. (mos.)	w/calf & #	pregnant	# observed calves	Tot. length (cm)	Hind foot (cm)	Heart girth (cm)	Head length (cm)	Neck circum. (cm)	Cond.	Drug Dosage	Placement Induction time (min.)
681	F	3-8-81	Warren Crk	7147	Black			0(10)				209	72		53			5+2.5+2.5mg M99	L. rump 22
682	M	3-8-81	Gardner Crk	6497	Yellow 74		16908	Adult				286	79	189	73	89	5	9mg+5mg M99 100mg Rompun	L. rump 13
683	F	3-9-81	Kosina Crk	6498	Yellow 75	16626		9(106)	Y(1)	Y	1	295	78	240	78	90	7	10mg M99 200mg Rompun	Rump 11
684	F	3-9-81	Kosina Crk	6499	Yellow 76		16846	8(94)	Y(1)	Y	0				78	80		12.5mg M99	L. rump 11.5
685	F	3-9-81	Watana Crk	7149	Black		16690	0(10)				199	71		54	64		5mg M99	L. side 9
686	F	3-9-81	NE of Watana L	7153	Black			0(10)				224	70	152	58			5+2.5mg M99	Top rump 10
687	F	3-9-81	Watana L	6458	Yellow 89	16174		4(46)	N	Y	1	293	80	200	73			10mg M99 2.5mg Rompun	R. rump 10
688	F	3-9-81	Jay Crk	6457	Black	16991		Adult	Y(1)	N	0	293		220	71	81		5mg M99	10
689	F	3-9-81	Watana L	7143	Black	16573		0(10)				219	70	160	55	64		5mg M99	R. rump 5
690	M	3-9-81	Kosina Crk	7156	Black			0(10)				208	65	163	54	71	5	--	L. rump 8
691	F	3-9-81	NE of Watana L	6500	Yellow 77		15841	9(106)	N	Y	0	290			77		7.5	10mg M99 200mg Rompun	10
692	F	3-9-81	Watana Crk	6461	Yellow 64		16515	9(106)	Y(1)	Y	1	294	84	196	77		6	5+10mg M99 2.5mg Rompun	L. flank L. hip 12
693	F	3-9-81	Kosina Crk	7148	Black		8447	0(10)				228	67	160	58	60		5mg Rompun	Flank 7
694	F	3-8-81	Tsusena Crk	6501	Yellow 78		16113	13(154)	w/yrlg(1)	Y	0	304	88	188	71	81		2.5+5mg M99	L. neck & rump 20
695	F	5-7-81	NW of Fog Lake	6426	Yellow 67	16568		Adult	w/yrlg(1)	N	0	307	84		78			--	--
696	M	5-7-81	NW of Fog Lake	7157	Black			0(10)	w/cow			223	75					--	--
697	F	5-7-81	SW of Warren Crk	6431	Yellow 49			Adult	Y		0	284	78	189	75	84		11mg M99 100mg Rompun	10

has been employed (Gasaway et al. 1979; Smith and Franzmann 1979) and continues to be considerably less than that obtained from use of succinylcholine chloride (Didrickson et al. 1977; Ballard and Taylor 1980) and does not influence subsequent calf survival as suspected for the latter drug (Ballard and Tobey 1981).

Average age of cow moose tagged in spring 1980 was 9.4 years (S.D.=3.8) while the three bulls averaged 4.3 years (S.D.=0.6). The 12 adult cow moose captured in 1981 averaged 7.6 (S.D.=2.9). Mean ages of cow moose tagged in the upper Susitna River Basin in 1976 and 1977 (Ballard and Taylor 1980) were compared with those captured in 1980 and were found to be significantly (t test, $P<0.05$) younger. The 1976 and 1977 ages were adjusted upward to correspond with the 1980 tagging period, making it possible to examine the same cohorts during both periods. Cow moose in 1976 averaged 7.5 years (S.D.=3.4) of age while those in 1977 averaged 7.0 years (S.D.=3.8). In 1976-77 cow moose 10 years of age or older represented 25 percent of the sample; however, in 1980 they represented 62 percent of the sample. In 1976 and 1977 moose from 2 to 4 years of age comprised 21 and 40 percent, respectively, of the captured moose while in 1980 they comprised 21 percent. Differences between the age structures was most evident for moose 5 to 9 years of age. These findings indicate that the age structure of the adult cow segment has become older since 1976-77. Although reasons for this shift are uncertain, predation and mortality due to the severe winter of 1978-79 appear likely. The age structure of adult cow moose captured in 1981 were not compared with other tagging years because of small sample size (n=12).

The reported age structure of other Alaskan moose populations was younger. In the Gakona, Gulkana, and Chistochina drainages of Game Management Unit 13, Van Ballenberghe (1978) reported that 49 percent of his tagged moose were 10 years old or older. Bailey et al. (1978) reported that on the Kenai Peninsula cow moose 10 years old or older comprised 28-34 percent of the sampled moose, while in the Peter's Hills region west of Talkeetna they comprised 38 percent of the sample, Didrickson and Taylor (1978). Moose from 6 to 11 years of age (38% of the 1980 Susitna sample) are the most productive members of the population, producing more twin calves than moose of other age classes (Markgren 1969); however, even older moose continue to regularly produce calves until death.

Of the 37 cow moose captured and palpated in April 1980, 23 (62%) were determined to be pregnant by rectal palpation, while in 1981 11 of 14 (79%) were determined pregnant. However, observations of the radio-collared cows following capture in 1980 from fixed-wing aircraft revealed that four cows which had been diagnosed as not pregnant subsequently had calves. Therefore, the actual pregnancy rate was at least 73 percent and may have been higher. Cows captured in 1981 were not monitored frequently enough during calving to determine the accuracy of pregnancy diagnoses. Reasons for the false diagnoses in 1980 and perhaps in 1981 may be attributed to the inexperience of some of the field staff. Of the eight participating individuals in 1980, only two could be considered experienced and current (≥10 moose within past 2 years). Given these problems the 1980 and 1981 pregnancy rates may have been comparable to the 88 percent observed in 1977 which was comparable with the rates determined elsewhere in Alaska (Ballard and Taylor 1980). Low pregnancy rates could also result from at least two other factors: low bull:cow ratios and nutritional stress. It has been speculated that low bull:cow ratios could influence conception rates (McIlroy 1974; Bishop and Rausch 1974; Bailey et al. 1978 and others). During 1979 bull:cow ratio reached a record low of 8.8 and thus this could have been a factor. However, low bull:cow ratios have occurred elsewhere and existing data suggest normal pregnancy rates.

Another, more plausible, reason for low pregnancy rates is nutrition. Poor nutritional condition may have caused lower pregnancy rates for several years on the Kenai Peninsula (Franzmann pers. comm.). Examination of blood data from Susitna moose indicate that the 1980 captured moose were more nutritionally stressed than those sampled from the same area in earlier years (Ballard and Taylor 1980).

Condition Assessment

Criteria developed by Franzmann and LeResche (1978) were utilized to assess the physical status of Susitna River moose. Analyses performed on moose tagged in 1975 and 1977 had suggested that Susitna moose were in good physical condition relative to other Alaskan moose populations (Ballard and Taylor 1980). However, adult moose examined in spring 1979 had the lowest values of certain blood parameters of any moose examined in Unit 13 and were judged to be nutritionally stressed due to winter severity (op. cit.).

Blood values for 34 individual moose sampled in April 1980 and 13 adults sampled in 1981 are presented in Tables 6A, 6B and 7. In previous studies, blood parameters suggested that moose from the Devils Mountain area may have been in poorer physical condition than those examined elsewhere in the Basin. Small sample sizes, however, prevented any firm conclusions. To examine this hypothesis further, blood samples from moose captured in 1980 were divided into groups above and below the proposed Watana dam (Tables 6A and 6B). Five blood parameters which Franzmann and LeResche (1978) believed were the most useful for assessing condition were compared. They were as follows: Packed cell volume (PCV), hemoglobin (Hb), calcium (Ca), phosphorus (P) and total protein (TP). No significant differences (t test, $P>0.01$) were detected for these five parameters, suggesting that moose above proposed Watana reservoir exhibited similar trends of condition and below the blood values from adult cow moose captured in 1980 and 1981 were compared with those collected previously in GMU 13 and elsewhere in Alaska (Table 8). Samples in Table 8 are listed in order of high to low PCV values which Franzmann and LeResche

Table 6A. Blood values from adult moose radio-collared downstream from Watana dam site, April 1980.

Accession Number	Hemo-globin g/100ml	Packed cell vol. %	Calcium mg/100ml	Phos-phorus mg/100ml	Glucose mg/100ml	BUN mg/100ml	Uric Acid mg/100ml	Choles-terol mg/100ml	Bili-rubin mg/100ml	Alk. Phos. mg/100ml	L.D.H. mu/100ml	S.G.O.T. mu/100ml
120617	14.0	35.5	10.3	4.9	96.0	8.0	0.3	53.0	0.1	36.0	213.0	67.0
120619	19.3	43.0	10.0	5.8	101.0	5.0	0.5	54.0	0.1	49.0	223.0	73.0
120622	20.0+	39.5	9.5	6.1	122.0	6.0	0.3	70.0	0.1	53.0	167.0	51.0
120628	20.0+	48.8	10.5	6.0	154.0	3.0	0.4	66.0	0.2	62.0	218.0	51.0
120629	15.0	43.0	11.0	4.6	151.0	4.0	0.2	78.0	0.1	38.0	169.0	56.0
120630	18.5	44.5	10.1	5.9	120.0	6.0	0.4	57.0	0.2	57.0	223.0	56.0
120631	18.0	42.0	10.1	6.2	177.0	6.0	0.2	54.0	0.2	27.0	241.0	70.0
120632	17.0	41.0	10.0	5.7	118.0	4.0	0.4	76.0	0.1	50.0	219.0	62.0
120633	18.0	38.0	9.9	7.1	173.0	7.0	0.3	39.0	0.1	89.0	205.0	54.0
120634	18.5	44.0										
120635			10.7	4.3	122.0	8.0	0.4	72.0	0.2	59.0	213.0	54.0
120643	20.0+	54.0										
120644	17.5	41.0	10.0	7.0	115.0	7.0	0.6	50.0	0.1	75.0	252.0	79.0
n	12	12	11	11	11	11	11	11	11	11	11	11
x	17.98	42.86	10.19	5.78	131.73	5.82	0.36	60.82	0.14	54.09	213.00	61.18
S.D.	1.92	4.86	0.41	0.89	27.63	1.66	0.12	12.34	0.05	17.65	25.85	9.66

Table 6A (cont.). Blood values from adult female moose radio-collared downstream from Watana dam site, April 1980.

Accession Number	Total Protein SMAK test g/100ml	Albumin SMAK test g/100ml	(Electro-phoresis) Albumin g/100ml	Albumin g/100ml	Globulin g/100ml	Alpha 1 g/100ml	Alpha 2 g/100ml	Beta g/100ml	Gamma A/G Ratio
120617	6.3	3.6	4.7	1.6	0.2	0.3	0.4	0.8	2.9
120619	6.8	3.8	5.1	1.7	0.5	-	0.4	0.9	3.0
120622	7.7	3.3	4.2	3.5	0.5	0.6	0.5	1.9	1.2
120628	6.9	3.9	5.0	1.9	0.3	0.4	0.4	0.9	2.6
120629	7.7	3.4	4.7	3.0	0.3	0.5	1.9	0.5	1.5
120630	6.9	4.0	5.2	1.7	0.6	-	0.4	0.8	3.0
120631	6.9	4.0	5.0	1.9	0.3	0.4	0.4	0.8	2.7
120632	7.1	3.8	4.8	2.3	0.3	0.4	0.5	1.1	2.1
120633	5.9	3.6	4.4	1.5	0.3	0.4	0.4	0.5	3.0
120634									
120635	6.8	4.0	5.2	1.6	-	0.6	0.3	0.7	3.2
120643									
120644	7.1	3.9	5.1	2.0	0.3	0.3	0.3	1.1	2.5
n	11	11	11	11	10	9	11	11	11
x	6.92	3.75	4.85	2.06	0.36	0.43	0.54	0.91	2.52
S.D.	0.52	0.25	0.33	0.64	0.13	0.11	0.46	0.38	0.66

Table 6B Blood values from adult female moose radio-collared upstream from Watana dam site, April 1980.

Accession Number	Hemo-globin g/100ml	Packed cell vol. %	Calcium mg/100ml	Phos-phorus mg/100ml	Glucose mg/100ml	B.U.N. mg/100ml	Uric Acid mg/100ml	Choles-terol mg/100ml	Bili-rubin mg/100ml	Alk. Phos. mg/100ml	L.D.H. mu/100ml	S.G.O.T. mu/100ml
120618	17.5	43.5	10.7	5.9	121.0	7.0	0.2	45.0	0.2	33.0	204.0	56.0
120620	17.0	42.8	10.1	5.4	112.0	8.0	0.2	62.0	0.2	41.0	189.0	86.0
120621	18.0	44.3	10.3	5.3	117.0	5.0	0.3	110.0	0.2	104.0	216.0	66.0
120623	18.0	41.0	8.5	5.0	122.0	8.0	0.2	42.0	0.2	21.0	183.0	48.0
120624	17.0	42.8	10.4	5.4	131.0	4.0	0.2	54.0	0.2	43.0	166.0	49.0
120625	15.5	22.3	10.0	5.2	136.0	3.0	0.1	59.0	0.2	33.0	164.0	59.0
120636			10.1	5.3	152.0	5.0	0.3	40.0	0.2	57.0	180.0	40.0
120637			10.2	5.2	128.0	6.0	0.5	62.0	0.2	97.0	190.0	54.0
120638			11.2	6.0	154.0	8.0	0.2	53.0	0.2	42.0	222.0	54.0
120639			10.2	7.3	121.0	6.0	0.3	56.0	0.1	30.0	207.0	69.0
120640			10.3	6.3	137.0	6.0	0.2	43.0	0.1	41.0	153.0	41.0
120645	17.0	44.0	10.5	4.1	105.0	4.0	0.5	54.0	0.2		229.0	85.0
120646	17.0	44.0	10.4	5.6	102.0	7.0	0.3	68.0	0.2	75.0	197.0	55.0
120647	16.5	42.0	10.8	5.3	111.0	6.0	0.3	61.0	0.2	46.0	215.0	51.0
120648	19.5	48.0	10.5	2.1	147.0	2.0	0.4	52.0	0.2	66.0	278.0	94.0
120649	16.2	42.0										
120650	17.4	47.0	10.4	5.8	130.0	5.0	0.2	55.0	0.1	58.0	273.0	54.0
120651	16.1	42.0	10.5	4.3	116.0	4.0	0.2	71.0	0.2	36.0	262.0	57.0
120652	18.0	47.0	10.2	2.1	160.0	2.0	0.2	53.0	0.1	82.0	181.0	46.0
120653	19.0	48.0	9.7	2.3	119.0	5.0	0.3	63.0	0.3	68.0	216.0	63.0
120654	16.5	41.0	10.5	4.5	143.0	4.0	0.2	49.0	0.1	42.0	199.0	51.0
120655	17.5	42.0	10.4	4.8	102.0	3.0	0.2	62.0	0.1	40.0	201.0	53.0
120656	17.0	45.0	10.0	3.9	121.0	3.0	0.3	71.0	0.3	56.0	219.0	78.0
n	18	18	22	22	22	22	22	22	22	21	22	22
$\bar{x}$	17.26	42.71	10.27	4.87	126.68	5.05	0.26	58.41	0.18	52.90	206.55	59.50
S.D.	1.00	5.58	0.50	1.33	16.81	1.86	0.10	14.49	0.06	22.13	32.91	14.63

Table 6B (cont.). Blood values from adult female moose radio-collared upstream from Watana dam site, April 1980.

Accession Number	Total Protein SMAK test g/100ml	Albumin SMAK Test g/100ml	(Electro-phoresis) Albumin g/100ml	Globulin g/100ml	Alpha 1 g/100ml	Alpha 2 g/100ml	Beta g/100ml	Gamma g/100ml	A/G Ratio
120618	7.1	4.0	5.2	1.9	0.6		0.4	0.8	2.8
120620	7.1	3.9	5.0	2.1	0.6		0.6	0.9	2.3
120621	7.0	4.0	5.0	2.0	0.5	0.4	0.5	0.7	2.4
120623	5.2	3.0	3.9	1.3	0.2	0.3	0.3	0.5	3.1
120624	7.8	3.8	5.1	2.7	0.6		0.6	1.5	1.9
120625	6.7	3.6	4.5	2.2	0.3	0.4	0.4	1.1	2.1
120636	6.6	3.6	4.6	2.0	0.5		0.5	0.9	2.4
120637	6.8	4.0	5.1	1.7	0.6		0.5	0.7	2.9
120638	7.9	4.1	5.2	2.7	0.2	0.4	0.6	1.4	2.0
120639	6.7	3.8	5.1	1.8	0.3	0.4	0.5	0.6	2.9
120640	6.6	3.7	4.8	1.8	0.2	0.3	0.4	0.5	2.7
120645	6.9	3.6	4.7	2.2	0.7		0.5	1.1	2.1
120646	7.0	3.7	4.8	2.2	0.8		0.5	0.9	2.2
120647	7.0	3.8	4.9	2.1	0.6		0.4	1.1	2.3
120648	6.9	4.0	4.9	2.0		0.7	0.5	0.7	2.4
120649									
120650	6.6	4.0	5.0	1.6	0.6		0.4	0.6	3.1
120651	6.7	3.6	4.5	2.2	0.3	0.4	0.4	1.1	2.0
120652	7.0	3.9	5.2	1.8	0.6		0.4	0.8	2.8
120653	6.9	3.8	5.0	1.9	0.6		0.4	0.9	2.7
120654	6.7	3.9	4.9	1.8	0.3	0.4	0.4	0.7	2.8
120655	6.7	3.7	4.5	2.2	0.3	0.4	0.5	1.0	2.0
120656	7.1	3.8	4.8	2.3	0.2	0.6	0.4	1.1	2.1
$\underline{n}$	22	22	22	22	21	11	22	22	22
$\bar{x}$	6.86	3.79	4.85	2.02	0.46	0.43	0.46	0.89	2.45
S.D.	0.50	0.23	0.31	0.32	0.19	0.12	0.08	0.27	0.39

Table 7. Blood values from adult cow moose sampled in spring, 1981 in the Susitna River Study Area of southcentral Alaska.

Accession Number	Hemo-globin g/100ml	Packed cell vol. %	Calcium mg/100ml	Phos-phorus mg/100ml	Glucose mg/100ml	BUN mg/100ml	Uric acid mg/100ml	Choles-terol mg/100ml	Bili-rubin mg/100ml	Alk. Phos. mg/100ml	L.D.H. mu/100ml	S.G.O.T. mu/100ml	Age (months)
120662	20.0	50	10.5	4.5	118	3	0.4	76	0.2	73	210	51	96
120663	18.5	48	10.6	5.1	136	2	0.4	74	0.2	76	167	48	96
120666	15.5	37											105
120668	16.0	39	10.2	6.6	130	3	0.4	57	0.1	73	185	58	94
120671	17.0	41	10.4	6.8	110	1	0.3	76	0.1	80	277	63	46
120673	19.0	47	11.1	5.1	109	4	0.3	84	0.2	70	257	75	Adult
120680	20.0	48	10.9	5.5	134	3	0.2	71	0.2	54	299	66	22
120683	16.4	42	11.5	3.8	176	4	0.3	87	0.1	63	221	72	106
120687	15.6	37	10.0	5.1	114	2	0.4	57	0.1	35	183	71	31
120688	19.2	47	11.2	5.4	127	2	0.4	82	0.2	78	193	52	Adult
120691	19.5	45	10.6	4.2	117	3	0.6	131	0.2	39	282	T a/	106
120692	17.5	45	9.4	5.2	173	4	0.3	56	0.1	62	142	50	106
120694	19.5	47											154
120695			10.3	5.1	83	4	0.2	62	0.1	31	203	48	Adult
n	13	13	12	12	12	12	12	12	12	12	12	11	
$\bar{x}$	17.98	44.08	10.56	5.20	116.53	2.92	0.35	76.08	0.15	61.17	218.25	59.45	
SD	1.71	4.41	0.57	0.86	44.75	1.00	0.11	20.43	0.50	17.47	49.47	10.34	

a/ T = trace; not included for computations

Table 7. (cont.d)

Accession Number	Total Protein SMAC test g/100mg	Albumin SMAK test g/100ml	(Electro-phoresis) Albumin g/100ml	Albumin g/100ml	Globulin g/100ml	Alpha 1 g/100ml	Alpha 2 g/100ml	Beta g/100ml	Gamma A/G Ratio	Age (months)
120662	7.1	4.2	4.9		2.2	6.3	0.4	0.4	2.2	96
120663	7.2	4.0	5.0		2.2	0.2	0.4	0.4	2.2	96
120666			4.5		2.0	0.4	0.3	0.5	2.2	105
120668	6.2	4.1	4.9		2.7	0.2	0.3	0.4	3.0	94
120671	6.3	3.9	4.7		1.6	0.3	0.4	0.3	3.0	46
120673	7.4	4.4	5.2		2.2	0.3	0.5	0.5	2.4	Adult
120680	6.6	4.2	5.0		1.6	0.2	0.4	0.3	3.0	22
120683	7.0	3.9	4.9		2.1	0.2	0.3	0.6	2.4	106
120687	6.1	3.5	4.4		1.7	0.2	0.2	0.3	2.6	31
120688	6.7	4.0	4.9		1.8	0.2	0.4	0.4	2.8	Adult
120691	6.9	4.7	4.0		2.9	0.1	1.7	0.4	1.4	106
120692	6.1	3.7	4.3		1.8	0.2	0.3	0.4	2.4	106
120695	6.3	3.7	4.5		1.8	0.1	0.3	0.5	2.4	Adult
n	12	12	13		13	13	13	13	13	
$\bar{x}$	6.66	4.03	4.71		2.05	0.68	0.45	0.42	2.46	
SD	0.46	0.33	0.34		0.40	1.69	0.38	0.09	0.44	

Table 8. 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 13 (Mar. 1981) 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)	10.56	0.57(12)	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)	5.20	0.86(12)	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)	116.5	44.8(12)	109.9	16.3(18)
Total Protein g/dl	7.07	0.57(45)	7.14	0.63(54)	7.43	0.40(61)	6.70	0.83(30)	6.66	0.46(12)	7.20	0.54(18)
Albumin g/dl	3.82	0.39(45)	-	-	5.21	0.39(61)	4.21	0.51(30)	4.03	0.33(12)	4.80	0.41(18)
Beta globulin g/dl	0.72	0.09(45)	-	-	0.60	0.11(61)	0.55	0.12(30)	0.42	0.09(13)	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)	18.0	1.7(13)	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)	44.1	4.4(13)	43.4	2.8(19)
Total Length (females) cm	301.5	81.0(23)	288.5	18.0(38)	295.6	10.9(115)	288.5	15.3(210)	291.0	13.0(13)	-	-
Chest Girth (females) cm	201.3	13.8(25)	195.4	12.7(34)	191.3	14.3(105)	182.2	16.3(194)	203.2	16.3(11)	-	-
Hind Foot (females) cm	81.5	1.8(16)	-	-	80.0	2.9(79)	79.9	3.8(203)	84.2	7.1(11)	-	-
Shoulder Height (females) cm	-	-	-	-	185.5	11.1(7)	174.9	14.1(65)	-	-	-	-

Table 8. (cont'd)

Blood Values	GMU 13 Susitna Study Area (Apr. 1980) Mean	SD	Yakutat (Mar. 1980) 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	10.24	0.47(33)	10.98	0.57(41	9.52	(1.14(13)	9.81	0.64(39)	10.80	0.43(57)
Phosphorus mg/dl	5.17	1.26(33)	3.71	1.06(41)	4.90	0.84(13)	3.90	1.09(39)	4.35	0.86(57)
Glucose mg/dl	128.36	20.74(33)	143.8	23.1(41)	107.9	21.0(13)	116.2	26.1(39)	158.1	22.2(57)
Total Protein g/dl	6.88	0.50(33)	7.45	0.43(41)	5.65	0.60(13)	6.60	0.44(39)	7.79	0.43(57)
Albumin g/dl	4.85	0.31(33)	5.38	0.30(41)	-	-	3.76	0.46(39)	5.05	0.28(57)
Beta globulin g/dl	0.48	0.27(33)	0.62	0.09(41	-	-	0.58	0.10(39)	0.74	0.11(57)
Hemoglobin g/dl	17.55	1.45(30)	16.7	1.3(42)	16.9	1.5(11)	15.9	2.2(39)	16.4	1.3(54)
PCV %	42.77	5.22(30)	40.6	3.6(42)	40.6	3.6(11)	39.9	4.6(39)	39.0	5.4(56)
Total Length cm	288.5	15.3(34)	289.2	13.0(39)	286.0	17.5(13)	282.6	9.1(254)	302.1	6.8(54)
Heart Girth cm	200.3	17.2(33)	202.6	12.2(39)	188.1	14.2(13)	179.5	11.1(252)	201.1	12.2(53)
Hind Foot cm	80.9	4.4(31)	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	-	-

(1978) believed was the most useful parameter for assessing condition class. They believed the following blood 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. Seven of eight of these values in 1980 and six of eight in 1981 were below these desirable levels. Mean PCV and Hb values from each sampling period were compared by t test. PCV values for 1980 Susitna moose were significantly different ($P<0.05$) from those obtained at the Copper River Delta, GMU 13 in 1975 and 1977, GMU 15C, GMU 5, the Moose Research Center and GMU 9. No significant differences ($P>0.05$) were detected between 1980 PCV values and those found in GMU 13 in 1979, when moose were nutritionally stressed due to winter severity, and for GMU 14C. Similar differences and similarities were detected for Hb values. PCV values obtained in 1981 were not significantly ($P>0.05$) different from those in 1980 nor those found in GMU 15C and GMU 14C. All other PCV samples were significantly different ($P<0.05$) from those obtained in GMU 13 in 1981.

Blood and morphometic values from calves sampled in March 1981 (Table 9) were compared with calves sampled in another area of Unit 13 during March 1979 (Table 10). The comparison suggests that March 1981 calves were in better physiological condition and perhaps larger than those sampled in March 1979. Winter 1978-79 was the second most severe winter recorded in the Nelchina Basin in terms of total snowfall whereas winter 1980-81 was relatively mild. Therefore, we would have anticipated that the calves sampled in 1981 would be in better condition than those sampled in 1979. The apparent differences in size were not anticipated, however, and could be related either to differences between areas or perhaps differences in food availability related to snow conditions.

Previous studies of moose condition in 1975 and 1977 in GMU 13 had suggested that moose were in relatively good physical con-

Table 9. Selected blood and morphometric values of calf moose captured in March and May 1981 in the Susitna River Study Area of southcentral Alaska.

Moose ID #	Blood Values Hb	PCV	Ca	P	TP(SMAC)	Morphometric Values TL cm	CG cm	HF cm
120669	18.0	43	10.3	4.7	6.0	205.5	154.0	69.0
120670	20.0	44	9.5	5.8	3.8	229.2	172.7	73.0
120674						229.9	175.3	73.7
120675	17.5	40	10.7	5.6	5.9	218.4	167.6	74.9
120676	20.0	50	11.2	5.8	6.6			
120677						203.2		
120678	16.5	33	10.4		5.9			
120679			9.0	3.2	5.7			
120681	17.0	43	10.7	7.2	6.3	209.0		72.0
120685	20.0	46	10.4	7.8	5.9	199.4		71.1
120686	19.7	47	10.5	4.2	5.9	223.5	152.4	69.8
120689	19.0	40	10.9	6.5	5.9	218.5	160.0	70.2
120690	20.0	46	11.3	7.0	6.4	208.0	162.6	65.0
120693	17.5	45	10.8	6.2	6.1	228.0	160.0	67.3
120696			10.0	5.3	5.2	223.0	--	75.0
x	18.65	43.36	10.44	5.78	5.82	216.3	163.1	71.0
SD	1.38	4.52	0.64	1.31	0.70	10.83	8.26	3.15
n	11	11	13	12	13	12	8	11

Table 10. Comparison of selected blood and morphometric values for calf moose sampled in two areas of Game Management Unit 13 of southcentral Alaska during March 1979 and 1981.

Year	% Hemoglobin			Packed Cell Volume			Total Protein			Total length (cm)			Chest girth (cm)			Hind foot (cm)			Neck circumference (cm)			Head length		
	n	x	S.D.	n	x	S.D.	n	x	S.D.	n	x	S.D.	n	x	S.D.	n	x	S.D.	n	x	S.D.	n	x	S.D.
1979	60	16.2	1.7	61	36.7	4.2	61	5.0	.7	48	207.1	9.9	40	138.9	11.7	57	73.8	3.2	38	59.2	4.4	48	54.6	2.6
1981	11	18.7	1.4	11	43.4	4.5	13	5.8	.7	12	216.3	10.8	8	163.1	8.3	11	71.0	3.2	6	65.1	4.1	9	55.6	2.5
test of significance		<0.001			<0.001			<0.001			<0.025			<0.001			<0.025			<.025			<0.05	

dition compared to moose populations elsewhere suggesting at the that time that deteriorating range conditions were not yet a problem (Ballard and Taylor 1980). Recent blood data suggests that the physical condition of moose has deteriorated to some degree since that time. It is generally accepted that good moose habitat is closely linked with the frequency of wild fire. Since there have not been any sizable wildfires in GMU 13 for at least 30 to 35 years (op. cit.), a gradual deterioration in habitat quality could be anticipated. However, even though the quality or condition of moose habitat may be gradually deteriorating, available evidence suggests that the population is not yet at carrying capacity.

Wolf and Cowling (1981) reported an average moose browsing intensity of 65 percent in nearby Mount McKinley National Park. Browsing intensity ranged from 35 to 86 percent. Although no formal browsing studies have been conducted in GMU 13 casual observations along the Susitna River and elsewhere in the unit suggest that the intensity may be similar to that in the Park. However, even at the heavy level of browsing, the McKinley moose herd does not appear to be limited by range conditions but instead appears to be limited by predation (op. cit.). They speculated that the McKinley herd could increase an additional 10-15 percent before reaching carrying capacity. We suggest that moose in GMU 13 are also below range carrying capacity as evidenced by moose population increases following reductions in predator densities.

Studies of moose calf mortality in the upper Susitna River Basin above the Denali Highway had suggested that predation by bears was responsible for 79 percent of the early calf losses (Ballard et al 1981). A bear reduction program reduced early neonatal losses from an estimated 55 percent to an estimated 9 percent. (Ballard et al. in press). If the available moose range was at carrying capacity, we would have expected a significant number of calves to have died from starvation during the first winter following the bear reduction program. Such was not the case, as first and 2nd year winter mortality was only 6 and 4 percent, respectively (op. cit.). We infer from this high rate of survival that the population is not limited, at least on a short term basis, by range conditions. The bear reduction program alone may have allowed the population to increase by as much as 19 percent. In summary then it appears that although blood data suggest that range quality in the Susitna study area has deteriorated to an undetermined degree, other evidence suggests that the range could support a larger number of moose.

Movements

Between October 1976 and mid-August 1981, over 2700 locations were obtained on 207 moose of both sexes and all age classes for movement and mortality studies in the Susitna and Nelchina River Basins. Only seventy-five of these were captured specifically for Susitna Hydroelectric studies during 1980 and 1981, but many of the other moose provided pertinent information. An average of 13.1 and 11.0 radio locations per moose were obtained in 1980 and 1981, respectively, for the 75 moose.

Seasonal movements and general areas occupied by individual radio-collared moose by month of observation from October 1976 through mid-August 1981 are presented in Appendix A. Location and degree of overlap of radio-collared moose home ranges are depicted in Figs. 9 and 10. The radio-collared moose exhibited all of the types of movements described by LeResche (1974) for moose in North America. For purposes of this report, however, they could basically be divided into two groups: sedentary and migratory. A sedentary moose is defined as one which has confined its movements to a relatively small area and where portions of the summer and winter range overlap. A migratory moose on the other hand is defined as one with a relatively large home range with nonoverlapping summer and winter home ranges. The latter type of moose often moves from 16 to 93 km between seasonal home ranges. Both movement types often involve seasonal changes in elevation.

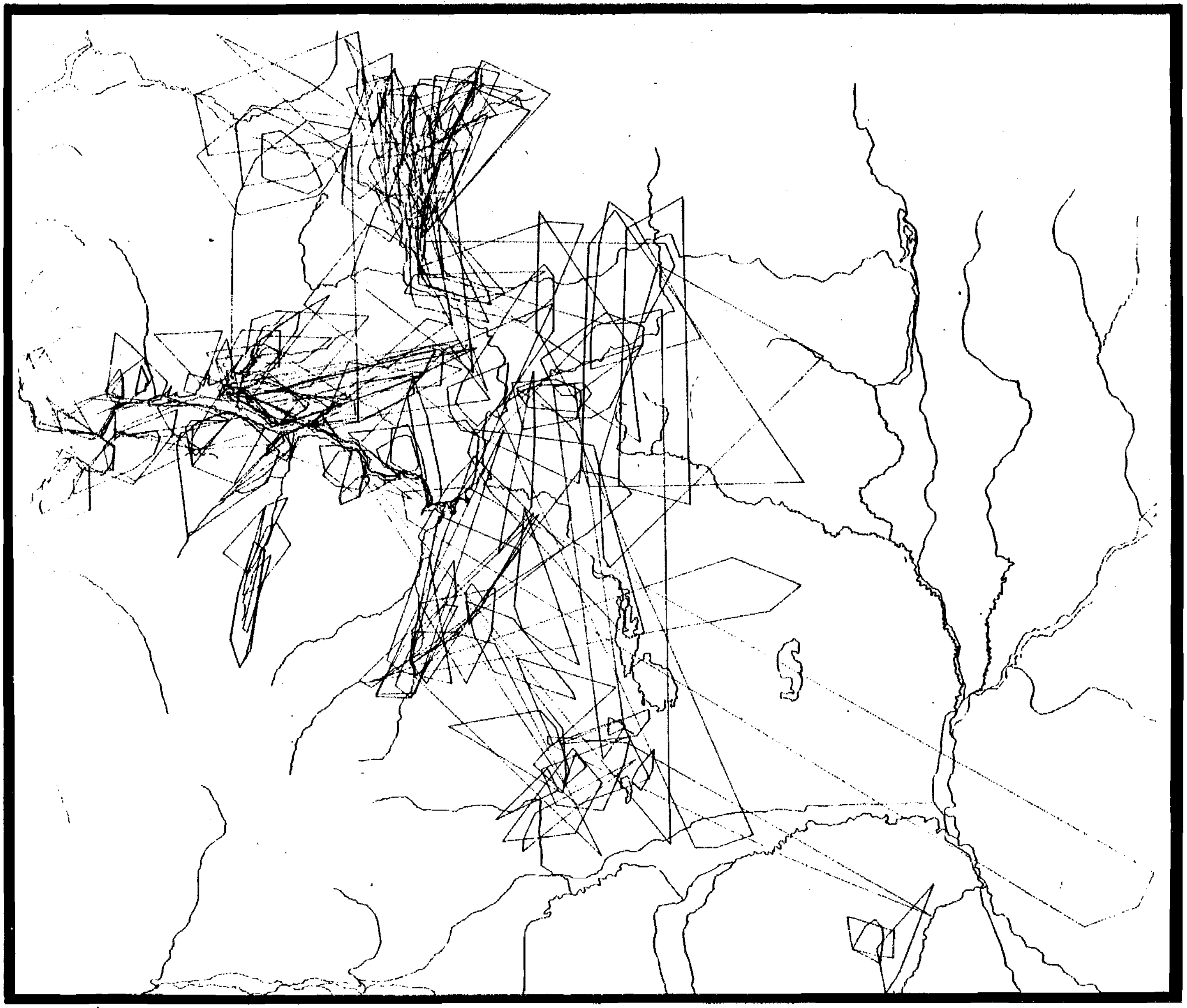


Figure 9. General location of home ranges of radio-collared moose studied from October 1976 through mid-August 1981 in the Nelchina and upper Susitna River Basins of Southcentral Alaska. (scale: 1 cm = 12500 meters)

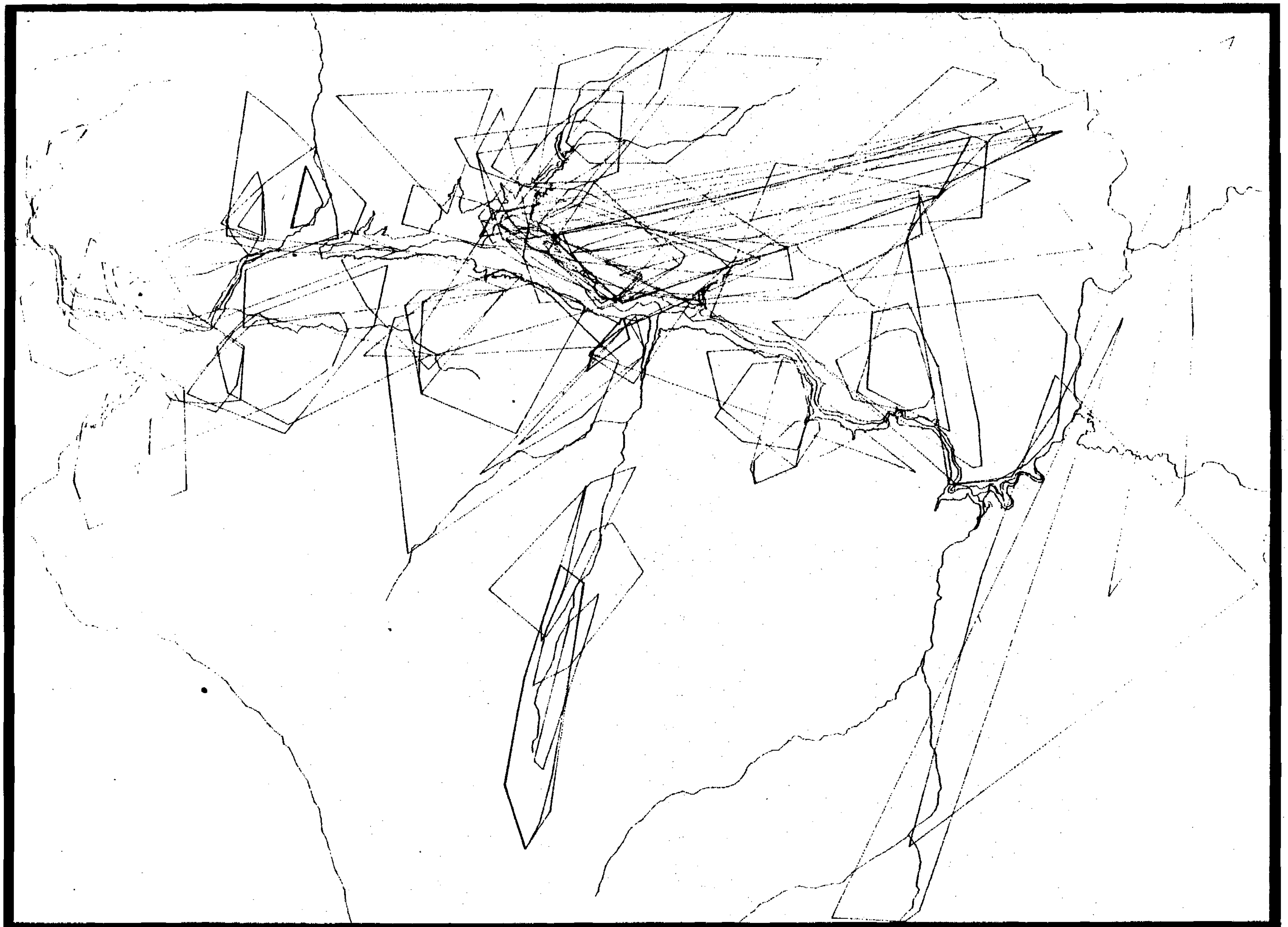


Figure 10. General location of selected home ranges of radio-collared moose studied for Susitna Hydroelectric studies from October 1976 through mid-August 1981 in the upper Susitna River Basin of Southcentral Alaska. (scale: 1 cm = 5000 meters)

In earlier moose movement studies (Ballard and Taylor 1980; Ballard et al. 1981) it was suggested that most of the migratory moose were distributed from Jay Creek and eastward. Additional information collected in 1981 suggest that a large number of migratory moose occur in the Watana Creek area as well.

Movement patterns of most moose examined from 1976 through 1981 appeared to approximate the drainage pattern of creeks and tributaries of the main stem rivers. Consequently, most movements in the upper Susitna involve a north-south movement pattern. General movement and migration patterns are depicted in Fig. 11.

Elevation, slope and aspect usage by moose

Average monthly elevations at which radio-collared moose were located from October 1976 through mid-August 1981 are summarized in Table 11. Generally, moose occupied relatively low elevations ($\bar{x}$=2577 ft. for April, and 2641 ft. for May) during late spring and early summer. As summer progressed, moose generally moved to higher elevations with the highest average elevation occurring in December ($\bar{x}$=2955 ft.). Statistical comparisons suggest that many of the average monthly values were quite similar but there were significant differences ($P<0.10$) between winter and summer elevations. In earlier studies of moose movements in Unit 13 both Van Ballenberghe (1978) and Ballard and Taylor (1980) described the altitudinal movements of moose as follows: "during summer these moose occupied areas at about 2500-3000 ft (762-914m) elevation, and during winter habitat types at the 1800-2200 ft (548-671m) elevation were utilized." The analyses provided in Table 11 do not fit this pattern. Summer elevational use appears to be quite similar but winter elevational use during this study was not. Mean monthly elevations from December through March ranged from 2685 ft through 2954 ft which were considerably higher than the 1800-2200 ft. elevations reported earlier. Although portions of the data used for this analysis were derived from the earlier movement studies reported by Ballard and Taylor (1980) over half of the locations were obtained during 1980 and

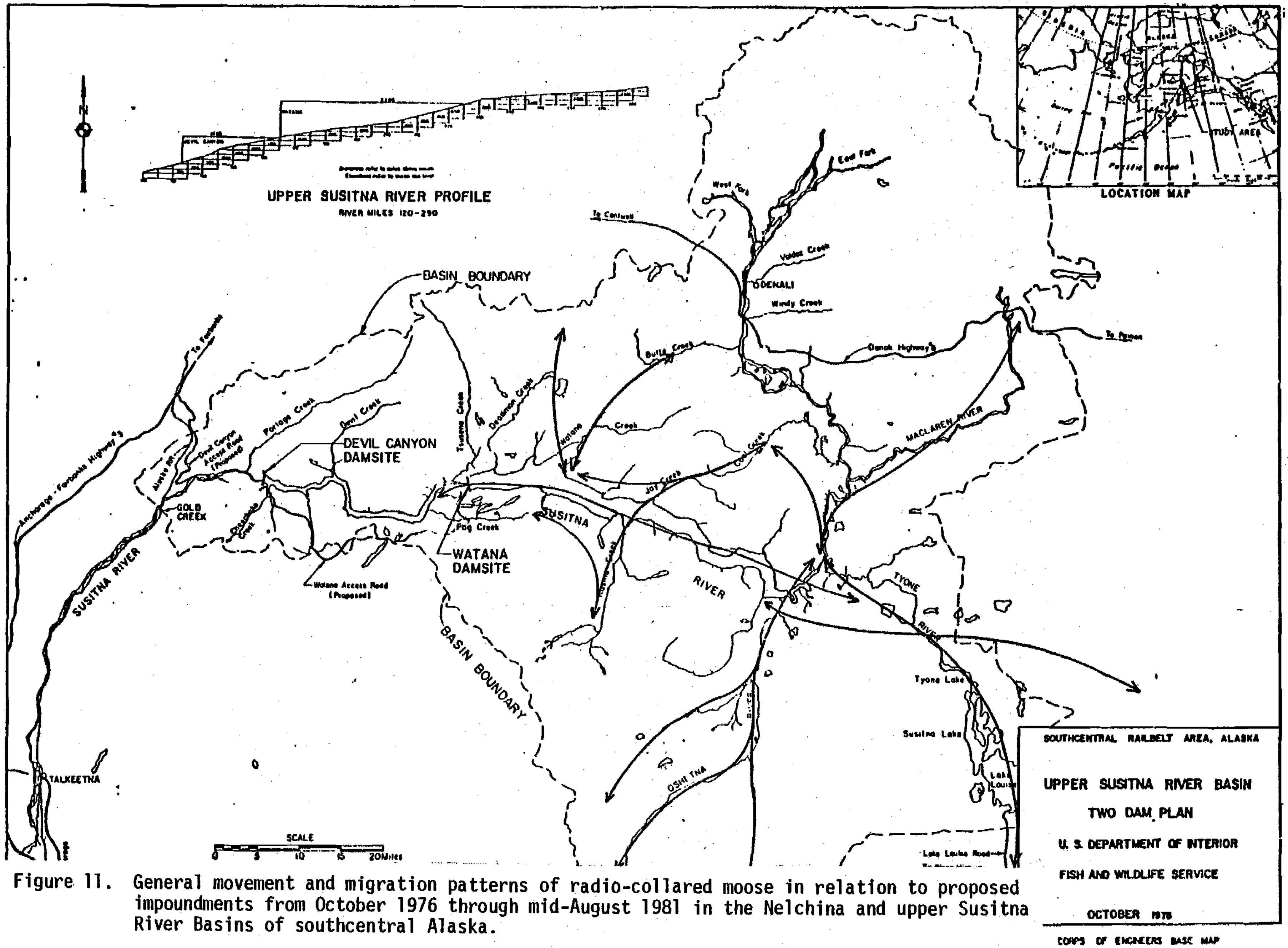


Figure 11. General movement and migration patterns of radio-collared moose in relation to proposed impoundments from October 1976 through mid-August 1981 in the Nelchina and upper Susitna River Basins of southcentral Alaska.

Table 11. Summary of elevational use by approximately 200 radio-collared moose (both sexes and all age classes) from October 1976 through mid-August 1981 in the upper Susitna and Nelchina River Basins of southcentral Alaska.

Tests of significance 1/ (P<0.10)													
Month	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Mean elevation	2800	2736	2686	2577	2641	2690	2755	2790	2745	2997	2953	2955	2749
Standard deviation	461.8	468.0	442.4	461.9	449.0	426.6	531.2	509.6	451.8	488.6	480.4	475.7	
Sample size	66	98	285	204	341	424	218	174	130	193	168	116	2417
Range of elevations													
Min.	1800	1400	1700	1500	1400	1300	–	1800	1800	1400	1450	1600	
Max.	3900	3900	4600	4100	3800	4400	4200	4800	4000	4200	4400	4600	

1/ Values which are underlined were not significantly different (P<0.10) (from Scheffe).

1981. From October 1976 through mid-August 1981 winter severity in terms of total snow depths was relatively mild for the winters of 1976-77, 1977-78, 1979-80 and 1980-81. Only the winter of 1978-79 was considered severe (Eide and Ballard in press). Because funding was not available to adequately monitor Susitna moose during winter 1978-79 only a few radio-locations were obtained. Therefore, the data summary primarily represents the altitudinal movements of moose during relatively mild winters.

We suspect that high winds and temperature inversions reduced snow depths at higher elevations making winter food more available at higher rather than at lower elevations. Consequently, moose were not forced to concentrate on lower winter range as they would when upland snow depths become excessive. Therefore, moose movement and concentration patterns exhibited during this study only reflect those of mild winters and thus the use and importance of areas to be inundated by the project are probably not adequately addressed from the data available.

The slope of the general area occupied by each radio-collared moose was classified from topographic maps. Slopes were classified into four broad categories: flat - 0 to 10°; gentle - 11 to 30°, moderate - 31 to 60°, and steep - 61 to 90°. During both summer and winter, which for this analysis are defined as May through August and November through April, respectively, both flat and gentle slopes accounted for 91 percent of the usage. Moderate and steep slopes accounted for only 9 percent of the total observations.

General aspect of each radio-collared moose observation were also classified from topographic maps. Aspect was classified into 10 categories, eight of which comprised the axes of the compass. The remaining two classifications were flat and gully. A summary of all observations is presented in Table 12. Gross examination suggests that no single aspect was strongly selected by moose. However, overall, flat, gully and southerly exposures comprised 54 percent of the observations during winter while during summer

Table 12. Summary of aspect usage by radio-collared moose of both sexes and all age classes as determined from topographic maps from October 1976 through mid-August 1981 in the Nelchina and upper Susitna River Basins of southcentral Alaska.

Aspect	Winter #	Winter %	Summer #	Summer %	Total	%
Flat	190	16.7	212	13.2	402	14.7
Gully	56	4.9	98	6.1	154	5.6
North	119	10.5	214	13.3	333	12.1
Northeast	97	8.6	122	7.6	219	8.0
East	121	10.7	170	10.6	291	10.6
Southeast	126	11.1	174	10.8	300	10.9
South	151	13.3	174	10.8	325	11.9
Southwest	88	7.8	113	7.0	201	7.3
West	90	7.9	129	8.0	219	8.0
Northwest	97	8.6	201	12.5	298	10.9
Totals	1135	100.0	1607	99.9	2742	100.0

they comprised 48 percent of the observations. There also appeared to be a slight increase in the use of northern exposures during summer (28 percent in winter versus 33 percent in summer). However, these analyses have not been statistically tested and should only be considered tentative. Because not all moose were located at the same frequency throughout the year a more in depth analysis of individual moose in relation to the impoundments is necessary.

Habitat Usage

Table 13 summarizes habitat use of radio-collared moose as observed from fixed-wing aircraft from October 1976 through mid-August 1981. Year-round, spruce habitats comprised the most frequently used habitats with sparce and medium density, medium height black spruce comprising 35 percent of the total observations. This was not particularly surprising since the classification system was based on overstory vegetation and the "spruce-moose" association is well recognized. However, for the Basin in general conifer forests cover only 19 percent of the area (Univ. of Alaska, Palmer Agricultural Experiment Stat. 1981). Shrubland, however, comprised 40 percent of the area (op. cit.). The two types combined comprise 59 percent of the total area in the Basin but receive over 90 percent year-round use by moose according to aerial classification.

Vegetation studies (Univ. of Alaska, Palmer Ag. Exp. Sta., 1981) also suggested that spruce and more specifically black spruce stands received heavy usage by moose. For example, they suggested that "among black spruce stands, those occupying significant slopes (8-10°) appeared to be more productive of browse species, and in fact, had noticeably greater use by moose." They also suggested that browse production was lower in these stands relative to other vegetation, but that they had received heavy use, suggesting that such stands may be important for cover during severe winters. Observations of radio-collared moose during relatively mild weather suggested that spruce habitat

Table 13. Monthly use of habitat types by radio-collared moose of both sexes and all ages as determined from fixed-wing aircraft from 1977 through mid-August 1981 in the Nelchina and upper Susitna River Basins.

Vegetation Classification	Jan. #	Jan. %	Feb. #	Feb. %	Mar. #	Mar. %	Apr. #	Apr. %	May #	May %	June #	June %	July #	July %	Aug. #	Aug. %	Sept. #	Sept. %	Oct. #	Oct. %	Nov. #	Nov. %	Dec. #	Dec. %	Total #	Total %
Birch	0	0	0	0	0	0	0	0	.2	7	.1	.3	1	.6	0	0	0	0	0	0	0	0	0	0	4	.2
unidentified hardwood	0	0	0	0	0	0	0	0	0	0	1	.3	0	0	0	0	0	0	0	0	1	1.1	1	1.1	3	.2
dense medium height bl. spruce	2	4.8	2	3.3	0	0	8	6.7	12	4.4	21	6.8	10	5.9	10	7.4	9	7.8	4	3.0	2	2.2	1	1.1	81	4.6
dense medium height white spruce	0	0	0	0	0	0	3	2.5	2	.7	0	0	0	0	0	0	1	.9	2	1.5	1	1.1	0	0	9	.5
dense short bl. spruce	2	4.8	1	1.7	1	.5	2	1.7	6	2.2	5	1.6	0	0	1	.7	5	4.3	1	.7	2	2.2	1	1.1	27	1.5
dense tall bl. spruce	0	0	0	0	1	.5	1	.8	0	0	0	0	4	2.4	0	0	0	0	0	0	0	0	1	1.1	7	.4
dense tall white spruce	1	2.4	6	10.0	7	3.4	4	3.4	9	3.3	8	2.6	2	1.2	0	0	2	1.7	2	1.5	2	2.2	4	4.3	47	2.7
Alder	0	0	0	0	0	0	0	0	0	0	0	0	2	1.2	2	1.5	0	0	0	0	0	0	0	0	4	.2
dense medium height bl. spruce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.5	0	0	0	0	0	0	0	0	2	.1
medium dense medium height bl. spruce	4	9.5	17	28.3	57	27.8	38	31.9	84	31.0	59	19.1	36	21.3	23	16.9	27	23.3	18	13.3	13	14.1	17	18.3	393	22.5
medium dense short spruce	6	14.3	2	3.3	21	10.2	7	5.9	15	5.5	29	9.4	9	5.3	11	8.1	8	6.9	2	1.5	2	2.2	2	2.2	114	6.5

Table 13. (cont.d).

Vegetation Classification	Jan. #	Jan. %	Feb. #	Feb. %	Mar. #	Mar. %	Apr. #	Apr. %	May #	May %	June #	June %	July #	July %	Aug. #	Aug. %	Sept. #	Sept. %	Oct. #	Oct. %	Nov. #	Nov. %	Dec. #	Dec. %	Row Total #	Row Total %
medium dense tall spruce	0	0	0	0	1	.5	3	2.5	3	1.1	2	.6	5	3.0	4	2.9	0	0	0	0	0	0	1	1.1	19	1.1
medium dense tall wh. spruce	2	4.8	5	8.3	5	2.4	9	7.6	14	15.2	18	5.8	4	2.4	11	8.1	7	6.0	10	7.4	3	3.3	4	4.3	92	5.3
upland brush and willow	14	33.3	18	30.0	34	16.6	12	10.1	44	16.2	72	23.3	53	31.4	32	23.5	29	25.0	58	43.0	35	38.0	40	43.0	441	25.2
sparse dense medium spruce	8	19.0	6	10.0	58	28.3	24	20.2	56	20.7	57	18.4	21	12.4	17	12.5	14	12.1	24	17.8	19	20.7	11	11.8	315	18.0
sparse short spruce	2	4.8	1	1.7	13	6.3	3	2.5	14	5.2	22	7.1	17	10.1	6	4.4	9	7.8	2	1.5	7	7.6	8	8.6	104	6.0
sparse tall spruce	1	2.4	0	0	1	.5	0	0	4	1.5	0	0	5	3.0	4	2.9	1	.9	0	0	2	2.2	0	0	18	1.0
sparse tall white spruce	0	0	2	3.3	6	2.9	5	4.2	6	2.2	14	4.5	0	0	13	9.6	4	3.4	12	8.9	3	3.3	2	2.2	67	3.8
Column total	42	2.4	60	3.4	205	11.7	119	6.8	271	15.5	309	17.7	167	9.7	136	7.8	116	6.6	135	7.7	92	5.3	93	5.3	1747	100.0

types were used heavily and that 48 percent of all observations occurred on slopes from 1 to 10°.

Use of upland brush-willow habitat types corresponded with observed elevational movements of moose. Use of this habitat type was at its lowest during the month of April when moose were at relatively low elevations just prior to calving. Use gradually increased through summer reaching a plateau of 43 percent in October and remaining at a relatively high use percentage through February. As mentioned earlier we suspected the use of relatively high elevations from late fall through winter was the result of mild winters which allowed these habitat types to be available.

During calving in May, sparse and medium dense, medium height spruce habitats were utilized by moose. We suspect these lower elevational types are selected by cow moose because of both escape cover and earlier green up of foliage. Several habitat types such as birch, alder, and several spruce types did not appear to be selected by moose (Table 14) according to aerial observation. However, ground observers (U. of Ak., Pal. Exp. Sta. 1981) suggested that both birch and alder stands appeared to receive at least some use and some stands were heavily used by moose.

Plans were developed to overlap existing radio-location data over the 1:63,360 scale vegetation maps provided by the Palmer Agricultural Experiment Station. This approach was to be investigated on an experimental basis (Miller and Anctil 1981). At the time this report was prepared data forms were being keypunched and therefore the analysis was not available. Even when the analysis is complete, however, it may do little to explain moose usage of the described habitat types.

Some of the potential problems envisioned with this approach have already been described (Miller and Anctil 1981). One major problem is that of utilizing overstory vegetation to classify habi-

Table 14. Summary of Susitna River Crossings and calf production and mortality of 75 radio-collared moose studied from 11 April 1980 through December 1981 in the Upper Susitna River Basin of Southcentral Alaska.

Moose #	Sex-Age	# times located		# occasions crossed Susitna River		Dates of River Crossings		Date 1st observed with calves		# calves observed		Dates when calves last observed		# Calves lost		# Calves surviving		Misc. Notes
		1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	
120617	F-A	20	14	0	0	--	--	0	5/29	0	2	--	5/29	-	1	-	1	
120618	F-A	13	3	0	0	--	--	0	5/29	0	1	--	5/29	-	1	-	0	Dead 7/1/81 Bear pred.
120619	F-A	16	14	1	5	5/13-6/4	5/10-6/1 6/1-7/1 10/2-10/27 10/27-11/18 11/18-12/9	0	6/1	0	1	--	7/1	-	1	-	0	
120620	F-A	2	-	-	-	--	--	-	--	-	-	--	--	-	-	-	-	Dead 4/22/80
120621	F-A	1	-	-	-	--	--	-	--	-	-	--	--	-	-	-	-	Lost collar
120622	F-A	18	13	0	0	--	--	0	0	0	0	--	--	-	-	-	-	
120623	F-A	10	4	0	0	--	--	0	<10/7	0	1	--	--	-	0	-	1	
120624	F-A	14	11	0	4	-- 9/16-10/5 10/5-10/28 10/28-11/17	9/9-9/16	5/25	5/29	1	1	6/26		1	7/1	0	0	
120625	F-A	6	-	0	-	--	--	-	-	-	-	--	--	-	-	-	-	Dead 6/26/80 poss. bear pred.
120626	M-A	13	8	0	2	--	7/22-8/17 8/17-9/10	-	-	-	-	--	--	-	-	-	-	Killed '81 hunting season
120627	M-A	12	-	3	-	4/22-5/14 6/26-7/10 7/28-8/1	--	-	-	-	-	--	--	-	-	-	-	Killed '81 hunting season
120628	F-A	16	13	0	1	--	11/18-12/4	5/22	0	2	0	5/22	--	2	-	0	-	
120629	F-A	15	13	0	0	--	--	5/31	0	2	0	5/31	--	2	-	0	-	

Table 14. (Cont.d).

Moose #	Sex-Age	# times located		# occasions crossed Susitna River		Dates of River Crossings		Date 1st observed with calves		# calves observed		Dates when calves last observed		# Calves lost		# Calves surviving		Misc. Notes
		1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	1980	1981	
120630[1]	F-A	13	16	0	0	--	--	6/10	0	2	0	6/10	--	1	-	1	-	
120631	F-A	14	11	0	0	--	--	0	0	0	0	--	--	-	-	-	-	
120632	F-A	12	--	0	-	--	--	-	-	-	-	--	--	-	-	-	-	Lost collar 7/14-8/12/80
120633	F-A	3	--	0	-	--	--	-	-	-	-	--	--	-	-	-	-	Lost collar 4/22-5/13/80
120634	F-A	15	12	0	0	--	--	5/31	5/29	1	2	5/31	5/29	1	1	0	1	
120635	F-A	16	14	1	2	4/22-5/31 9/17-10/2	9/9-9/17	5/31	5/29	2	2	5/31	5/29	2	2	0	0	
120636	F-A	14	12	0	0	--	--	-	5/26	-	1	--	5/26	-	1	-	0	
120637[2]	F-A	16	13	0	0	--	--	5/31	0	2	0	6/26	--	1	-	1	-	
120638	F-A	13	7	0	0	--	--	0	<7/1	0	1	--	7/1	-	1	-	0	Both cow-calf killed by bear
120639	F-A	18	10	0	0	--	--	<7/14	0	1	0	7/14	--	1	-	0	-	
120640[1]	F-C	13	13	0	0	--	--	6/2	<7/1	1	1	--	--	0	0	1	1	
120641[4]	F-A	17	15	0	0	--	--	5/31	6/1	2	1	6/26	6/1	1	1	1	0	
120642	M-A	14	12	0	0	--	--	--	--	-	-	--	--	-	-	-	-	
120643	F-A	18	11	0	0	--	--	--	5/29	-	1	--	5/29	-	1	-	0	
120644	F-A	14	13	0	0	--	--	6/2	0	2	0	6/2	--	2	-	0	-	
120645	F-A	14	13	0	0	--	--	5/25	5/22	2	1	6/6	5/22	2	1	0	0	

Table 14. (Cont.d).

Moose #	Sex-Age	# times located 1980	# times located 1981	# occasions crossed Susitna River 1980	# occasions crossed Susitna River 1981	Dates of River Crossings 1980	Dates of River Crossings 1981	Date 1st observed with calves 1980	Date 1st observed with calves 1981	# calves observed 1980	# calves observed 1981	Dates when calves last observed 1980	Dates when calves last observed 1981	# Calves lost 1980	# Calves lost 1981	# Calves surviving 1980	# Calves surviving 1981	Misc. Notes
120646	F-A	3	--	0	-	--	--	--	--	-	-	-	-	-	-	-	-	dead 5/80 from collaring or wolf pred.
120647	F-A	18	14	2	2	5/25-5/27 5/27-5/31	7/22-8/4 8/4-9/9	--	5/26	-	2	-	5/26	-	1	-	1	
120648	F-A	14	14	0	0	--	--	6/27	5/26	1	1	1	5/26	0	1	1	0	
120649	F-A	14	15	0	0	--	--	5/25	--	1	-	5/25	-	1	-	0	-	
120650	F-A	16	16	0	0	--	--	5/27	--	1	-	-	-	-	-	1	-	
120651	F-A	13	1	0	0	--	--	--	--	-	-	-	-	-	-	-	-	Dead 1/9/81 wolf pred.
120652	F-A	16	14	0	0	--	--	6/2	--	2	-	6/2	-	2	-	0	-	
120653	F-A	14	14	0	0	--	--	5/27	--	2	-	5/27	-	2	-	0	-	
120654	F-A	14	12	0	0	--	--	--	--	-	-	-	-	-	-	-	-	
120655	F-A	14	12	0	2	--	9/8-9/16 9/16-10/28	--	--	-	-	-	-	-	-	-	-	
120656	F-A	16	2	0	0	--	--	6/27	--	2	-	6/27	-	1	-	1	-	
120662	F-A	10	11	0	0	--	--	--	7/28-9/9	-	1	-	-	-	0	-	1	
120663	F-A	10	12	0	0	--	--	--	6/27-7/28	-	1	-	-	-	0	-	1	
120664	F-A	11	1	0	0	--	--	--	--	-	-	-	-	-	-	-	-	
120666	F-A	10		0		--	--	--		-		-	-	-	1	-	-	
120667	M-A	12		0		--	--	--		-		-	-	-	-	-	-	
120668[6]	F-A	13		0		--	--	--		-		-	-	-	1	-	-	

Table 14. (Cont.d).

Moose #	Sex-Age	# times located 1980	1981	# occasions crossed Susitna River 1980	1981	Dates of River Crossings 1980	1981	Date 1st observed with calves 1980	1981	# calves observed 1980	1981	Dates when calves last observed 1980	1981	# Calves lost 1980	1981	# Calves surviving 1980	1981	Misc. Notes
1206696	F-C		12		0		—		—	–		–		–		–		Killed by wolves 12/6/81
120670C	F-C		4		0		—		—	–		–		–		–		lost radio contact 5/22
120671[7]	F-A		11		0		—		—	–		–		–	1	–		
120672[7]	M-C		11		0		—		—	–		–		–		–		
120673[8]	F-A		3		0		—		—	–		–		–		–		lost collar
120674[8]	M-C		12		0		—		—	–		–		–		–		
120675[9]	M-C		13		0		—		—	–		–		–		–		
120676[1]	M-C		13		2		9/16-10/1 10/1-10/27		—	–		–		–		–		
120677[2]	M-C		13		2		8/4-9/10 9/10-10/1		—	–		–		–		–		
120678[3]	F-C		13		0		—		—	–		–		–		–		
120679[4]	F-C		14		0		—		—	–		–		–		–		
120680[10]	F-Y		11		0		—		—	–		–		–		–		
120681[11]	F-C		5		0		—		—	–		–		–		–		
120682	M-A		6		0		—		—	–		–		–		–		
120683[12]	F-A		13		2		4/15-5/26 5/26-6/24		<6/24	1		–		–	1	1		
120684[13]	F-A		13		0		—		—	–		–		–	1	–		
120685[14]	F-C		10		0		—		—	–		–		–		–		
120686[15]	F-C		12		2		7/22-9/9 9/21-10/1		—	–		–		–		–		

Table 14. (Cont.d).

Moose #	Sex-Age	# times located 1980	# times located 1981	# occasions crossed Susitna River 1980	# occasions crossed Susitna River 1981	Dates of River Crossings 1980	Dates of River Crossings 1981	Date 1st observed with calves 1980	Date 1st observed with calves 1981	# calves observed 1980	# calves observed 1981	Dates when calves last observed 1980	Dates when calves last observed 1981	# Calves lost 1980	# Calves lost 1981	# Calves surviving 1980	# Calves surviving 1981	Misc. Notes
120687[16]	F-A		11		0		--		5/26		1		-		0		1	
120688	F-A		12		0		--		--		-		-		-		-	
120689[16]	F-C		11		0		--		--		-		-		-		-	
120690[13]	M-C		11		0		--		--		-		-		-		-	
120691[15]	F-A		12		0		--		--		-		-		-		-	
120692[14]	F-C		11		0		--		6/24		1		-		0		1	
120693[12]	F-C		12		3		4/15-5/26 5/26-6/24 10/1-10/27		--		-		-		-		-	
120694[10]	F-A		13		0		--		--		-		-		-	1	-	
120695[17]	F-A		9		3		7/18-7/28 7/28-9/9 9/17-10/2		--		-		-		-	1	-	
102696[17]	M-C		9		1		7/18-7/22		--		-		-		-		-	
102697	F-A		11		0		--		--		-		-		-		-	

tat when understory is often more important to moose. The upper Susitna and Nelchina Basins contain approximately 24 species of willow (*Salix* sp.). Of this total several appear to be selected by moose while others are avoided. It is often impossible to identify willow on photographs or from aircraft, let alone to separate different species of willow. It is likely that the distribution of these species of willow selected by moose strongly influences seasonal distribution of moose and is important in determining the importance of a particular area of habitat to the moose population. Therefore, the available vegetation maps probably do not reflect the quality of each area as moose habitat, except in a very gross, indirect way. This is not a serious problem for areas where concentrations of moose have been observed. We can infer that these are important. However, it is a problem where only low or moderate moose densities have been observed. Such areas may be high quality moose habitat that might become important under different environmental conditions, such as deeper snow, or at higher moose populations levels. Therefore, the Phase I studies appear inadequate for quantifying the effects of loss of specific habitats on the ability of the area to support moose. They even may not allow a relative ranking of the quality of all habitats for moose.

River Crossings

Between October 1976 and December 1981 33 radio-collared moose crossed the Susitna River a minimum of 73 occasions. General locations of these crossings are depicted in Figure 12. Of the 75 moose captured in 1980 and 1981, 15 crossed the river in the area of the proposed impoundments a minimum of 40 occasions (Table 14).

Of the 40 river crossings by radio-collared moose during 1980 and 1981, all occurred during the months of May through November. Distribution of the crossings was as follows: May - 20.0%, June - 7.5%, July - 12.5%, August - 12.5%, September - 25%, October - 12.5%, and November - 10%. These observations generally corres-

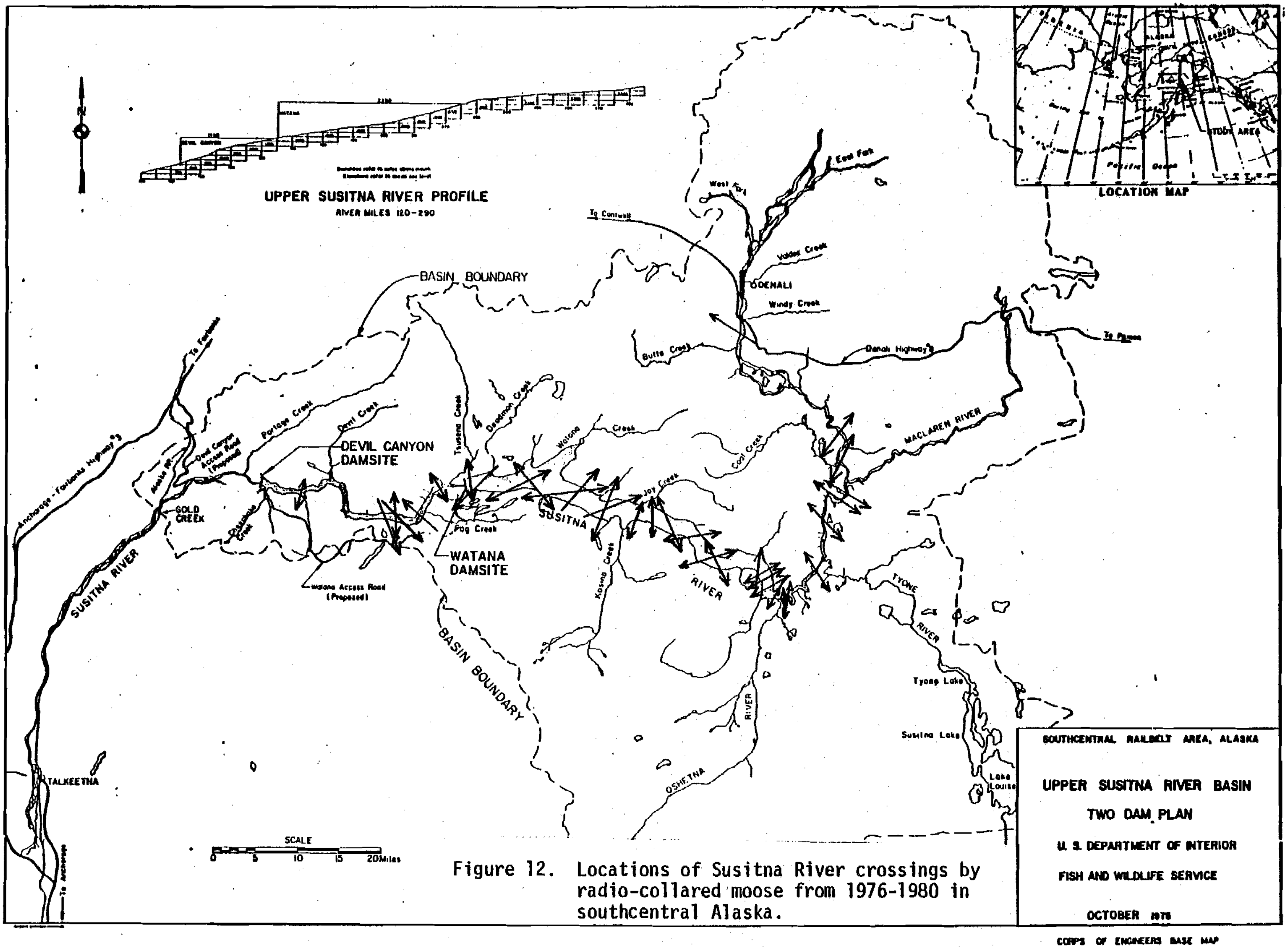


Figure 12. Locations of Susitna River crossings by radio-collared moose from 1976-1980 in southcentral Alaska.

pond with the altitudinal movement patterns presented earlier.

On 24 March 1981 the Susitna River was surveyed for evidence of moose river crossings from the mouth of Portage Creek to the mouth of the Tyone River. A total of 73 sets of moose tracks were observed crossing the river. Fifty-six of these were observed on the Susitna River between Goose Creek and the Tyone River. Ten sets were observed between Jay and Kosina Creeks while 4 and 3 sets were observed in the vicinity of the mouth of Watana and Tsusena Creeks, respectively. Based upon locations of radio-collared moose and track sightings combined, river crossings of the Susitna River appear to occur throughout the proposed impoundment area, but are relatively concentrated in the following areas: mouth of Fog Creek to the area opposite Stephan Lake, from the mouth of Deadman Creek upstream for approximately 5 miles, Watana to Jay Creek, and from Goose Creek to Clearwater Creek.

Breeding Concentrations

Breeding concentrations of moose were determined by plotting the locations of all radio-collared cow moose between 20 September through 20 October 1977 through 1980 (Fig. 13). Most moose of both sexes occupied upland sites away from the proposed impoundment areas. Concentrations occurred in the following areas: Coal Creek to the big bend in the Susitna River, Clarence Lake, uplands between Watana and Jay Creeks, Stephan Lake to Fog Creek, and the uplands above the mouth of Tsusena Creek. Other concentration areas away from the proposed impoundments include northwestern Alphabet hills, the Maclaren River, and the area above the mouth of Valdez Creek.

Calving Areas

From 1977 through 1981 moose parturition generally occurred from 15 May through 15 June with a peak occurring between 25 May and 2 June. In 1981 at least two cases of late parturition were ob-

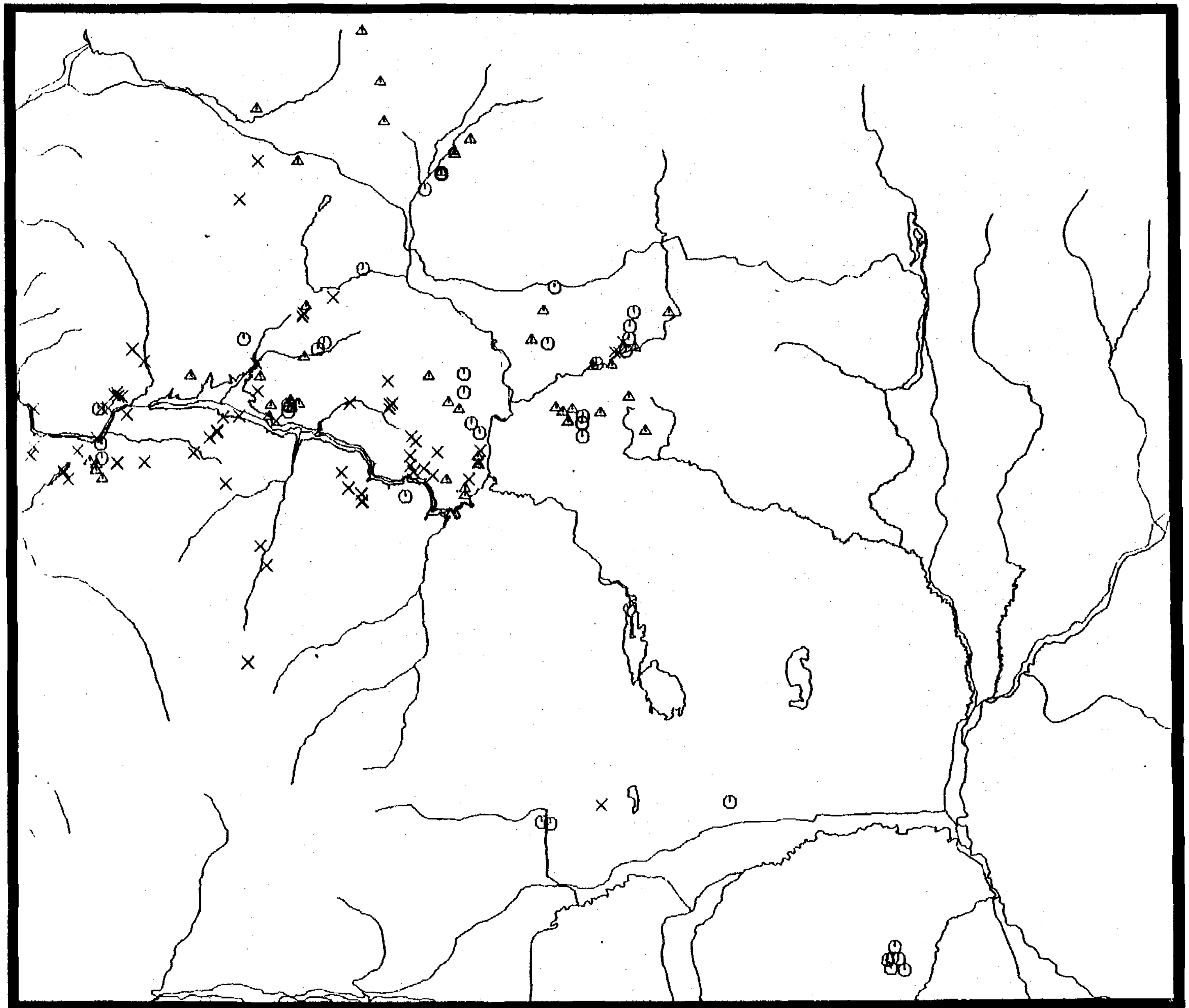


Figure 13. Locations of radio-collared moose during the rut (20 September–20 October) from 1977 through fall 1980 in the Nelchina and upper Susitna River Basins of Southcentral Alaska. (scale: 1 cm = 12500 meters)

served, one calf born after 28 July and another born between 24 June and 28 July. To determine if calving concentration areas occurred in or adjacent to the impoundment areas, all observations of radio-collared cow moose between 15 May and 15 June, 1977 through 1981 were plotted (Fig. 14). Although this method includes some cows which were not observed with calves, we believe it provides an approximation of areas where cows gave birth. Many cows that gave birth would not be observed with calves because of high calf mortality immediately following birth (Ballard and Taylor 1980; Ballard et al. 1981). Although moose parturition was widespread, several concentrations were evident. They include Coal Creek and its tributaries, along and near the Susitna River from the mouth of Tyone River downstream to a point several miles downstream from Clarence Lake Creek, Jay Creek to Watana Creek, mouths of Deadman and Tsusena Creek, Fog Creek to Stephan Lake, and opposite Fog Creek to Devil Creek. Both upland brush and open spruce appeared to be important habitat types.

Winter Distribution and Numbers of Moose in Relation to Impoundments

A moose winter distribution survey was conducted from 4 through 25 March 1980 in portions of the Susitna River Basin containing subpopulations of moose which could be influenced by the proposed project. One thousand eighty-six moose were counted in 26.1 hours of survey effort. Undoubtedly not all moose in the area were observed during this cursory survey. General distribution of observed moose is depicted in Fig. 15. Approximately 60 moose (6%) were observed at elevations which would be inundated at normal pool level. Only two moose were observed in Devil Canyon pool area while the remainder were in the Watana impoundment with 38 (66%) concentrated at Watana Creek. Although relatively few moose were observed along the Susitna River bottomlands, large concentrations of tracks indicated that moose had utilized these areas earlier in the winter. Additionally heavy cover in these low areas decreased the liklihood of observing moose which were present. Large track concentrations were observed at the mouths

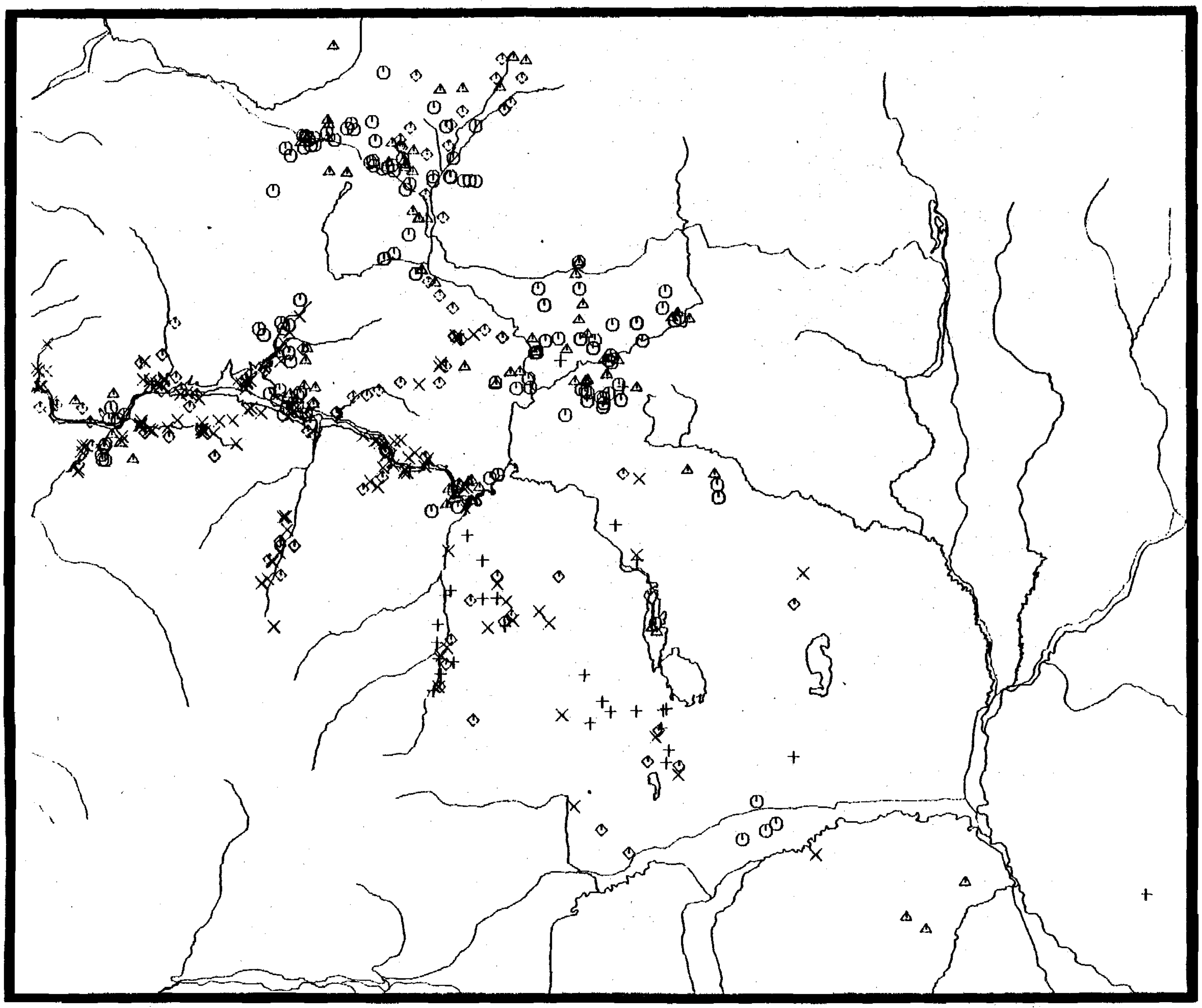


Figure 14. Locations of radio-collared moose during parturition (15 May–15 June) from 1977 through 1981 in the Nelchina and upper Susitna River Basins of Southcentral Alaska. (scale: 1 cm=12500 meters)

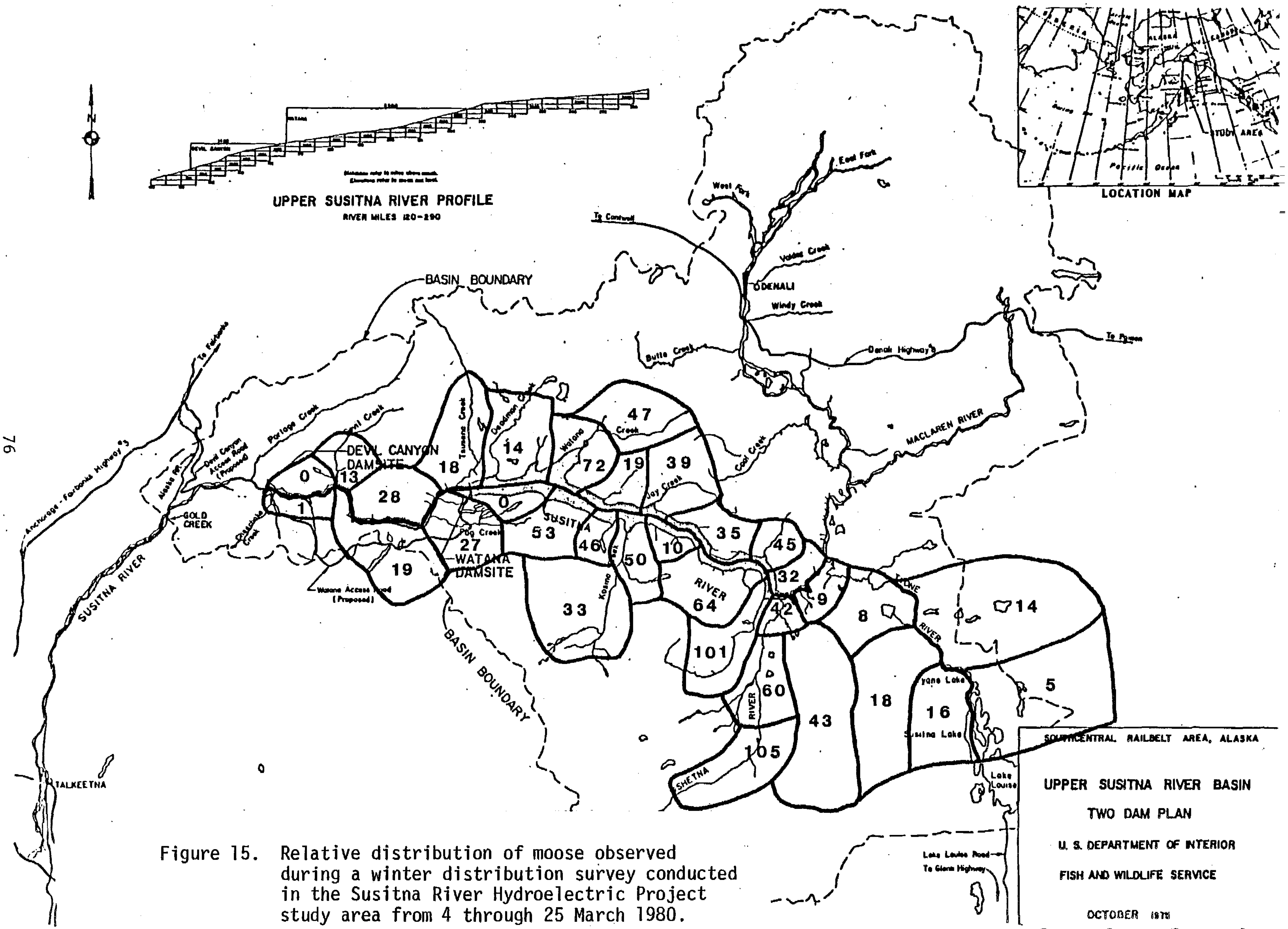


Figure 15. Relative distribution of moose observed during a winter distribution survey conducted in the Susitna River Hydroelectric Project study area from 4 through 25 March 1980.

of Watana Lake, Watana Creek, Jay Creek and the Oshetna River. Tracks and subjective observations suggested that most moose had moved from the lowland areas which were covered by relatively deep snow to higher windswept elevations where snow cover was nearly absent.

The distribution of winter (Jan., Feb. and Mar.) observations of all radio-collared from October 1976 through mid-August 1981 is depicted in Fig. 16 while the distribution of summer sightings (June, July and Aug.) is depicted in Fig. 17. Comparison of the two distributions suggests that during both seasons moose generally occupied the same ranges although they were more concentrated during winter. As mentioned earlier, moose usage of most summer habitats during winter was probably attributed to a greater availability of moose browse due to relatively shallow snow depths. Most of these data were collected during winters 1976-77, 1977-78, and 1980-81, all mild winters in terms of total snow depths.

On 26 and 28 March, 1981, the Devil Canyon and Watana impoundment areas were intensively censused in an attempt to assess the number of moose to be displaced by the reservoirs. The Devil Canyon impoundment (55.6 mi^2) was counted at a survey intensity of 3.4 min/mi^2 and 28 moose (0.50 $moose/mi^2$) were observed. A portion (30.6%) of the lower impoundment area was then sampled at an intensity of 8.7 min/mi^2) to obtain a sightability correction factor. From the intensive census, it was estimated that 94% of the moose had been counted yielding a correction factor of 1.06. Thus, the corrected population estimate for Devil Canyon impoundment was 30 moose (0.54 $moose/mi^2$).

The Watana impoundment (72.4 mi^2) was censused at 3.86 $min./mi^2$ and 42 moose (0.58 $moose/mi^2$) were counted. The intensive flight was conducted at 10 min./mi within 33.1% of the total impoundment area. However, the estimated correction factor (0.71) obtained was lower than 1.0 rendering it useless for calculating a more accurate population estimate. The area, which had randomly been

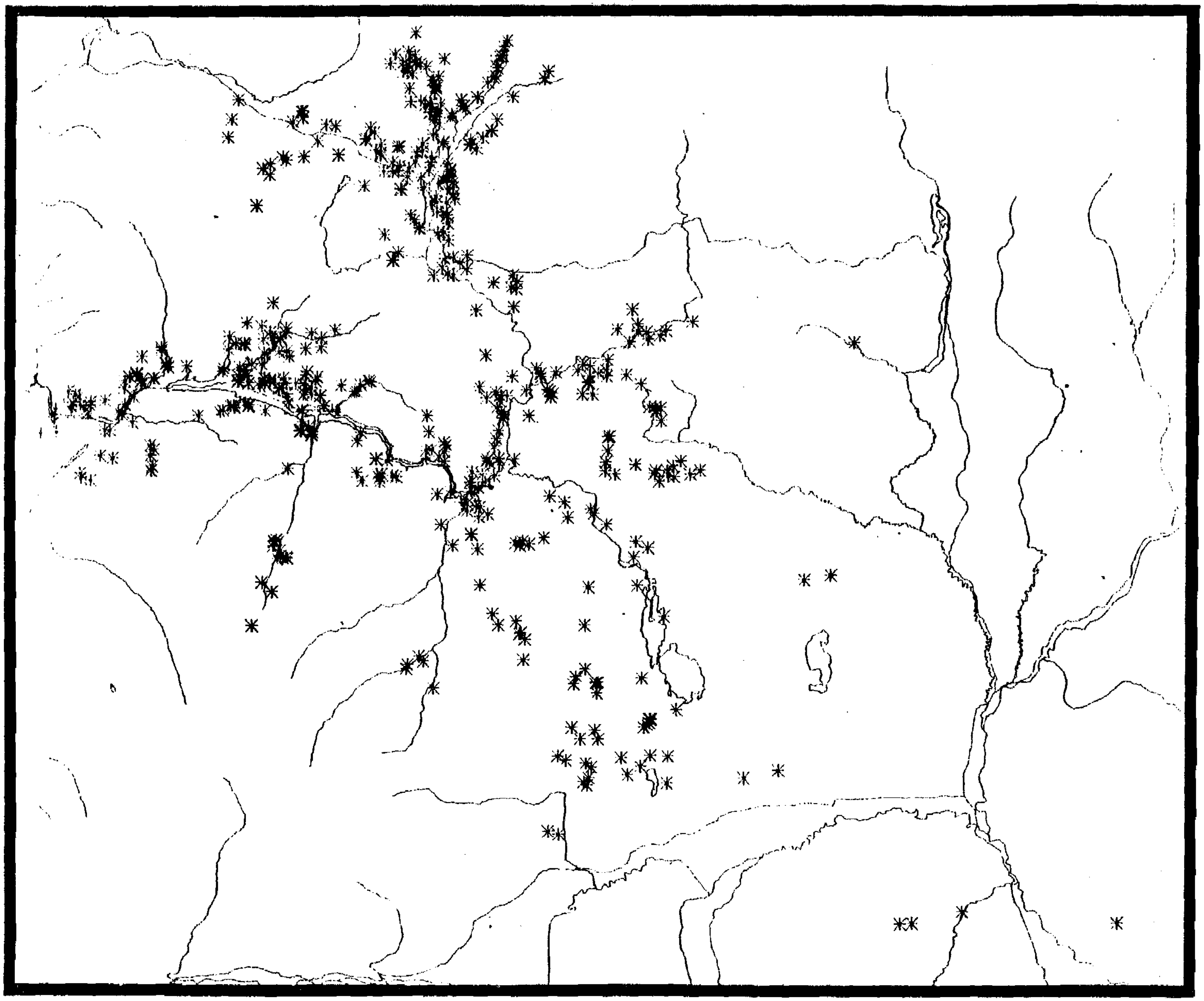


Figure 16. Distribution of winter (January, February and March) observations of radio-collared moose from 1977 through 1981 in the Nelchina and upper Susitna River Basins of Southcentral Alaska. (scale: 1 cm = 12500 meters)

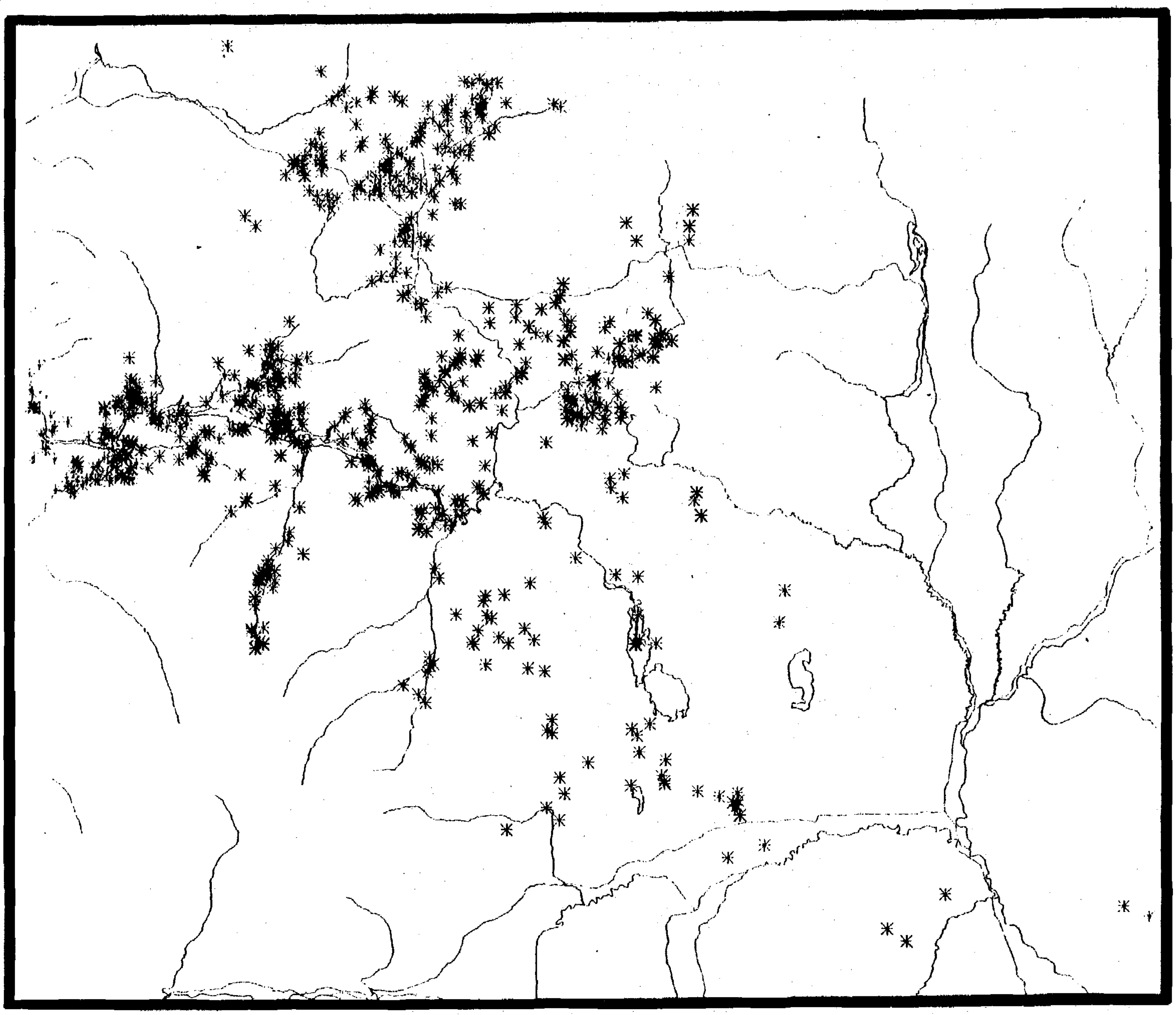


Figure 17. Distribution of summer (June, July and August) observations of radio-collared moose from 1977 through 1981 in the Nelchina and upper Susitna River Basins of Southcentral Alaska. (scale: 1 cm = 12500 meters)

chosen for intensive sampling was classified by stratification flights on a low density moose area while 44% of the Watana impoundment supported medium to high densities of moose. Therefore the estimate of 42 moose within the Watana impoundment area was not adjusted. The low numbers of moose occupying the two impoundments was not surprising since radio-locations suggested most moose were located away from them during this relatively mild winter.

Fall Distribution

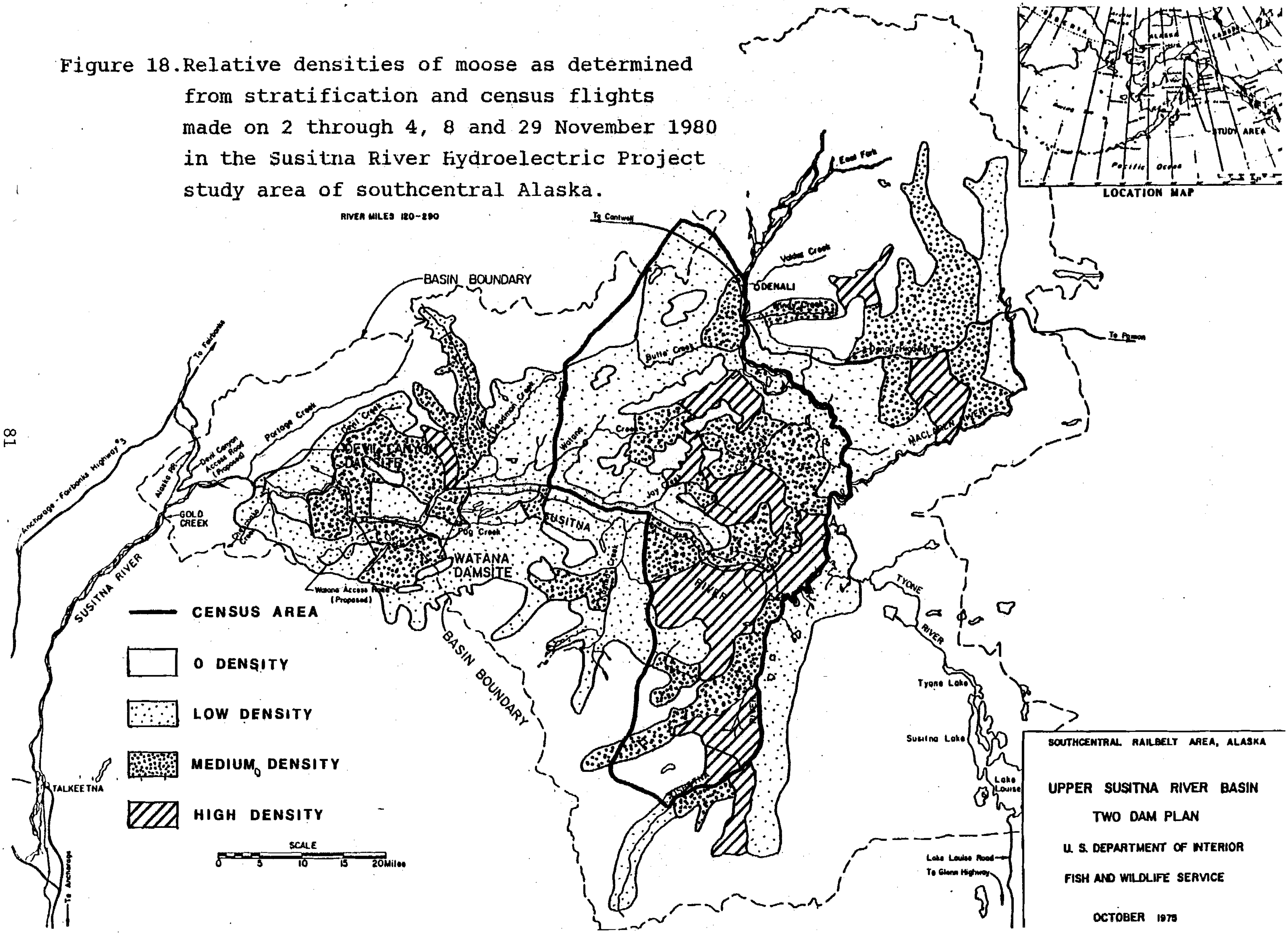
The general distribution of moose in November 1980 was reflected in stratification surveys conducted as part of a census. Both CA's 7 and 14 were stratified from fixed-wing aircraft from 2 through 4 November 1980. The Devil Canyon area was stratified on 29 November and count area 6 on 9 November 1980 using the same criteria which we had used in the Watana area.

Moose densities were stratified as high, medium and low based upon relative differences in moose tracks, numbers of moose observed and homogenity of habitat types. Boundaries of each sample area were based on prominent geographic features which could be identified from fixed-wing aircraft. Figure 18 depicts the relative densities and gross distribution of moose during November 1980. Distribution patterns exhibited by radio-collared moose were similar to those derived from the survey; generally moose densities were greater in upland areas located away from the proposed impoundment areas west of Jay Creek but were greater closer to the Watana impoundment east of Jay and Kosina Creeks due to the close proximity of upland areas. The exception to this generality was the relatively high density of moose just south of Devils Creek.

Fall Sex and Age Composition

During October and November in both 1980 and 1981 moose sex and age composition counts were conducted in count areas 6, and 7

Figure 18. Relative densities of moose as determined from stratification and census flights made on 2 through 4, 8 and 29 November 1980 in the Susitna River Hydroelectric Project study area of southcentral Alaska.



(Fig. 5). Count area 14 was not counted in 1981. The areas counted corresponded to count areas which have been surveyed annually since 1955. Sex and age composition count data and the resulting ratios for the period 1955 through 1981 are summarized in Tables 15 through 17.

History of the Game Management Unit 13 moose population has been described by Rausch (1969), Bishop and Rausch (1975), McIlroy (1974) and Ballard and Taylor (1980). Briefly the GMU 13 populations was increasing in the 1950's and peaked about 1960. After the severe winter of 1961-62, the population began declining and continued to decline with severe winters occurring in 1965-66, 1970-71, 1971-72, and 1978-79. Fall calf-cow ratios in addition to nearly all other ratios declined sharply and reached a record low for the basin in 1975. Although the decline was attributed to a variety of factors, predation by wolves was suspected of preventing the moose population from recovering during mild winters. Sex and age composition data for CA's 7 and 14 basically have exhibited the same patterns described for the unit. Although only one composition count has been conducted in the Devil Canyon area during this time period, it appears likely that this area has also followed the same general pattern. Beginning in 1975 predator densities were experimentally reduced north of the Susitna and Maclaren Rivers and therefore, some of the moose ratios in Tables 15 through 17 may reflect changes in predator densities. However, these changes were not considered significant except in 1979 when calf:100 cow ratios were increased in the northern portions of CA 7 due to reductions in brown bear density (Ballard and Spraker 1979; Ballard et al. 1980; Ballard et al. 1981). Since 1975 the moose population appears to have increased slightly or remained stable even though calf survival has remained relatively low.

Sex and age composition data derived from stratification surveys, sex-age composition counts, and the random stratified census in fall 1980 varied among the different types of surveys (Table 18).

Table 15. Summary of moose sex and age composition data collected annually each fall since 1955 in count area 6 north of the Maclaren River in Game Management Unit 13 of southcentral Alaska.

Date	Tot. M Per 100 F	Sm. M Per 100 F	Sm. M Per 100 Lq M	Sm. M % in Herd	Sm. M Per 100 M Calves	Calves Per 100 F	Incidence of Twins Per 100F w/calf	Calf % in Herd	Animals Per Hour	Total Sample
1955*	84.1	26.1	45.1	11.0	121.0	43.2	5.6	19.0	-	400
1956*	61.6	14.6	31.0	7.7	103.8	28.1	0.0	14.8	50	351
1957*	43.3	6.4	17.3	3.5	33.3	38.3	10.2	21.1	128	256
1958*	44.9	11.8	35.7	6.4	58.6	40.2	6.9	21.7	114	957
1959	N O	D A T A								
1960*	57.2	18.7	48.4	9.0	80.5	46.4	4.0	22.4	104	343
1961	70.1	27.3	63.8	12.5	112.8	48.4	16.0	22.2	78	424
1962	44.2	-	-	-	-	28.3	4.6	16.4	101	414
1963*	35.6	11.9	50.0	6.5	51.0	46.6	7.4	25.6	160	798
1964*	33.3	5.6	20.0	3.1	25.0	44.4	20.0	25.0	96	96
1965*	30.4	9.9	48.1	6.3	76.7	25.8	1.5	16.5	126	806
1966*	27.7	5.0	21.9	3.2	35.6	28.0	3.5	17.9	76	658
1967	29.7	5.4	22.1	3.4	37.4	28.8	0.8	18.1	86	681
1968	29.7	5.0	20.0	3.2	37.6	26.3	2.4	16.9	59	504
1969	35.7	13.6	61.2	7.8	81.1	33.5	2.8	19.3	46	384
1970	26.6	8.7	48.7	6.2	122.6	14.2	6.9	10.1	26	308
1971	30.0	4.2	16.7	2.8	37.0	22.8	3.9	14.9	39	362
1972	10.1	3.8	61.5	2.9	33.3	23.1	0.0	17.3	38	277
1973	20.7	7.3	54.8	5.2	77.3	19.0	2.3	13.6	20	324
1974	16.0	7.8	94.4	5.2	45.3	34.4	9.0	22.9	32	328
1975	17.6	7.8	80.0	5.7	84.2	18.5	5.6	13.6	31	279
1976	20.6	8.5	69.6	5.8	69.6	24.3	4.6	16.8	28	274
1977	16.7	5.6	50.0	3.7	32.9	33.8	13.2	22.4	46	352
1978	24.1	9.1	61.1	6.0	63.8	28.6	11.7	18.8	46	368
1979	14.6	3.0	25.9	2.2	23.7	25.3	9.3	18.1	39	326
1980	15.1	7.5	100.0	5.2	50.6	29.7	8.1	20.5	50	423
1981	26.5	15.9	-	9.6	82.3	38.6	5.1	23.4	53	530

Remarks: *Area boundary change - check maps
1969 Area #6

Table 16. Summary of moose sex and age composition data collected annually each fall since 1955 in count area 7 in Game Management Unit 13 of southcentral Alaska.

Date	Tot. M Per 100 F	Sm. M Per 100 F	Sm. M Per 100 Lq M	Sm. M % in Herd	Sm. M Per 100 M Calves	Calves Per 100 F	Incidence of Twins Per 100F w/calf	Calf % in Herd	Animals Per Hour	Total Sample
1957	N O D A T A									
1958	N O D A T A									
1959	N O D A T A									
1960	N O D A T A									
1961	N O D A T A									
1962	N O D A T A									
1963*	47.7	6.2	14.8	3.3	32.0	38.5	0.0	20.7	151	121
1964*	39.7	10.7	37.1	6.3	68.4	31.4	2.8	18.4	65	207
1965*	59.8	13.7	29.6	7.8	168.4	16.2	0.0	9.2	65	412
1966	48.3	6.3	15.1	3.8	62.8	20.1	0.0	11.9	33	293
1967	41.0	7.0	20.7	4.4	68.3	20.6	2.5	12.8	77	642
1968	N O D A T A									
1969	N O D A T A									
1970	34.7	8.9	34.4	5.0	42.2	42.1	8.6	23.6	43	864
1971	26.3	8.4	47.1	5.3	50.8	33.2	7.1	20.8	50	624
1972	20.6	2.7	15.1	2.0	31.0	17.5	3.7	12.6	53	665
1973	21.9	8.2	60.2	6.0	101.0	16.3	2.9	11.8	70	890
1974	12.6	4.2	50.0	3.0	29.6	28.3	6.3	20.1	48	672
1975	10.0	4.3	77.4	3.4	54.5	15.9	4.8	12.7	38	695
1976	12.3	4.3	54.9	3.2	40.3	21.6	7.1	16.1	46	865
1977	10.8	4.2	64.4	3.0	29.6	28.7	6.0	20.6	60	954
1978	14.8	8.0	117.3	5.9	79.2	20.2	4.1	15.0	65	1030
1979	8.8	2.4	36.6	1.8	20.3	23.3	5.8	17.7	60	838
1980	13.3	7.8	143.2	5.6	62.3	25.1	1.1	17.9	51	946
1981	14.2	5.0		3.4	31.7	31.6		21.7	49	1284

Remarks: *Area boundary change - check maps
1969 Area #7
Caution - early 1965 data used for 1964

Table 17. Summary of moose sex and age composition data collected annually each fall since 1955 in count area 14 in Game Management Unit 13 of southcentral Alaska.

Date	Tot. M Per 100 F	Sm. M Per 100 F	Sm. M Per 100 Lg M	Sm. M % in Herd	Sm. M Per 100 M Calves	Calves Per 100 F	Incidence of Twins Per 100F w/calf	Calf % in Herd	Animals Per Hour	Total Sample
1955*	105.6	29.6	38.9	10.5	80.8	73.2	10.6	26.0	-	200
1956	N O D A T A									
1957	72.5	11.7	19.2	5.2	46.5	50.3	4.9	22.6	127	381
1958*	86.8	11.2	14.8	5.0	60.3	37.0	7.4	16.6	98	441
1959	N O D A T A									
1960*	71.7	20.0	38.7	8.6	70.6	56.7	21.4	24.5	38	139
1961*	62.0	26.7	75.6	12.2	95.8	55.7	7.6	25.6	173	555
1962	56.3	18.2	47.7	10.1	152.7	23.8	1.8	13.2	92	416
1963	N O D A T A									
1964	N O D A T A									
1965	28.6	10.8	60.6	7.2	100.0	21.6	0.0	14.4	79	278
1966*	20.0	9.0	82.4	5.9	53.8	33.5	0.0	21.8	63	238
1967	39.0	6.8	21.2	3.9	40.0	34.1	2.9	19.7	118	355
1968*	9.4	4.0	75.0	2.8	22.2	36.5	3.8	25.0	154	108
1969	17.5	6.2	55.2	4.0	31.1	40.1	2.0	25.4	54	405
1970	19.4	3.7	23.5	2.2	16.7	44.4	2.1	25.9	80	185
1971	27.1	8.4	44.7	5.7	81.0	20.7	5.0	14.0	37	300
1972	21.4	9.2	75.0	6.2	72.0	25.5	0.0	17.4	54	288
1973	22.0	7.1	47.7	5.1	82.4	17.3	2.0	12.4	56	411
1974	15.4	5.1	50.0	3.4	29.1	35.2	3.7	23.4	40	500
1975	9.9	4.3	78.6	3.3	40.0	21.7	1.9	16.5	65	333
1976	9.2	4.6	100.0	3.6	46.4	19.9	3.0	15.4	50	447
1077	N O D A T A									
1978	20.5	9.2	80.6	6.6	100.0	18.3	2.0	13.2	50	379
1979	N O D A T A									
1980	13.7	9.6	235.7	7.4	117.9	16.2	3.8	12.5	51	447
1981	N O D A T A									

Remarks: *Area boundary change - check maps

Table 18. Comparison of moose sex-age ratios and aggregations derived from three different types of surveys which were conducted in the Susitna River Hydro Project Study Area during 1980.

Type of Survey	Date	Tot.M Per 100 F	Sm. M Per 100 F	Sm. M Per 100 Lq M	Sm. M % in Herd	Calves Per 100+ 2 yr≥	Calves Per 100 F	Incidence of Twins per 100 F w/calf	Calf % in Herd	Animals Per Hour	Total Sample	Count Time	Area Sampled mi 2/	Minutes/ mi 2/
Composition count	11/1-3	13.4	8.4	168.6	6.2	25.3	23.1	10.9	16.9	51.4	1393	27.1	945.2	1.7
Census	11/5-8	13.1	8.0	157.7	5.5	35.0	32.2	11.7	22.1	27.5	742	27.0	365.7	4.4
Stratification	11/2-4	--	--	--	--	--	--	--	--	--	581	5.3	945.2	0.3

	$\bar{x}$ Moose/Group	Percent of Observed Moose Comprised of Singles	Percent of Moose Comprised of Pairs	Percent of Moose Comprised of Groups of Three	Percent of Moose Comprised of Groups of Four or more
Composition count	3.0	5.8	29.3	14.5	50.4
Census	2.4	8.0	43.4	14.8	33.8
Stratification	2.8	8.3	29.6	16.5	45.6

In particular, census data indicated the calf:100 cow ratios generated from composition surveys are lower, while bull:cow ratios are generally higher than observed during the census. This pattern has been observed in other areas (Gasaway pers. comm.).

Reasons for these discrepancies were due to intensity of the various surveys and the probabilities of observing different moose groupings. For example, cow-calf pairs tend to be in smaller groups in dense vegetation while bulls tend to be in larger groups in more open habitat. As a result a high proportion of bulls and a low proportion of cows with calves tend to be seen on low intensity surveys such as composition counts. Composition data derived from intensive surveys such as the census are more likely to accurately reflect the true population composition.

Population Estimates

CA's 7 and 14 (Fig. 5) were intensively censused from 5 through 8 November 1980. A total of 743 moose were censused within 26 sample areas comprising 366 mi^2. Thus, 39 percent of CA's 7 and 14 was directly censused.

Table 19 summarizes calculations utilized to estimate the fall moose population in CA's 7 and 14 east of Jay and Kosina Creeks to the Susitna River in the project area during the census. Of the 945 mi^2 census area, 35 percent was classified as low moose density, 38 percent as medium moose density and 27 percent as high moose density. Based upon census data, each stratification was estimated to contain the following number of moose/mi^2: low--1.125, medium-1.847 and high--3.726. The estimated fall population for CA's 7 and 14 was 1,986 ± 371, (90% CI).

Not all moose were observed at a survey intensity of 4.4 minutes/mi^2 (Gasaway and Dubois, unpub. report). Consequently, portions of 10 sample areas were randomly chosen and were resurveyed at a sampling intensity of approximately 12 minutes/mi^2 in an effort to generate a sightability correction factor (Table 20).

Table 19. Summary of moose census data and subsequent population estimates for Count Areas 7 and 14 derived from surveys conducted from 5 through 8 November 1980 along the Susitna River in southcentral Alaska.

Moose Density Stratum	Low	Medium	High
Number of sample area censused	11	9	6
Total number of sample areas in each stratum	26	27	18
Area of each stratum - mi^2	333.8	355.3	256.1
Moose density per stratum	1.125	1.847	3.726
Population estimate per stratum	375	656	954
Total population estimate 90% CI = 1986 $\pm$ 371			
Sightability correction factor = 1.03			
Corrected population estimate = 2046 $\pm$ 382			

Table 20. Summary of sample areas resurveyed to determine sightability correction factor for the Susitna moose census conducted from 5 through 8 November 1980 in southcentral Alaska.

Stratification Density	Sample Area	Quad #	Date	Time Spent Surveying (min)	# Moose Observed 1st count	Intensive Count	Percent Observability
L	21	1	11/7/80	10	0	0	100%
M	49	2	11/8/80	11	12	13	92.3%
H	15		11/8/80	31	7	7	100%
M	34	2	11/5/80	19	4	4	100%
L	9	?	11/5/80	5 est	0	0	100%
H	16	3	11/5/80	5	0	0	100%
M	71	4	11/6/80	20	10	10	100%
H	64	?	11/5/80	5 est	4	4	100%
L	47	1	11/6/80	5 est	3	3	100%
L	23	?	11/6/80	19	0	0	100%
Totals	10	-	11/5-8	130	40	41	98
$\overline{X}$				13.0			

Correction factor = 1.03

With the additional surveying effort it was estimated that during the census approximately 98 percent of the moose were being observed yielding a correction factor of 1.03. Therefore, the corrected population estimate for CA's 7 and 14 was 2,046 ± 382, (90 percent CI) of which 22 percent were calves.

We were unable to census those portions of the study area lying west of Delusion and Kosina Creek because of deteriorating snow conditions. However, on 29 November the areas which had not been censused were stratified in an effort to provide a gross fall population estimate for the study area. A total of 179 moose were observed during 3.6 hours of surveying time. Eight hundred and thirty mi^2 were stratified, of which 562 mi^2 were classified as low moose density, 256 mi^2 as medium moose density and only 12 mi^2 as high moose density. The size of each stratum was multiplied by the individual density estimates derived for CA's 7 and 14 (Table 19) to derive a crude population estimate of 1,151 moose. Adding this figure to the population estimate for CA's 7 and 14, the estimated population for the study area west of the Susitna and Oshetna Rivers was approximately 3,197 moose in early November.

Using methods similar to those described in the preceding paragraph, relative moose densities in CA 6 were also stratified.

This was done because CA 6 has a migratory population of moose which overwinter in the vicinity of the mouth of the Oshetna River. On 9 November a total of 205 moose were observed in 3 hours of survey flown in a Piper Super Cub. Relative density and distribution of these moose were depicted in Fig. 18. Of the 470 mi^2 stratified, 204 mi^2 (43%) were classified as low moose density, 207 mi^2 (44%) were classified as medium moose density and only 59 mi^2 (13%) were classified as high moose density. Extrapolating the average moose densities per stratum derived for CA's 7 and 14 (Table 19) to the mi^2 of each stratum in CA 6, we grossly estimated that area's fall moose population at 830 animals.

Not all of the potential impact areas were surveyed in 1980 because of high costs and poor survey conditions. These other potential impact areas which contain migratory moose include the western Alphabet Hills, the Lake Louise flats, and drainages of Tyone and Sanona Creeks.

Calf Production and Survival

Calf moose comprised 13 percent of the moose observed during the distribution survey in March 1980. This low calf percentage reflects poor calf survival during 1979-80 due to predation (both bear and wolf) and perhaps some winter mortality (starvation). Farther upstream above the Denali Highway where both bear and wolf densities had been experimentally lowered (Ballard et al. 1980), calf moose comprised 33 percent of the moose counted in late May 1980, reflecting increased calf survival due to the lower predator densities. Of 32 radio-collared cow moose which were intensively monitored from mid-May through mid-June 1980, 19 were subsequently observed with 30 calves for an observed calving rate of 0.94 calves/cow. Fifty-eight percent of the cows producing calves had twins. These rates of calf production were quite comparable with those observed in 1977 and 1978 (Ballard and Tobey 1981).

Mortality of newborn moose calves in 1980 was high. By 1 August 1980, 23 (77%) of the calves were missing. Rates of 1980 calf loss were compared with those observed in 1977 and 1978 (Fig. 19). Although causes of moose calf mortality were not determined in 1980, the pattern of loss was quite similar to that observed in 1977 and 1978 where predation by brown bear (*Ursus arctos*) was responsible for 79 percent of the calf deaths (Ballard et al. 1981). Calf mortality appeared to continue at a high level in 1981 as well.

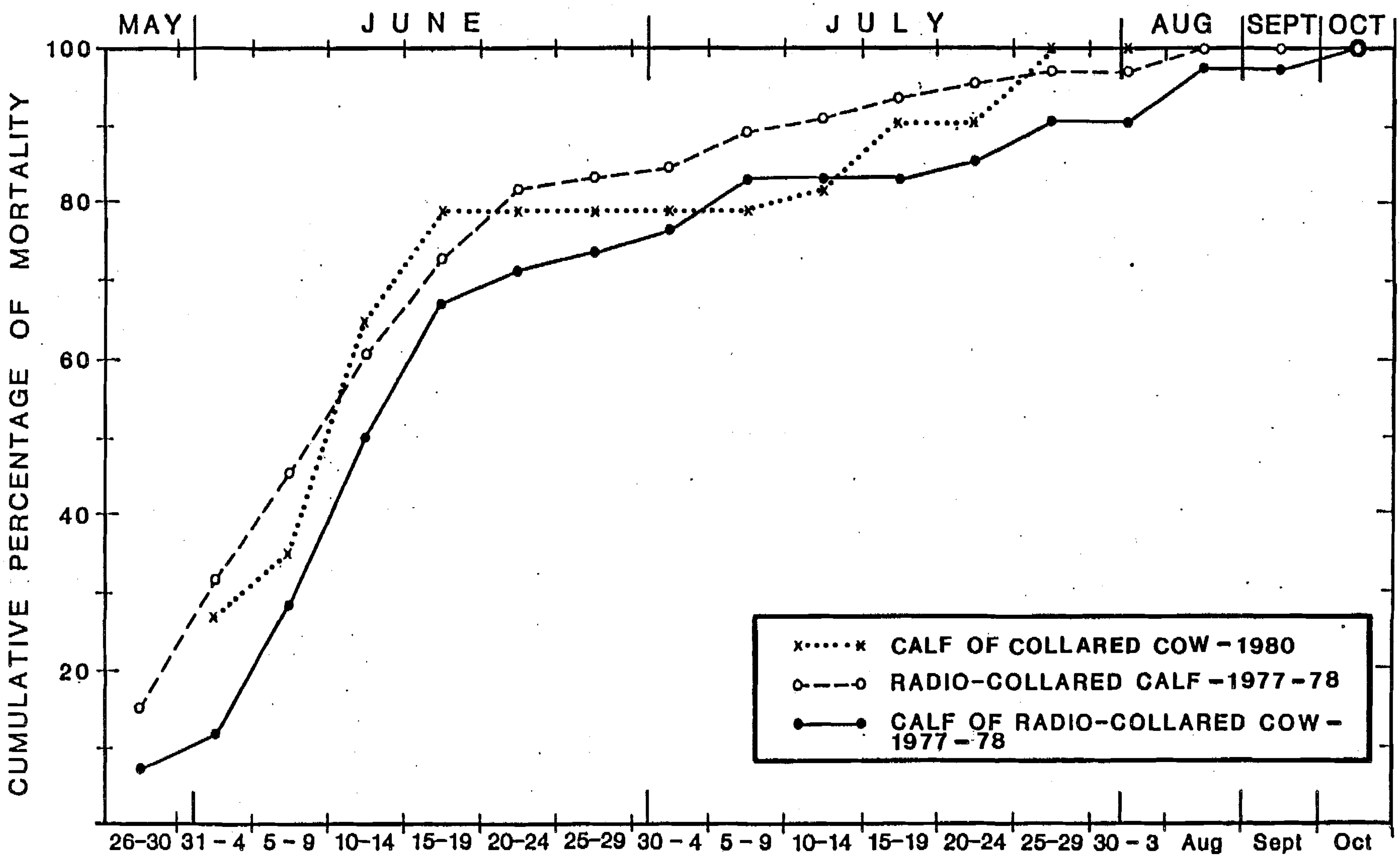


Figure 19. Dates of mortalities of collared and uncollared moose calves during 1977, 1978 and 1980 in the Nelchina and upper Susitna Basins, Alaska (modified from Ballard et al. 1981).

During the 1981 calving season we did not monitor radio-collared moose intensively enough to document parturition dates and rates of calf loss. However, of the 46 sexually mature cow moose which could have produced calves only 20 (43.5%) were observed with calves. Four (20%) produced twins. The calving rate for known producers was 1.2 calves/cow. Of the 24 known calves, 14 (58.3%) were missing by 28 July. This pattern of calf loss is quite similar to that of 1977, 1978, and 1980 when predation by bears accounted for most of the losses. However, overall calf survival may have improved in 1981.

Calf: 100 cow ratios in count areas 6 and 7 were the highest since 1964 and 1971, respectively. Reasons for the large increases are unknown but may be due merely to differences in moose movements, observer differences, survey conditions which would result in high probabilities of observing calf:cow pairs, and perhaps a slight increase in survival. Problems with the sex-age composition data may best be represented by the change in moose age structure and total number in count area 7 from 1980 to 1981 (Tables 15 and 16). In 1980 a total of 178 calves and 766 adults were observed, while in 1981 a total of 1006 adults were observed. Assuming that all of the calves in 1980 survived winter 1980-81, which is unlikely (Ballard et al in press), the total number of adults in 1981 should have been 844 instead of 1006. Therefore 21.1 percent of the increase in total numbers of adults can not be explained based upon 1980 data.

Subpopulations

Based upon moose movements studies conducted from 1976 through 1981 approximately 13 subpopulations of moose in the vicinity of the proposed project area can be identified. For purposes of this report we define a subpopulation as a group of moose which utilize similar winter and summer range moving to and from such areas in general synchrony. Generally, individuals of these subpopulations breed and calve in the same area. It should be pointed out, however, that under this definition subpopulations are not entirely discrete and many gradations between them exist. The subpopulations in the vicinity of the proposed impoundments are as follows:

(1) Devil Canyon to Upper Fog and Deadman Creeks Subpopulations. This subpopulation consists of moose which have relatively small home ranges with overlapping summer and winter home ranges. Some moose from this subpopulation probably never utilize the area to be inundated while for others the Susitna River runs through the middle or borders the annual home range. No migratory moose are known to occur in this area.

(2) Upper Tsisi and Upper Fog Creek to Susitna River Sub population. This relatively small subpopulation is comprised of moose which migrate short distances between winter and summer range. They may share summer and winter range with relatively sedentary (non-migratory) moose.

(3) Kosina Creek Subpopulation. For the most part this relatively small group of moose appear non-migratory and appear to occupy relatively small home ranges along the creek bottoms. It is possible based upon the movements of one calf, than an unknown sized segment of this subpopulation migrates down Kosina, crosses the Susitna River, proceeds up Jay Creek and possibly calves at Coal Creek.

(4) Watana Creek - Monahan Flats Subpopulation. An apparently small subpopulation of migratory moose periodically spend late winter and spring in the vicinity of the area between the mouths of Jay and Watana Creeks depending upon winter severity. In late spring this group migrates to Monahan Flats for calving where they remain through summer. In October they return to Watana Creek where they either remain through winter or they return to Monahan Flats, again apparently dependant upon winter severity.

(5) Watana Creek - (nonmigratory) Subpopulation. This subpopulation consists primarily of nonmigratory moose which occupy the drainages of Watana Creek. This subpopulation sometimes shares winter and summer range with the migratory Monahan Flats subpopulation, Watana Creek migratory moose, and moose which migrate back and forth from Watana to Coal Creek.

(6) Watana Creek - (migratory) Subpopulation. Moose from this subpopulation migrate from winter to summer range following the drainage of Watana Creek to upper Butte Creek. The degree of overlap with other subpopulations probably depends upon winter severity.

(7) Watana - Coal Creek Subpopulation. This migratory subpopulation was not detected until late in 1981. Moose from this group apparently winter in the vicinity of the mouth of Watana Creek and then migrate to upper Jay and Coal Creeks for calving. They generally remain in the latter area through summer and return to Watana Creek in late summer or fall. One moose from this subpopulation made a series of movements which either were atypical for moose from this area or may indicate the presence of an additional migratory subpopulation. Moose 668 resided from March through September 1981 in the uplands between Watana and Jay Creeks. By early October she had moved to Jay Creek. Between 5 Oct. and 17 Nov. 1981 she had moved north to the mouth of Windy Creek, perhaps for breeding, and then returned to Coal Creek. By early Dec. 1981 she had returned to Jay Creek.

(8) Jay - Kosina Creeks to mouth of Clearwater Creek Subpopulation. This subpopulation consists primarily of nonmigratory moose with relatively small home ranges. Considerable overlap in total home range occurs between individuals. Moose from this subpopulation usually share winter or summer range with migratory subpopulations from the following areas: Oshetna River, Black River, Maclaren River, Clearwater Creek, Butte Creek and Watana Creek.

(9) <u>Migratory Black and Oshetna River Subpopulation</u>. Moose from this relatively important subpopulation appeared to spend fall and winter in the upland areas. During early spring they migrated down the respective drainages to lowland areas for calving.

(10) <u>Migratory Clearwater Creek Subpopulation</u>. This subpopulation of moose generally summer in the Clearwater Mountains. During late October or November this group migrates southward and winters in the vicinity of the mouth of Clearwater Creek to the big bend in the Susitna River.

Calving for this subpopulation occurs either on the winter range or between winter and summer range. Winter range is shared with both migratory and sedentary moose from several other subpopulations.

(11) <u>Migratory Malclaren River Subpopulation</u>. This group of moose has movement patterns similar to those described for the Clearwater subpopulation.

(12) <u>Butte Creek Subpopulation</u>. Moose from this subpopulation generally reside and calf on Butte Creek and adjoining areas through summer and migrate down the Susitna River to the vicinity of the big bend. Winter range is shared with several other subpopulations. Moose from this subpopulation do not always migrate to winter range, instead they winter on summer range during mild winters.

(13) <u>Migratory Lake Louise Flats - Susitna River Subpopulation</u>. Moose from this subpopulation usually winter in the vicinity of the big bend of the Susitna River. During early spring migration to calving areas on the flats usually occurs. Successful cows often remain on the flats through summer, returning to the Susitna River in fall.

Moose Dispersal

Although the original objectives of this study did not encompass this aspect of moose biology, some preliminary information was obtained in 1981 from the collaring and relocating of sixteen 10 month old calves of radio-collared adults. At least 4 of 16 calves dispersed from the cows home range between March and December 1981. These movements were particularily interesting because they demonstrate the distances that moose from the impoundment area may travel suggesting that moose populations elsewhere in Unit 13 may partially depend on an influx of moose from the study area. Reductions in disperal due to the project could significantly affect hunting and moose population dynamics in areas far removed fromthe main impact area.

The movements of these four moose are briefly described:

(1) Male calf 672 of cow 671. Both cow and calf were captured at standing Bear Lake in March 1981. Both traveled eastward reaching Coal Creek by mid-August where they both remained together until early October. After which, the cow returned to Jay Creek while the calf proceeded northward to the mouth of Windy Creek. The cow continued to move down Jay Creek to Watana Creek where she arrived by early December. The calf on the other hand returned to Coal Creek by mid-November where he remained at least through mid-December.

(2) Male calf 674 of cow 673. Both were captured near the mouth of Watana Creek in March 1981. Unfortunately the cow slipped its collar shortly after capture but both remained in association near Watana Creek until late May. By late May the calf moved to upper Jay Creek where he remained without the cow until at least 10 September. Between 10 September and 1 October 1981 he moved northward, again unaccompanied by the cow, to the mouth of Windy Creek. He remained in the area between Windy and Clearwater Creeks above the Denali Highway from October through early December 1981 when this report was prepared.

(3) Female calf 685 of cow 692. Both were captured near the mouth of Watana Creek where they remained at least through the end of March. Between late March and 16 May both had moved to Coal Creek where they maintained a lose association while the cow gave birth to a new calf. The cow remained at Coal Creek to 1 October. During October the cow moved down Jay Creek and returned to the mouth of Watana Creek by mid-December 1981. Last years calf, however, traveled north to the big bend of the Maclaren River between 1 October and mid-December 1981. By 19 December 1981 it was located near Crazy Notch, north of the Denali Highway near the Maclaren River.

Home Ranges of Moose

Seasonal and total home range sizes for 162 radio-collared moose studied in GMU-13 from October 1976 through mid-August 1981 are presented in Appendix B. Areas inhabited by radio-collared moose were relatively large averaging 224.2 km^2 (87 mi^2), ranging from 3.8 (1.5 mi^2) to 2011 km^2 (1124 mi^2). Table 21 summarizes home range sizes by sex and age class of radio-collared moose. Although many of the sex-age comparisons may not be valid because of small sample sizes the comparisons suggest that large differences in home range sizes exist. Two-year old females had the largest seasonal and total home range size. In terms of total home range sizes in order of decreasing size the order by sex-age class was as follows: adult females, male calves, female calves, 2 yr. old bulls and adult bulls.

However, there were no significant differences ($P \geq 0.05$) with total home range sizes or maximum lengths between sexes or age classes.

LeResche (1974) reported that seasonal home ranges of moose were consistently small regardless of how far a moose moved between seasons. For convenience of analysis for this report we divided seasons into summer (April, May, June, July, August and

Table 21. Summary by sex and age class of seasonal and total home range sizes for radio-collared moose studied in the Nelchina and upper Susitna River Basin from October 1976 through mid-August 1981.

Sex	Age	Summer Home Range(km^2)			Winter Home Range(km^2)			Total Home Range(km^2)			Length of Home Range(km^2)		
		$\bar{x}$	St.D	N	$\bar{x}$	St.D	N	$\bar{x}$	St.Dev.	N	$\bar{x}$	St.Dev.	N
Male	Calf	41.9	58.7	6	108.1	106.1	21	196.4	257.3	27	29.3	18.6	27
Male	2 yr.	65.6	-	1	--	--	--	147.9	57.1	1	31.3	19.4	1
Male	Adult $\geq$3 yr.	59.2	28.6	3	25.2	22.1	3	97.1	21.9	4	18.6	3.9	4
Female	Calf	39.3	61.1	18	134.1	149.8	30	187.5	280.2	40	32.7	20.7	40
Female	2 yr.	443.2	455.1	3	292.9	321.7	3	377.6	575.6	5	27.4	27.8	5
Female	$\geq$3 yr.	148.7	236.7	76	123.6	299.8	73	248.2	449.7	85	27.1	23.9	85
TOTALS		129.3	222.2	107	125.2	244.0	130	224.2	381.3	162	28.7	22.0	162

September) and winter (October, November, December, January, February and March) which by strict definition would not allow us to compare Susitna seasonal home range sizes with those reported elsewhere in North America. However, a preliminary analysis of seasonal home ranges where migration points were excluded suggested that GMU 13 moose have significantly larger home ranges than those reported in the literature (Ballard and Taylor 1980). Ballard et. al. (1980) and Ballard and Taylor (1980) compared the summer home ranges of cow moose accompanied by calves with those reported elsewhere in North America and found that Unit 13 ranges were substantially larger. They also determined that predator densities influenced the movements and subsequently the home range sizes of the cow-calf pairs. The large seasonal and total home range sizes reported in our studies probably reflect an adaptation by moose to exploit habitats which are only seasonally available.

POTENTIAL IMPACTS ON MOOSE BY SUSITNA HYDROELECTRIC PROJECT

<u>Winter Habitat Loss</u> - The most obvious impact of the proposed project is loss of habitat, primarily through inundation but also through construction of project facilities such as roads, borrow pits, camps, etc. The normal pattern is for moose to occupy habitats at lower elevations during winter. Cows with calves use such areas more heavily than do bulls. The deeper the snow the heavier the use of lowland areas. Severe winters frequently cause population declines in moose. Therefore, lowland winter range is generally considered critical habitat for moose even though it might not be heavily used every year. Observations made during the winter of 1974-75 (U.S.F&W 1975) suggested that this pattern held true in the vicinity of the proposed impoundments.

We have not observed this pattern during this study. Snow depths have been less than normal and have in fact been shallower at higher elevations than below the levels of the proposed impoundments. Moose appear to have actually moved to higher elevations and use of the areas to be inundated has been light.

A key question is what happens during a more severe winter when snow depths are greater at higher elevations. Available information is inadequate to answer this question. It seems certain that during severe winters, use of the impoundment areas, particularly the portion of the area that would be flooded by the Watana Dam, is greater than observed in March 1981. However, until we are able to observe moose movement under deeper snow conditions, we will not be able to predict how much greater that use is.

Limited observations made by plant ecology studies (Subtask 7.12) personnel suggest that habitat within the Watana impoundment area may not support greater use by moose. They suggested that in November 1980 willow stands along Watana Creek and portions of the Susitna River within the Watana impoundment area had already been heavily browsed by moose (Univ. of Alaska, Ag. Exp. Stat. 1981). They continued, "consequently, it appears that browse supplies in the bottoms of the Susitna River Canyon and its tributaries may already be depleted before they would have much value as a browse reserve in late winter or during severe winters" (op. cit.). Although no data were presented on available browse, browse utilization, browse vigor or pellet groups this possibility can not be overlooked. More complete studies of the habitat are required.

The fact that current annual growth of major browse species has been consumed by fall does not necessarily mean an area has lost its value as critical range during a severe winter. Little is known about the ability of an overbrowsed range to sustain moose during a severe winter. If deep snows drive moose to the lowland areas where the current years growth has already been removed, the remaining forage may be sufficient to prevent a total loss of the population even though significant mortality from starvation may occur. Consequently, our knowledge of the movement patterns and habitat utilization of Susitna moose during a severe winter and our knowledge of the capacity of habitat to support moose during a severe winter are inadequate to draw meaningful conclusions.

However, in 1978-79, a severe winter, while capturing short-yearling moose in the Oshetna and Tyone River areas for mortality studies, we observed a number of starved moose (Ballard and Gardner 1981).

Survival of moose was much higher in riparian areas than in upland or flat lowland areas. We suspect survival of moose will be higher during a severe winter along the Susitna River than in many other habitats found in the area.

<u>Spring Habitat Loss</u> - We found that moose use of impoundment areas was greatest in spring and early summer. This may be a response to earlier snow melt and vegetation emergence at lower elevations. This is a critical period for moose, especially following severe winters. Moose tend to have a negative energy balance during winter. Their physiologic condition deteriorates usually reaching a low point around April. This trend is abruptly reversed when melting snow and new plant growth greatly increase the quantity and quality of available food. In a nutritionally stressed population, many moose may be near the point where their survival or, in the case of pregnant cows, their unborn calf's survival is in question. If availability of emergent vegetation is delayed, either by climatic conditions or loss of habitat where emergence is early, the population may suffer significant mortality.

<u>Habitat Alteration</u> - While there is some doubt as to the importance of habitat that will be inundated, there is little doubt that many areas immediatley adjacent to the impoundments are extremely important. There are several mechanisms that could alter some of these habitats.

For example, Henry (1965) predicted changes in precipitation would occur in portions of the Yukon Basin following the creation of Rampart Dam Reservoir. Also, in more southerly locales it has been demonstrated that large bodies of water influence the local environment; in effect, lengthening the fall season and delaying spring. Although the two proposed impoundments are relatively small in relation to the Rampart Project, small changes in climate might be more pronounced because of the steepness of the Susitna River Valley. Climatic changes may result in either more precipitation in terms of snow fall or a lengthening of spring thaw and a resulting delay in spring greenup. The climatic effects of the two impoundments could be highly detrimental to the large number of moose which utilize portions of the Basin within 5 miles of the project shoreline. As no studies have been undertaken to predict the effects of the impoundments on climate, we can not estimate the magnitude of their impact.

Some changes in vegetation are likely along the fringes of the impoundments. These might be beneficial to moose if the new plant community is comprised of desirable browse species. There will be a zone above the normal maximum level of the Watana impoundment that would flood only during extremely wet years. This might be conducive to growth of some species beneficial for moose such as willow. Also soil moisture conditions might create new riparian areas. Since no information is available on the effects of the impoundments on shoreline vegetation, any conclusions on their effect on moose is speculative.

Filling of the impoundments is likely to displace moose into surrounding habitat. Unless the moose population is below carrying capacity of the remaining habitat, there will be overbrowsing of this adjacent habitat until the population adjusts. Overbrowsing could reduce the carrying capacity for some period of time. The extent and duration of this reduction in carrying capacity depends on many factors which have not been studied. This impact would be temporary but could last from a few years to several decades.

Blockage of Migration - Our studies document a number of crossings of the Susitna River by moose. These crossings were most common during periods of migration. A number of our radio-collared moose displayed home ranges which would be bisected by the proposed impoundments. Moose attempting to migrate across the impoundments would encounter either open water or uncertain ice conditions. While some moose are still likely to cross impoundments particularly later in the winter, the option of having seasonal ranges on both sides of an impoundment is likely to be lost.

Several subpopulations of moose are known to rely on migrations across the impoundments. Therefore, blockage of migration appears to be a problem which will limit the ability of individual moose to adapt to an otherwise stressful situation such as localized overpopulation or severe winters.

Hazards - Mud and ice shelving around the Watana impoundment is likely to create hazards to moose. There are numerous instances where moose have been mired in mud or injured or killed by falls on ice.

Perhaps more important is the role these hazards might play in increasing vulnerability to predators. Wolves commonly kill moose at the edges of lakes suggesting that such areas facilitate hunting by wolves. The presence of ice shelves might further benefit the wolves. Our data indicate that densities of moose near the shore of the Watana impoundment are likely to be high in certain areas. The rate of predation by wolves, and possibly bears, could be significantly higher than in the absence of the impoundment.

Other hazards are likely to be created by construction of project facilities. Moose-vehicle collisions are likely to occur where roads pass through moose wintering concentrations. Routing of access roads and control of traffic levels will be major factors determining the seriousness of this problem.

Vulnerability to Hunting - The vicinity of the proposed impoundments is relatively lightly hunted because of limited access. There is some evidence that such areas help sustain harvest levels in adjacent accessible areas through dispersal.

Roads to the impoundments will greatly increase access by highway vehicle, ATV, boat and aircraft. There are already indications that hunting and trapping effort in the area have increased simply because workers at the Watana became familiar with the area and tended to return to the area. We can expect a substantial increase of interest in the area by the thousands of workers that will be brought in during construction and operation of the project.

Hunting and trapping can be controlled through existing State regulatory mechanisms. However, the risk of localized or short term overharvest will be increased and management of moose is likely to become less flexible. We can expect more restrictive regulations over a large portion of the Basin.

<u>Numbers of Moose to be Impacted by Susitna Hydroelectric Development</u>.

Because the mechanisms of impact of the Susitna Project on moose are likely to be complex and often indirect, it is difficult to accurately delineate a zone of impact and to estimate the number of moose that will be impacted. First, it is necessary to define an impact. Impacts can range from the permanent loss of the capacity of a habitat to support some number of animals, or even to support a population, to short term inconvenience to an individual animal. For the purposes of this discussion we are concerned with impacts that are likely to affect the size or productivity of the population. Impacted individuals would be effectively removed from the population, would be less capable of successfully reproducing under stressful conditions such as severe winters, or would have a shorter life expectancy due to environmental factors such as severe winters, predation or hazards.

We can assume that all moose whose entire home range falls within areas that will be inundated will be lost. As we move away from the impoundments we would expect a progressively smaller proportion of moose to experience progressively less severe impacts.

Therefore, based upon the observed movements of moose, the continuum of impacts ranges from the impoundment areas to approximately 110 miles (177 km) away from them. We have classified all impacts into three broad categories. Impact categories include: (1) severe impacts - moose which reside in the impoundment area or which spend significant portions of their life in close proximity to them (5 miles) will be subjected to all of the identified impacts in the previous section at their most severe intensity. Moose which fall into this category will suffer high rates of mortality, decreased natality and probably disruption of movements and dispersal; (2) moderate impacts - moose which are subjected to this level of impact do not reside in the impoundment area but do spend portions of the year in areas which would indirectly be influenced by the effects of the project. All of the mechanisms of impact identified in the previous section would exist but crowding, vulnerability to predation, blockage of migration and lower dispersal rates appear most important. Moose in this category would be expected to suffer lower rates of productivity and higher rates of mortality than before the project but the magnitude would be less than those which would be severely impacted; (3) slight impact - moose in this category would be affected indirectly by the project to varying but unknown degrees. All of the mechanisms of impact may operate on these moose but the severity will be much less than those in the severe or moderate category and thus the impacts may not even be detectable.

To estimate the numbers of moose which could be impacted both severely and moderately by the project we determined the average maximum length of total home range sizes for 162 radio-collared moose for which 4 or more observations had been made (Table 21 and Appendix B.). Based upon this analysis we determined that the average length of a total home range for all radio-collared moose of both sex and all age classes was 28.7 km^2 (17.8 mi.). We applied the measurement to the proposed impoundments and plotted this distance from the impoundment. We used the resulting area to determine moose which would be moderately affected by construction and operation of the proposed project. Further reference to this area will refer to the zone of impact (ZI). We also delineated a 5 mile zone from the edge of the impoundment, which roughly correlated to 1/3 of a moose home range, which we believed all residing moose would be severly impacted by construction and operation of the project. Specific delineations around borrow pits and access routes were not made. The 5-mile zone is referred to as the severe impact area (SIA).

Boundaries of the ZI and SIA were overlaid onto the boundaries of the area for which moose population estimates were made in 1980 (Fig. 17). The original stratification and census boundary reported in the first annual report (Ballard et. al. 1980) was expanded for this analyses to include an adjacent area which was also censused 1980 another study (Ballard et. al. in press). The combined population estimate for fall 1980 was 4,500 moose.

Individual total home range polygons for 167 radio-collared moose were overlaid on Fig. 17. The numbers of moose within portions of their home range in the area estimated to contain 4,500 moose in fall 1980 were tallied. Of the 167 moose for which home range polygons existed, 19 had home ranges which fell outside the area of interest. Of the 148 moose contained within the census and ZI boundaries, 100 of them had polygons which completely or partially overlapped the ZI while 79 completely or partially overlapped the SIA. The percentage proportions of radio-collared moose which overlapped the ZI and SIA were applied to the population estimate of 4,500 moose. This resulted in an estimate of 3,040 moose which seasonally or annually occupy the area within one home range of the impoundment or the ZI (zone of impact). These latter moose would be moderately, impacted by the project. Of that total an estimated 2,402 moose completely overlapped or had portions of their home range within 5 miles of the impoundment (SIA) and these moose would be severely impacted by the project.

Several biases exist with the methods utilized to estimate the number of moose to be severly or moderately impacted by the proposed project. Perhaps, most importantly, the method assumes that all areas within the census area received equal capture effort. Although this assumption can not be entirely fulfilled, the initial capture and distribution of radio-collars was generally based upon the distribution and density of moose present during a given capture year. Admittedly capture efforts in spring 1980 and spring 1981 were focused on areas immediately adjacent to the impoundments. For that reason and because of moose movements information, the area above the Denali Highway was added to the analysis. The addition of the area with its relatively large numbers of radio-collared moose which did not overlap the ZI or the SIA helped to reduce or even reverse the initial capture biases. Without the addition (correction), the estimates for numbers of moose occupying the ZI and SIA would have been 3,300 and 2,607, respectively. The analysis also assumes that immigration and emigration of moose were equal. Although too few moose have been captured outside of the area to measure immigration the preliminary analysis of movement data suggests that a significant number of yearling moose may emigrate from the area.

An additional criticism of the methods used in this section are that moose which have very small portions of the home range within the impact areas are given equal weight with those which have most or all of their home range in the area. This argument could be valid except that moose which become displaced from the reservoir area will then be competing for home range space with those moose which have small areas within the impact zone.

Regardless of the biases associated with this method we believe it provides a minimum estimate of the numbers of upstream moose which will be severely or moderately impacted by the project.

No attempt was made to enumerate the numbers of moose which would be slightly impacted. In conclusion, we estimate that 2,400 moose would be severely impacted by the project and an additional 900 would be moderately impacted.

PROPOSED STUDIES FOR PHASE II

Phase I studies have identified a number of potential impacts that construction and operation of the project would have on moose. It also has identified a number of areas where additional information is necessary before a complete evaluation of the project's effects on moose can be made. The following study segments have been designed to fulfill the additional data requirements.

The importance of the two proposed impoundment areas to both migrant and sedentary moose during a severe winter has been a topic of much speculation during Phase I studies. Determining the importance of the project area to the several identified subpopulations of moose during severe winter conditions is necessary. To accomplish this objective we propose that moose studied in Phase I be recollared early in Phase II and that they be monitored bimonthly to determine their location during a severe winter. Winter severity will be determined by continued monitoring of snow depths at established snow courses and weather station data. When winter conditions become severe the identified zone of impact will be intensively censused so that the numbers of moose which would be impacted by the project during severe winter conditions can be determined.

While the above-mentioned studies are in progress, a more concerted effort should be made to determine habitat use by moose in relation to plant availability. This will require a redirection of Phase I plant studies so that they focus on important moose habitat types. Concurrently with vegetation studies a moose food habits study should be initiated to determine the seasonal important of different plant species. Willows appear to constitute a significant portion of the winter diet but relatively little is known concerning the diet during the remaining seasons. Food habits will be investigated through a combination of pellet analyses, analyses of rumen contents, and from ground observations of moose.

During Phase I studies, an attempt was made to determine if dispersal of juvenile moose from the project area could be an important aspect of moose biology which potentially could be impacted by the project. During the first year following the capture and collaring of 16 calves, at least 4 (25%) have made significant dispersals away from the project area. Additional dispersals will probably occur during the calves' second and third year of life. Therefore, it appears that dispersal of juvenile moose could be significantly impacted by the project. Reductions in the magnitude of dispersal observed thus far could significantly affect the population dynamics of moose which are far removed from the project area and consequently could affect human hunting success in other areas. To acquire additional information on this important aspect of moose biology the surviving calves of radio-collared cows should be captured in fall 1982 and 1983 and monitored bimonthly concurrently with the cows for a minimum of 2 years.

During Phase I studies, mortality of calves of radio-collared cows was quite high. Earlier studies in other areas of south-central Alaska documented predation by brown bears as the most important neonatal mortality factor. The latter study areas were not inhabited by black bear and generally had lower wolf densities than those in the study area. Therefore, calf mortality in the project area could be attributable to 3 species of predators. Determination of the amount of moose calf mortality attributable to each predator species is necessary to evaluate the project's effects on both predator and prey. Although a number of justifications exist for pursuing a calf mortality study in relation to the impoundments, one potential ramification concerns determining the extent of mortality attributable to black bears. If black bears constitute a major source of calf mortality, a decreased black bear population due to flooding of den sites potentially could increase calf moose survival in the areas immediately adjacent to the impoundments. The same may also be true for brown bear and wolf predation. To determine the exact causes of moose calf mortality we propose that 75 newborn moose calves be captured and radio-collared in 1983 and 1984. Survival and determination of causes of mortality should be monitored through each summer.

All discussions concerning mitigation of impacted moose habitat have focused on either controlled burning or crushing as tools for compensating for moose losses. Although biologists generally agree that fire and/or crushing appear to benefit vegetation for moose, little quantitiative data exist on the degree, magnitude, or timing of a moose population response. Information on these parameters in several habitat types is necessary to determine the size, duration, anticipated costs, and anticipated results before a mitigation program can realistically be designed or implemented. We propose that a study be initiated in the upper Susitna Basin to investigate these questions. The initial study could consist of an evaluation of a planned management burn by the Bureau of Land Management in fall 1982 and 1983. Minimally, this evaluation should consist of determination of moose numbers and distribution during winter prior to and after the burn. These objectives would be accomplished by conducting a series of moose distribution surveys, an intensive census, and capture and radio-collaring of several moose to determine the numbers and distribution of moose in and adjacent to the area before and after the fire. The immediate response of moose inhabitating the burned area would be determined by monitoring 15 adult moose which would be captured and radio-collared immediately before the burn is initiated. They would be monitored daily while the burn was in progress and monthly afterwards.

In order for the burns to be successful in terms of benefits to the moose population, it is imperative that calf survival improve. If observation of the radio-collared cow moose do not demonstrate an improvement in calf survival, a small calf mortality study should be conducted to determine causes of mortality.

ACKNOWLEDGEMENTS

A large number of individuals from the Alaska Department of Fish and Game (ADF&G) participated in various aspects of the project and it would be difficult to give each individual recognition. Paul Arneson, Enid Goodwin, Dennis McAllister, Sterling Miller and Robert Tobey all participated in the tagging operation. David Harkness aged moose teeth.

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William Gasaway and Stephen Dubois, both ADF&G, advised us on the use of their census technique for estimating moose numbers. Bill also advised and participated in the census. SuzAnne Miller, ADF&G, participated in the stratification flights and advised on various statistical procedures. Other ADF&G members participating in the moose surveys included Sterling Eide, Dennis McAllister, and Sterling Miller. We also acknowledge the assistance provided by the following pilots: Both Kirk and Lynn Ellis, Don Deering, Ken Bunch and Al Lee. Jeffrey Coffin, R & M Consultants, assisted with determining suitable locations and with installing the snow depth markers.

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APPENDIX A

Appendix A (Figures 1 - 49) depicts movements and home ranges of individual radio-collared moose studied in the Nelchina and Susitna River Basins of Southcentral Alaska from October 1976 through mid-August 1981.

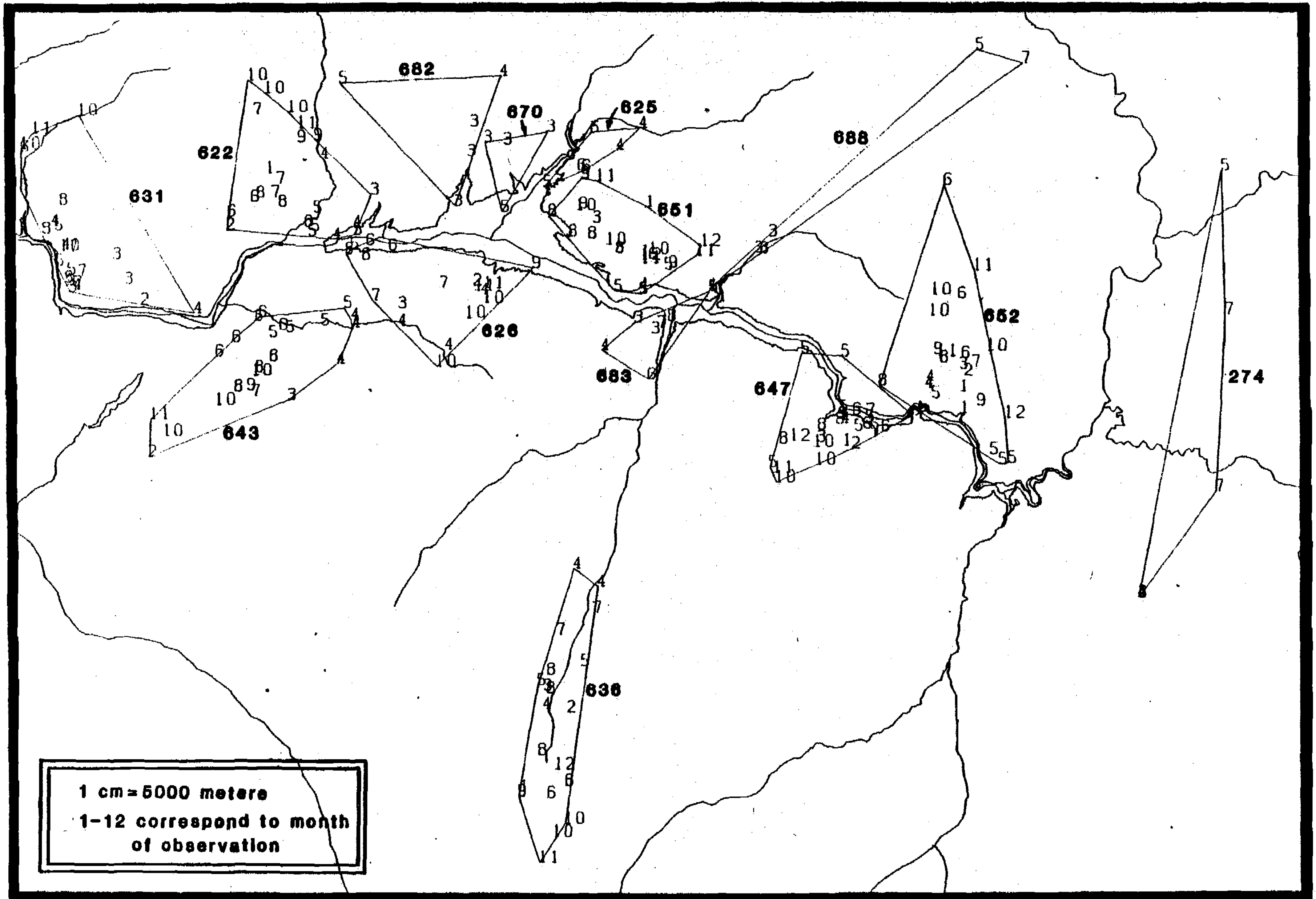


Figure 1. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 274, 622, 625, 626, 631, 636, 643, 647, 651, 652, 670, 682, 683 and 688.

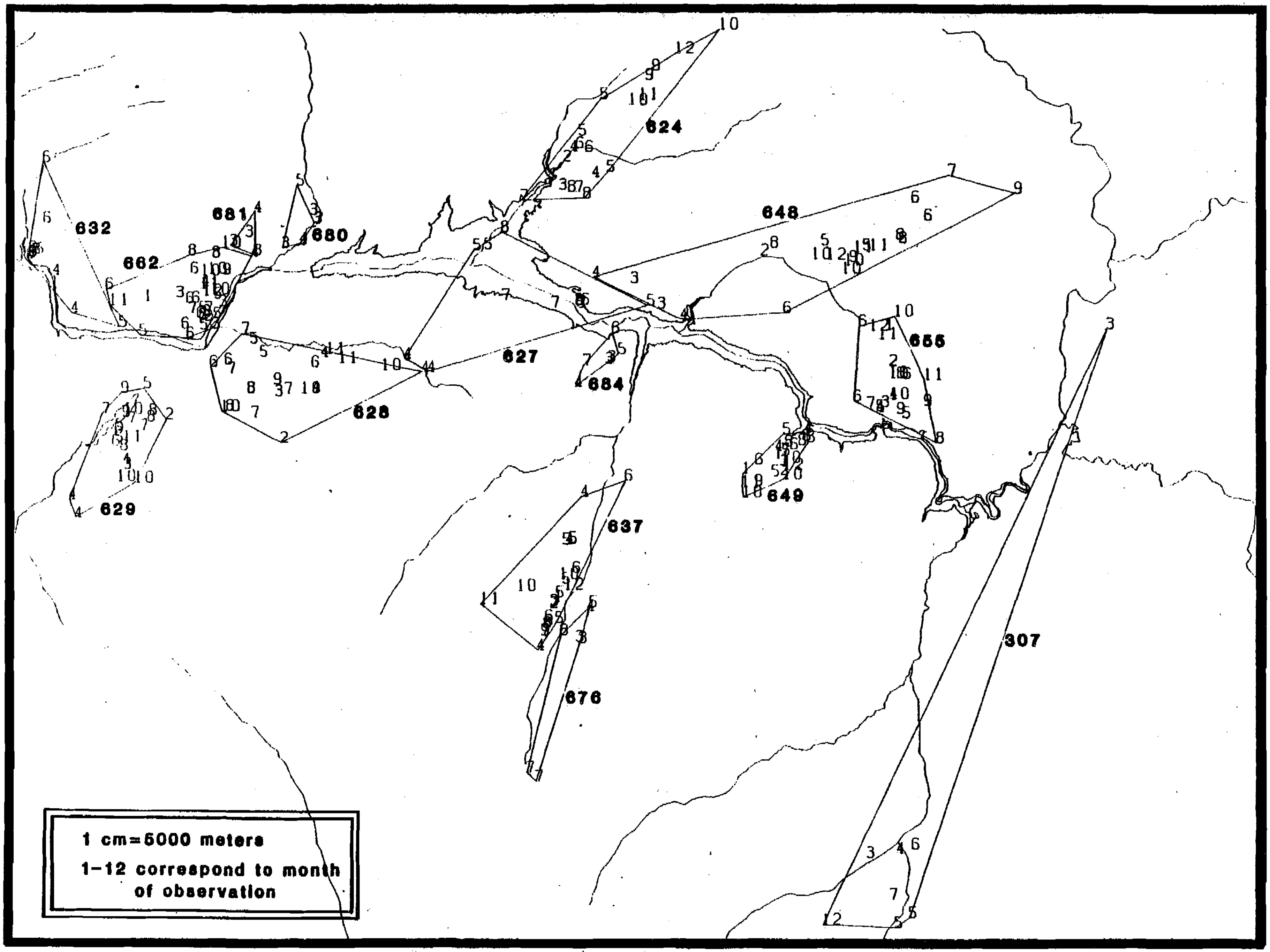


Figure 2. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 307, 624, 627, 628, 629, 632, 637, 648, 649, 655, 662, 676, 680, 681 and 684.

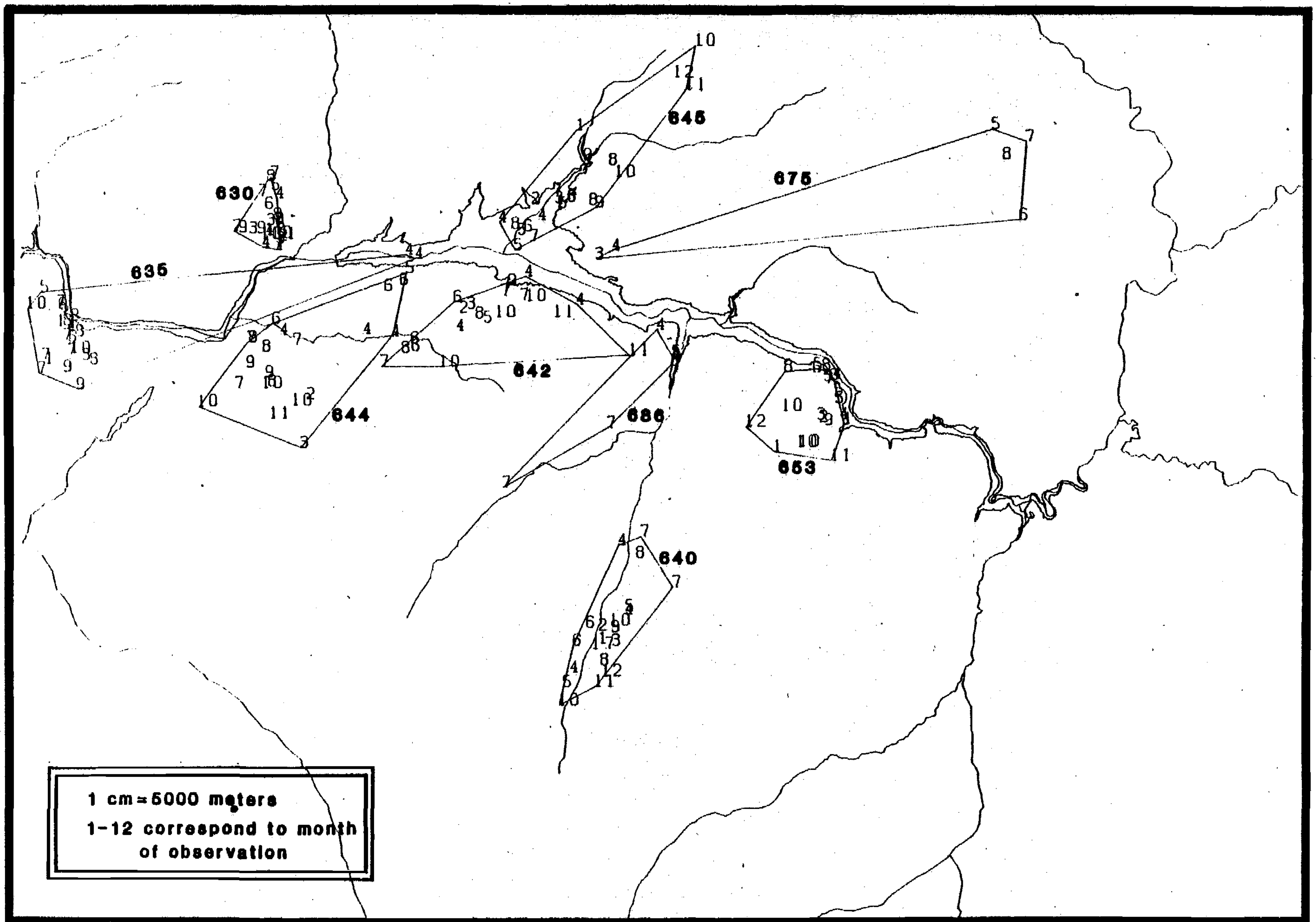


Figure 3. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 630, 635, 640, 642, 644, 645, 653, 675 and 686.

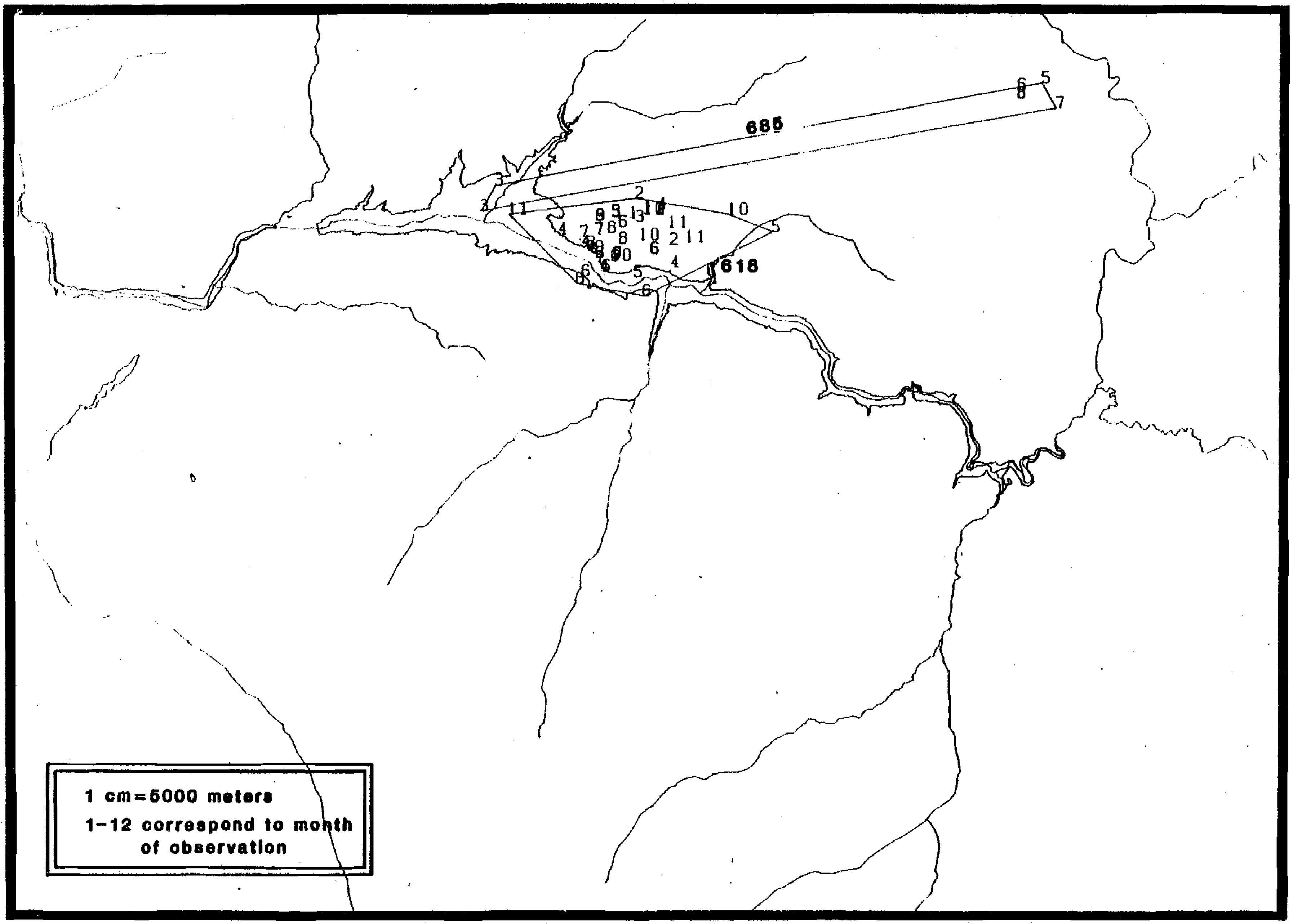


Figure 4. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 618 and 685.

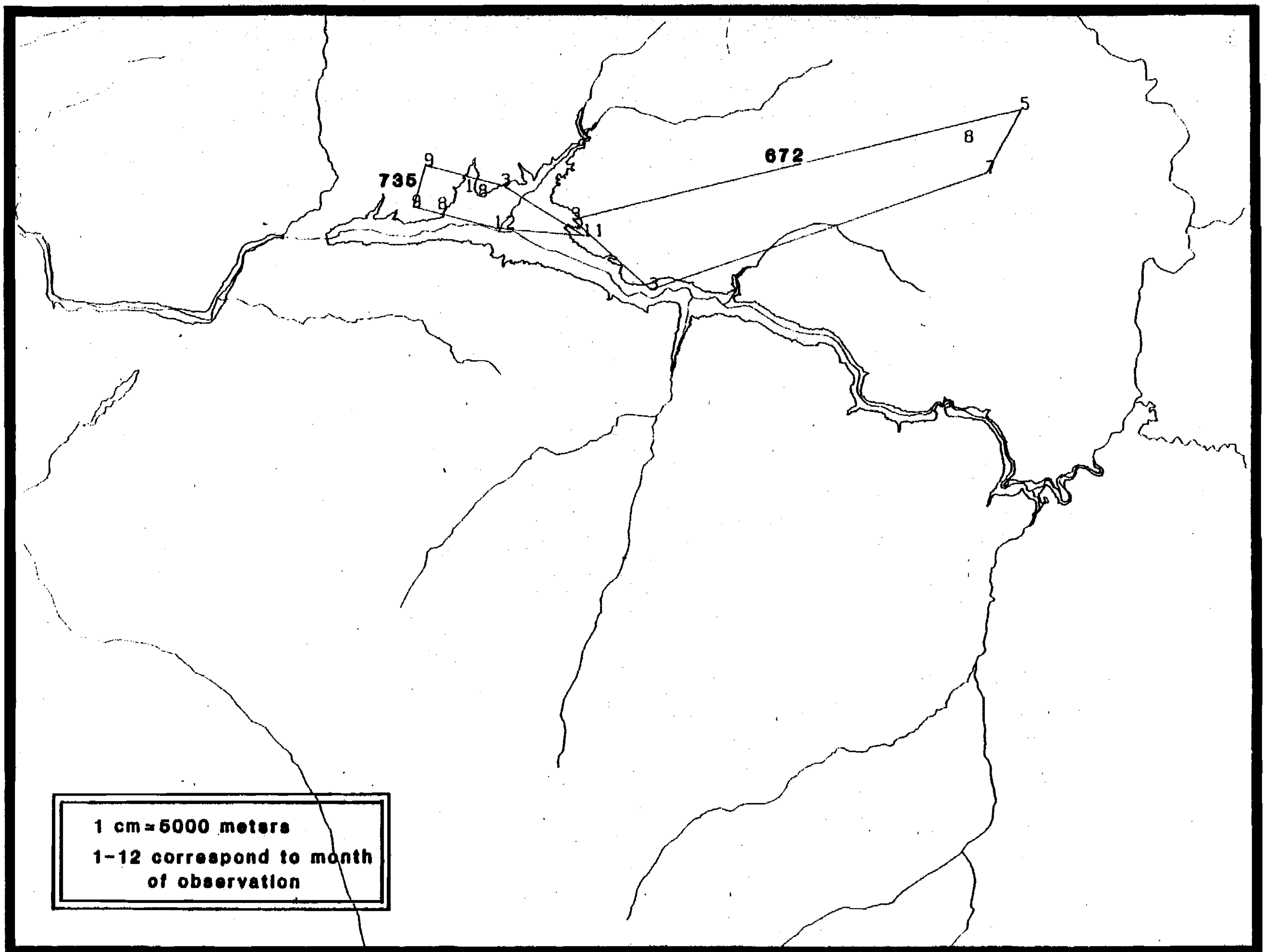


Figure 5. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 672 and 735.

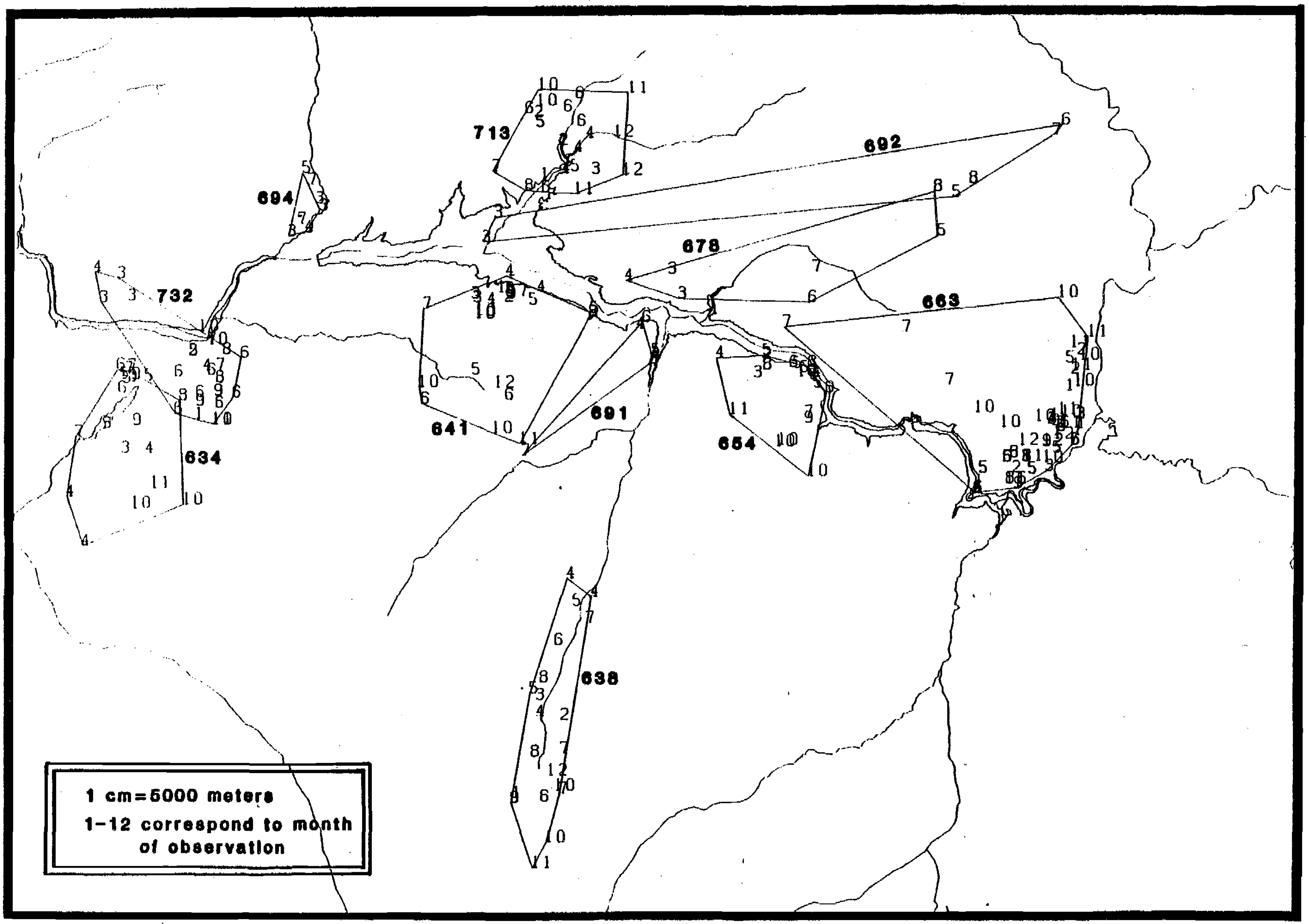


Figure 6. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 634, 638, 641, 654, 663, 678, 691, 692, 694, 713 and 732.

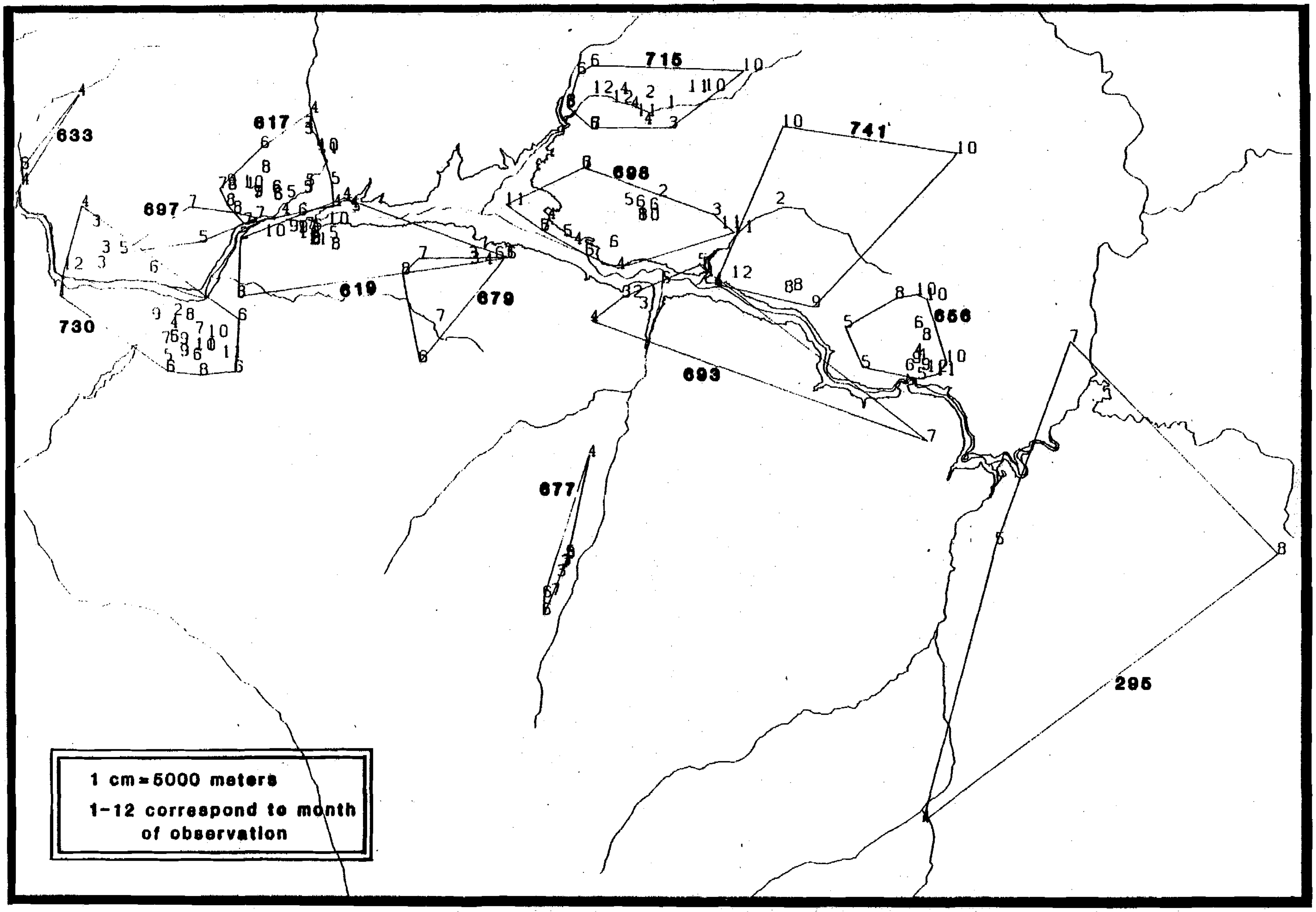


Figure 7. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 295, 617, 619, 633, 656, 677, 679, 693, 697, 698, 715, 730 and 741.

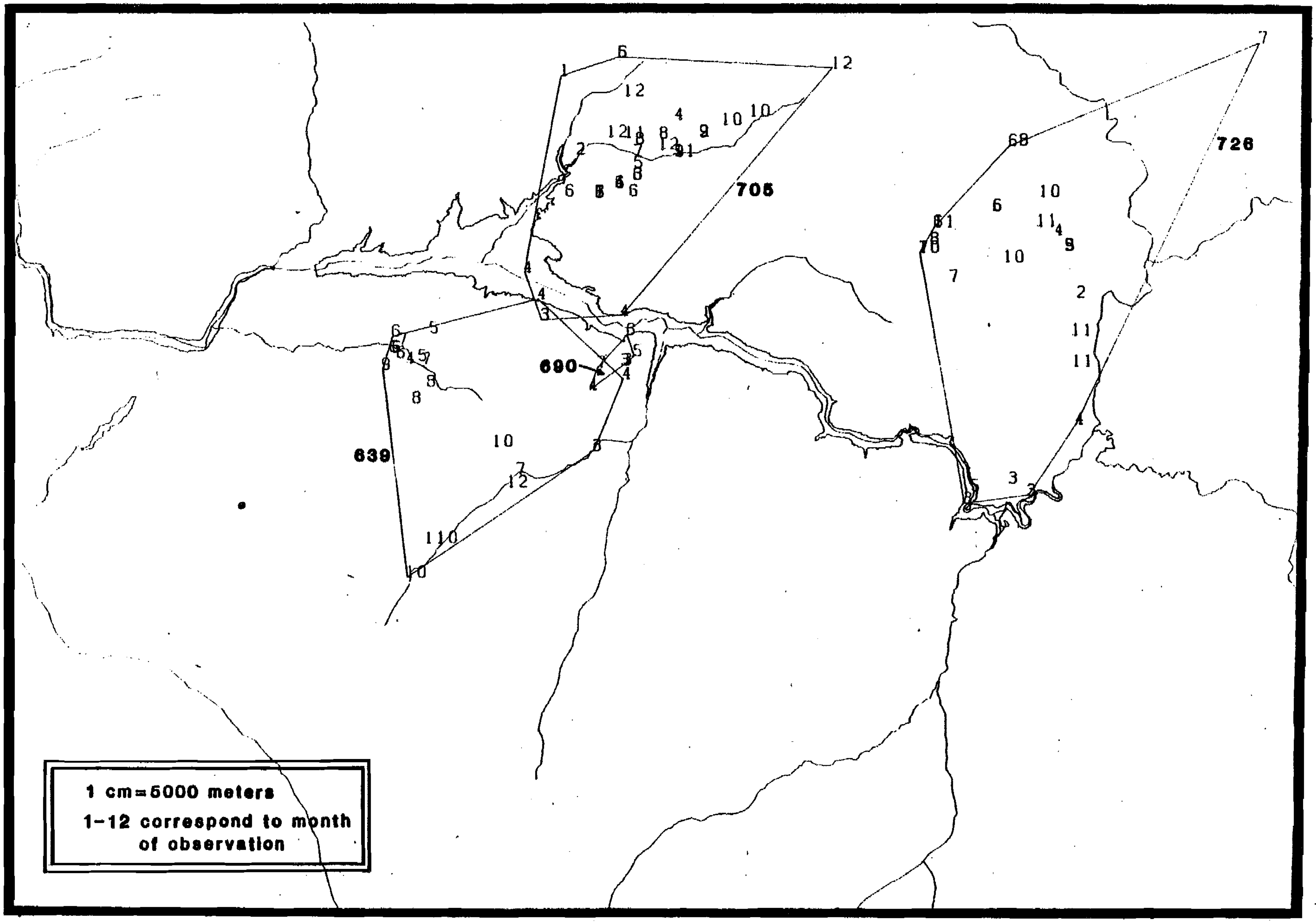


Figure 8. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 639, 690, 705 and 726.

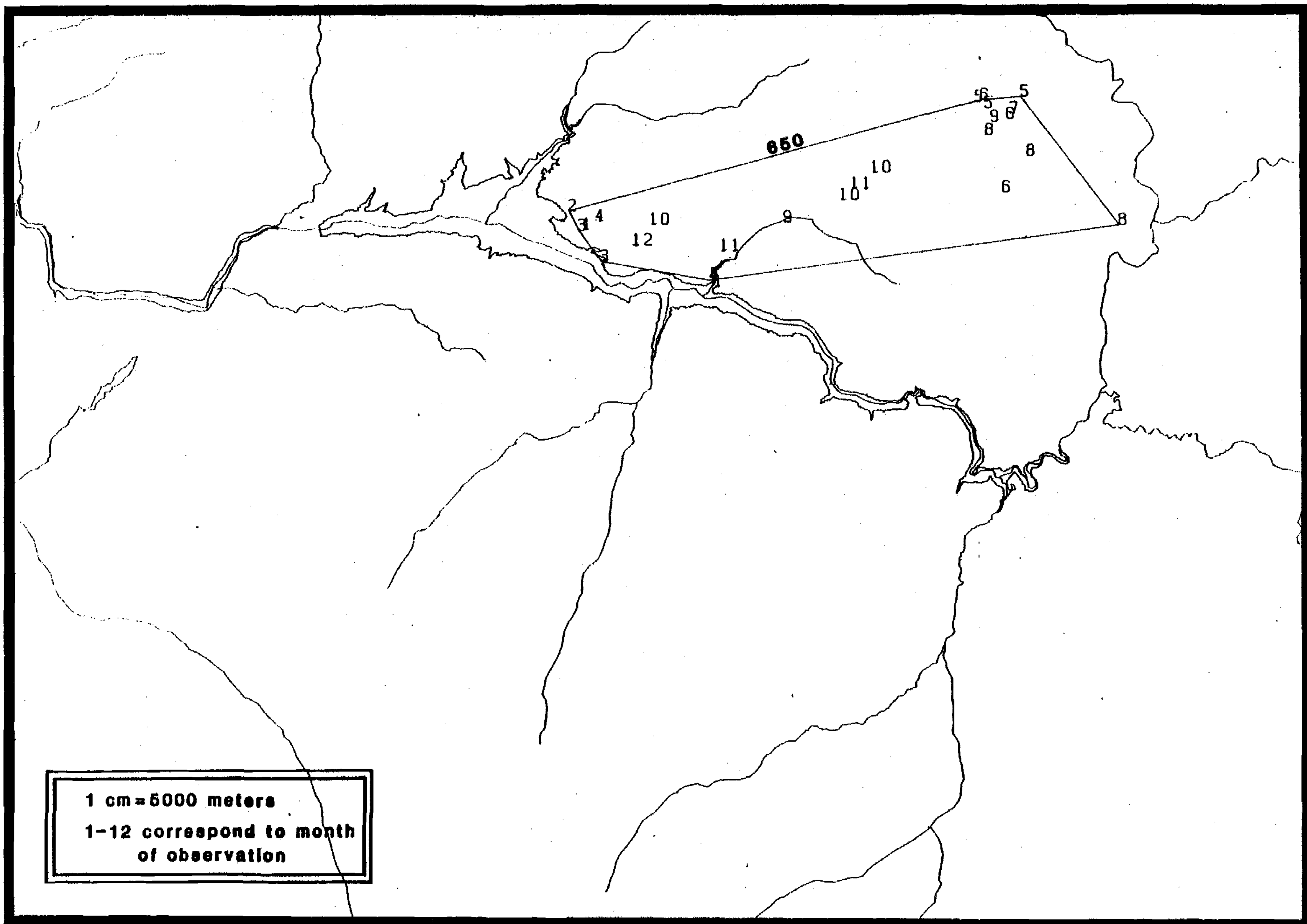


Figure 9. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 650.

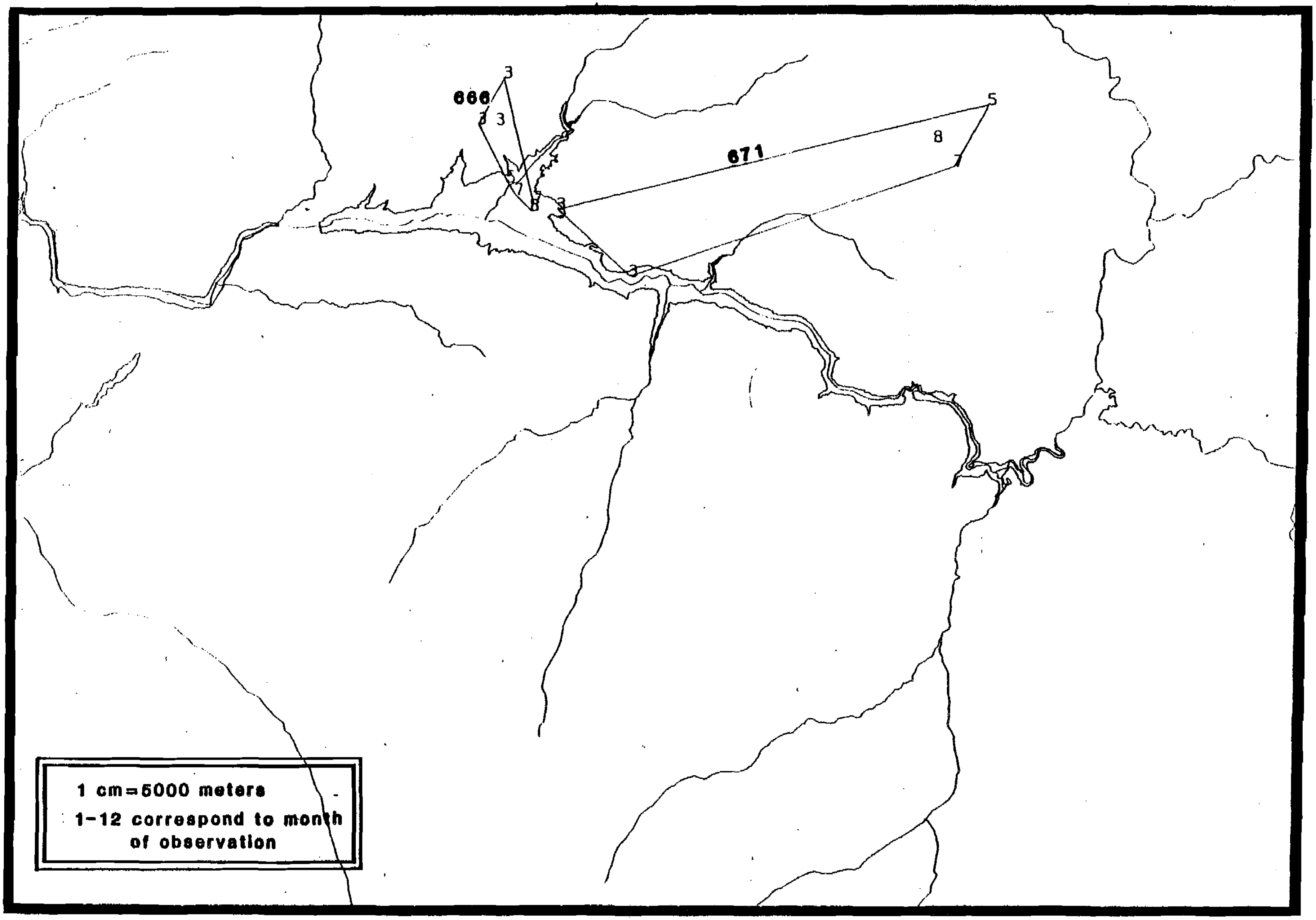


Figure 10. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 666 and 671.

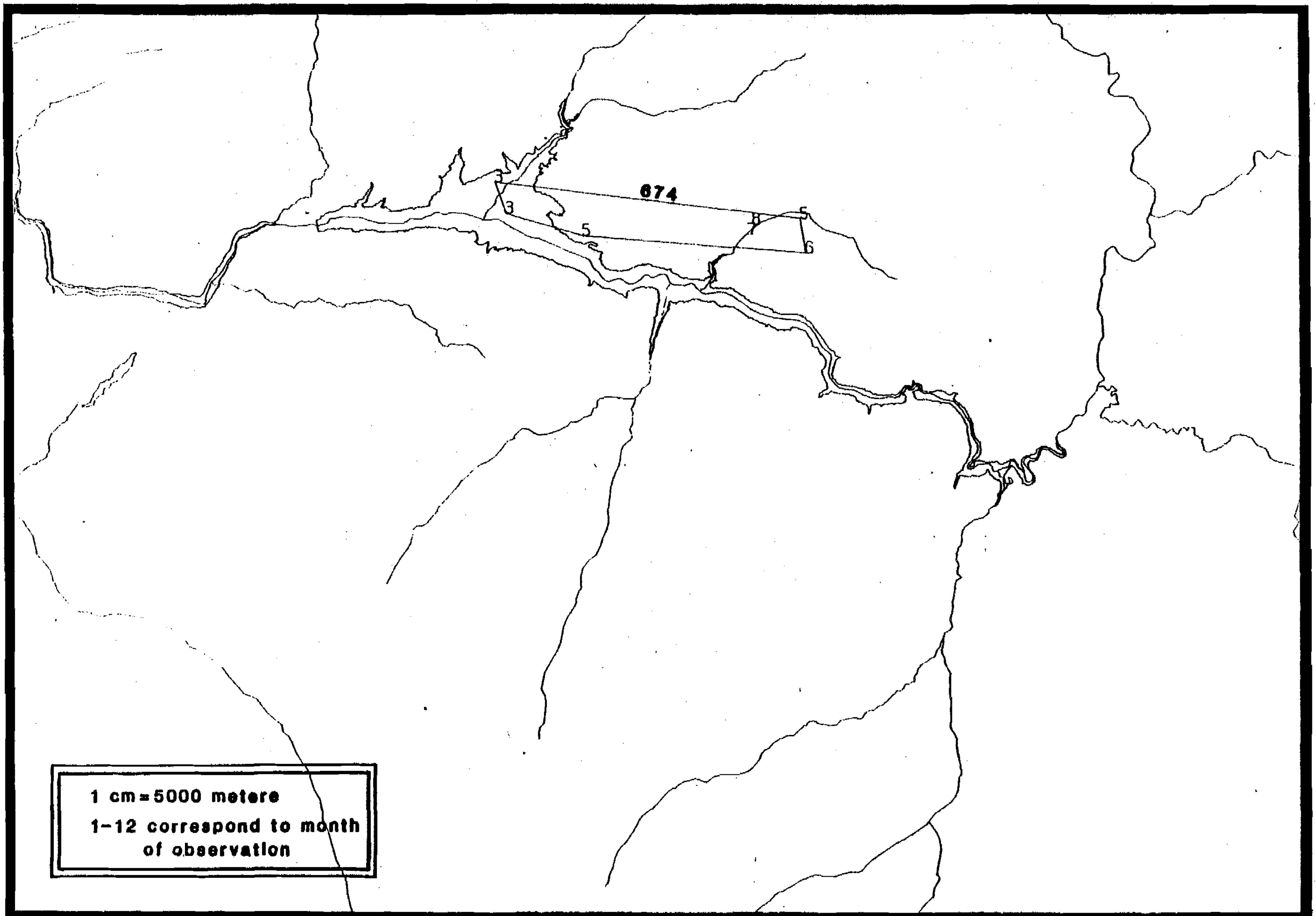


Figure 11. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 674.

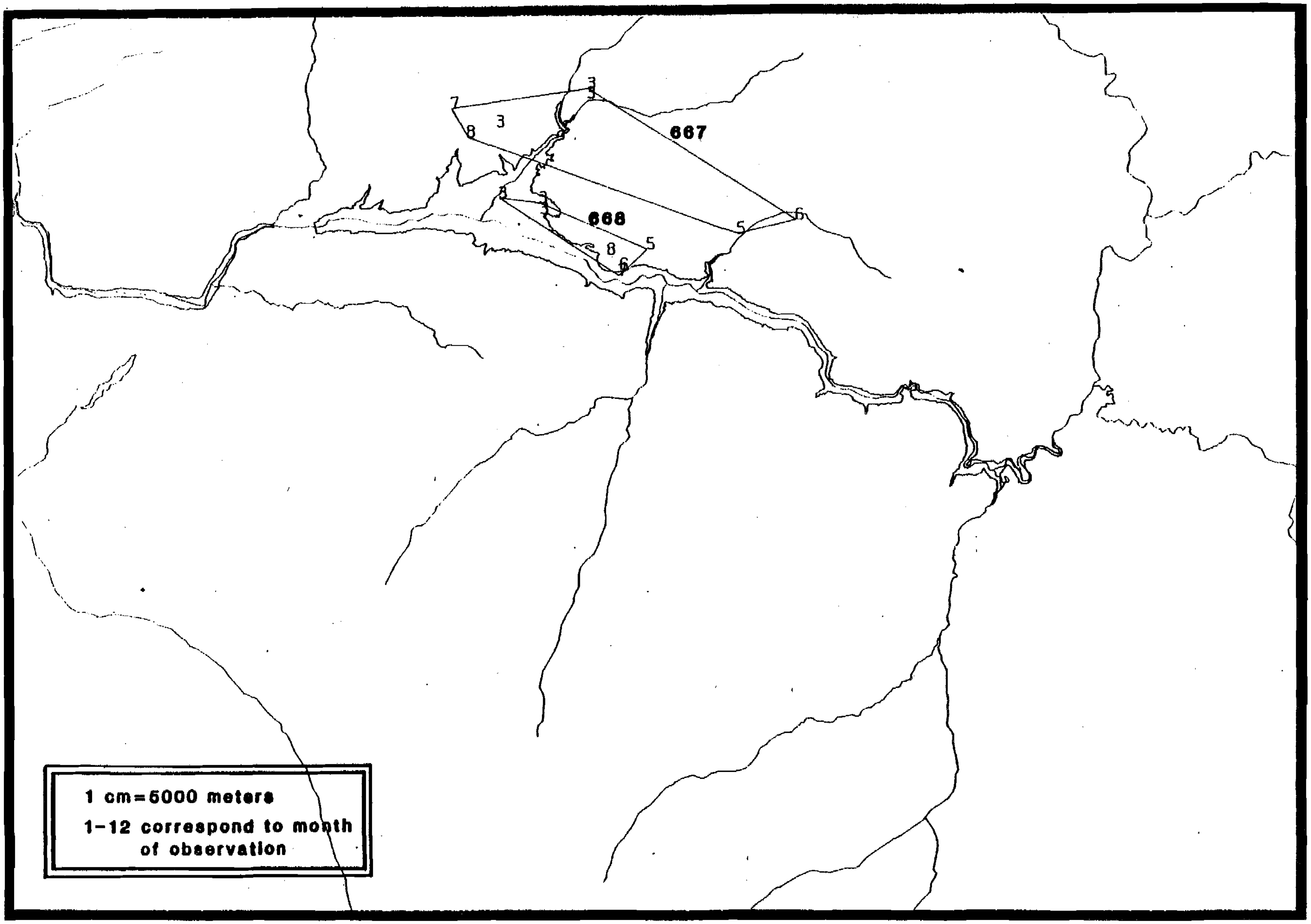


Figure 12. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 667 and 668.

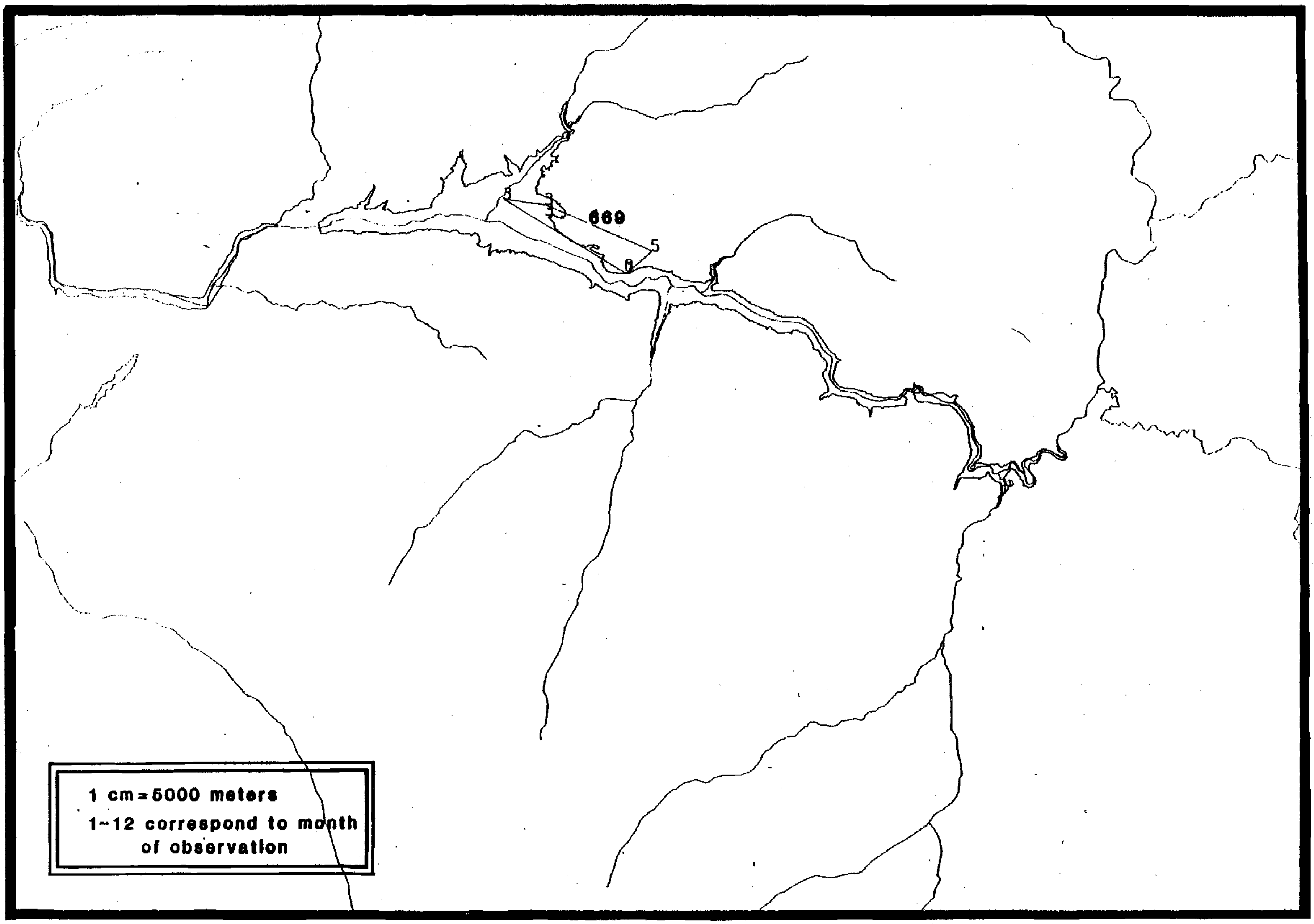


Figure 13. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 669.

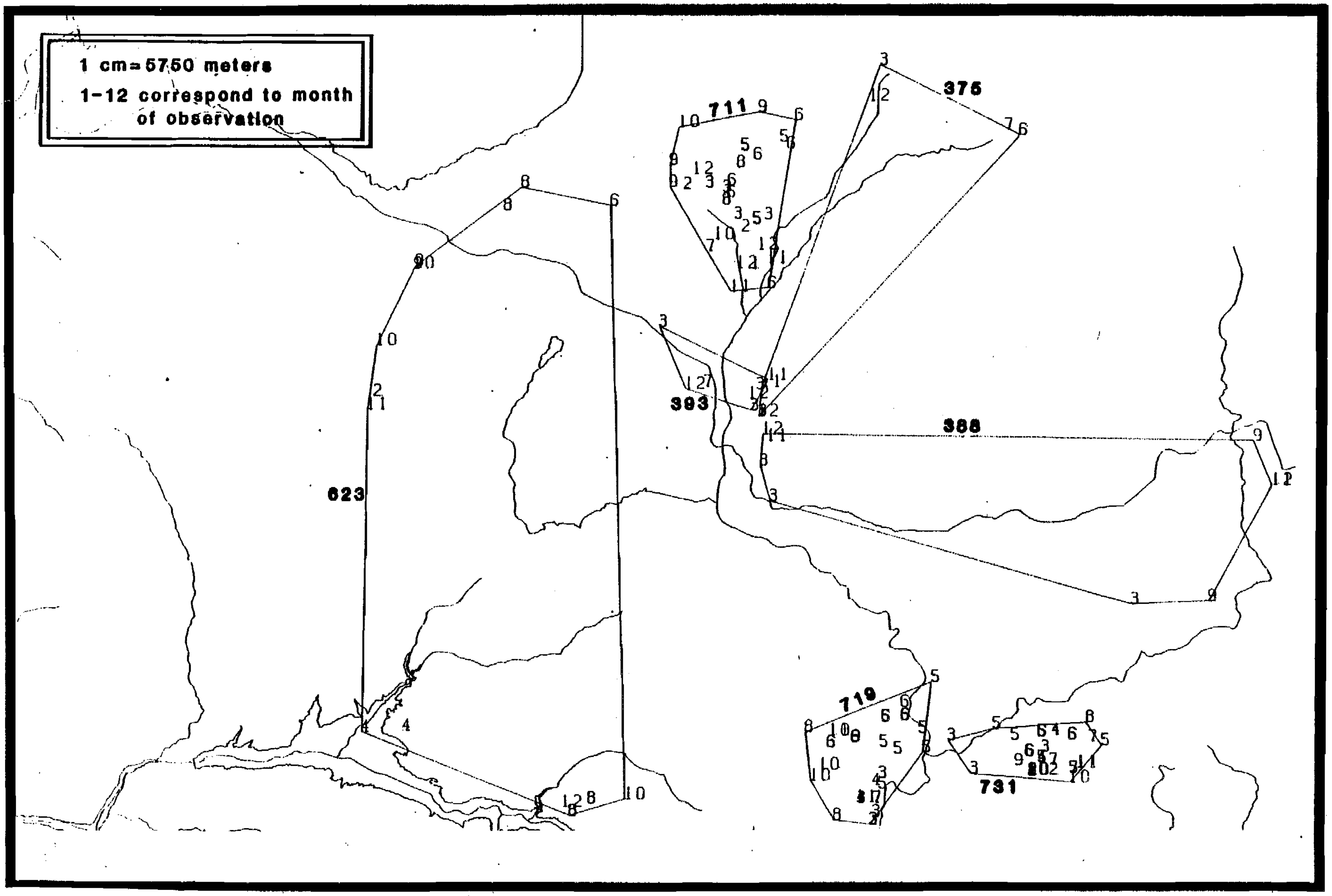


Figure 14. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 375, 388, 393, 623, 711, 719 and 731.

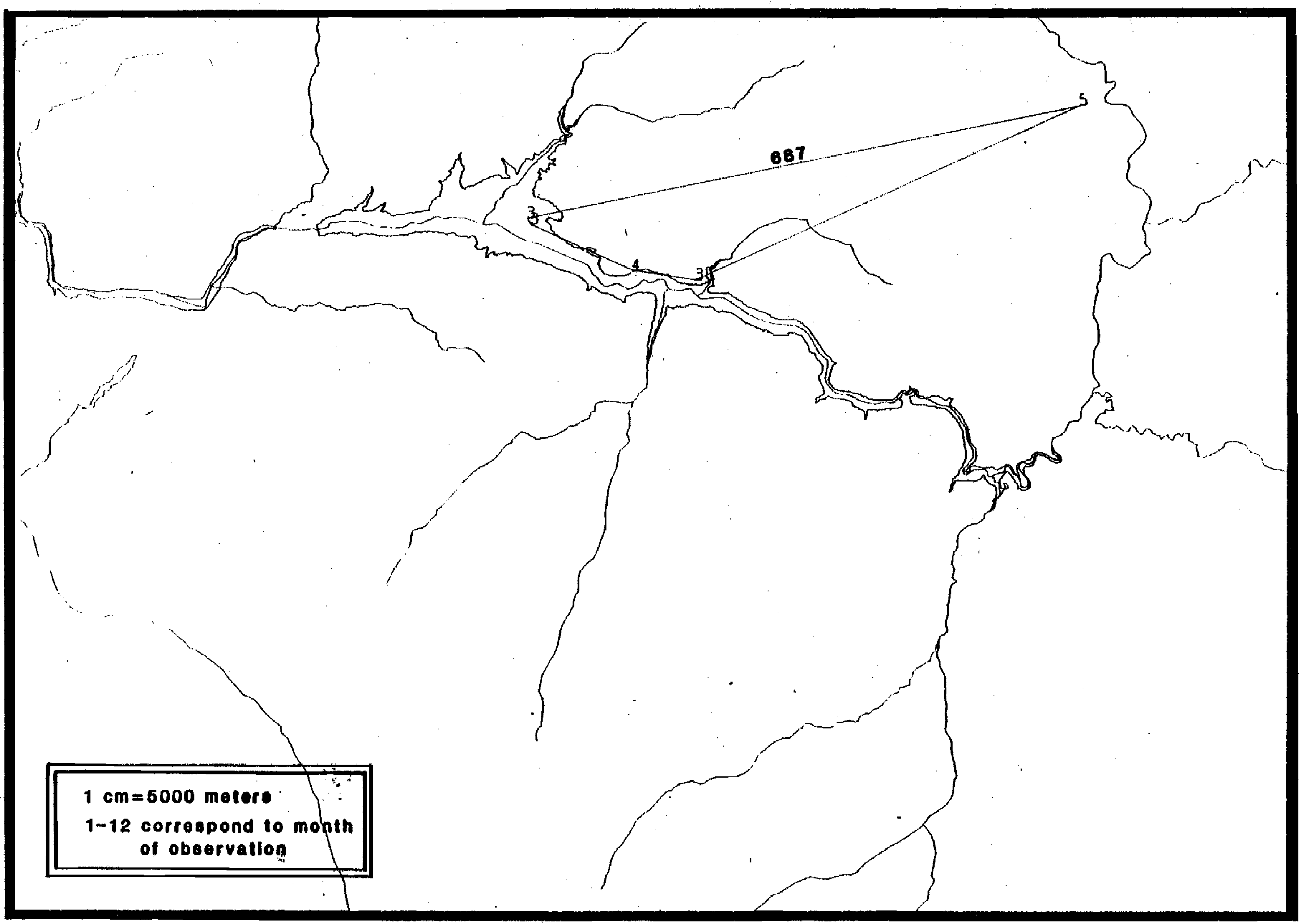


Figure 15. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 687.

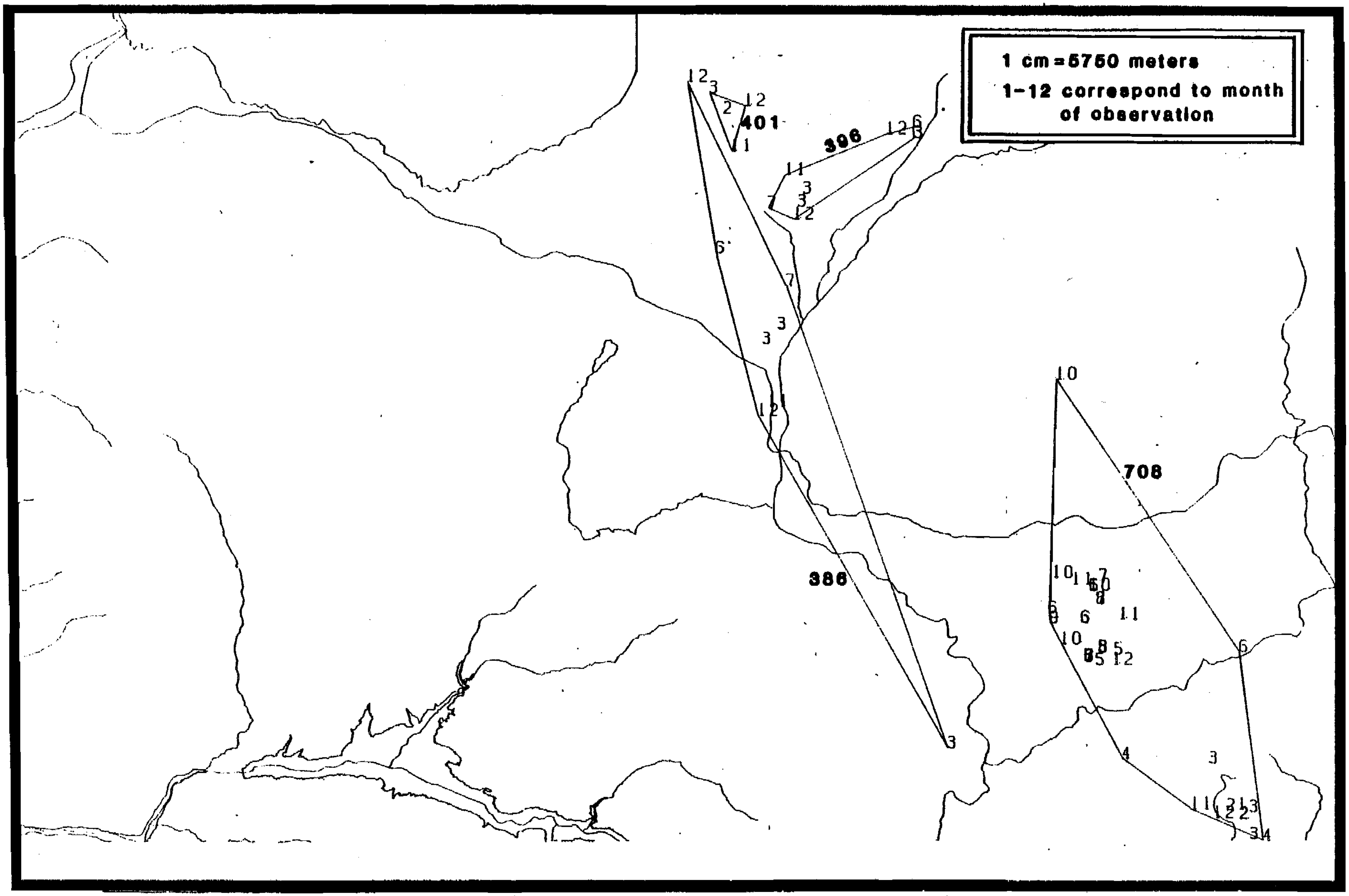


Figure 16. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 386, 396, 401 and 708.

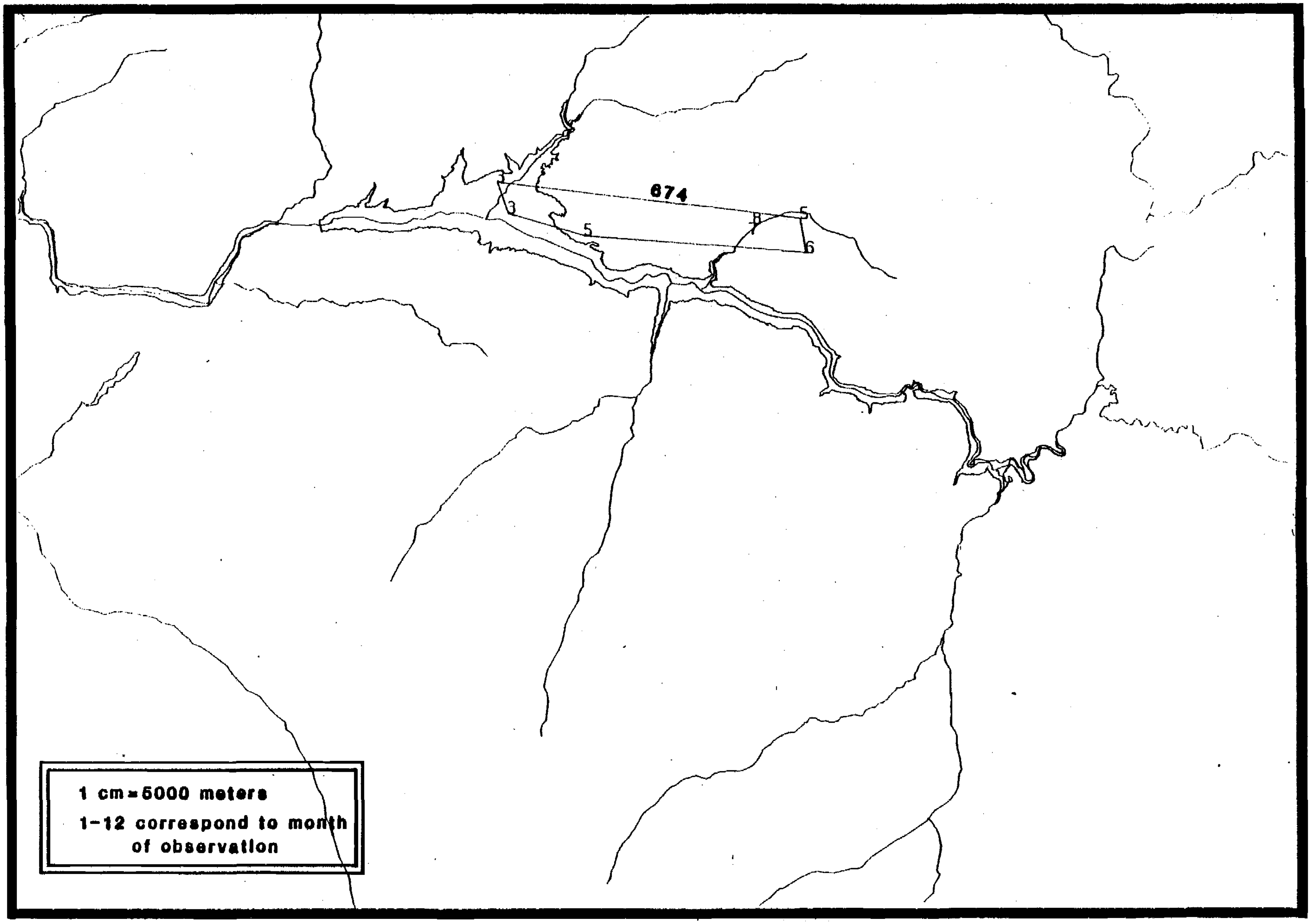


Figure 17. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 674.

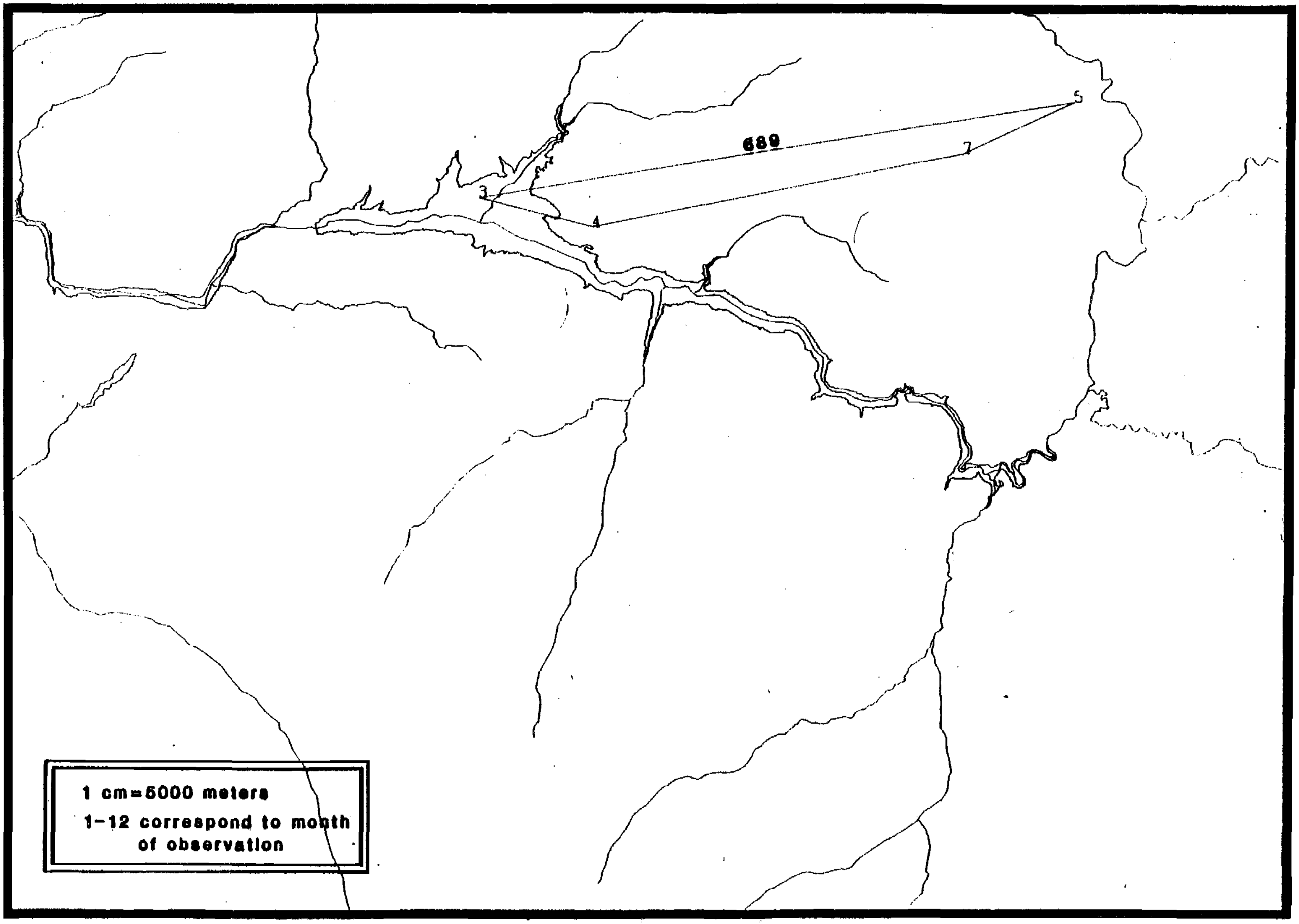


Figure 18. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 669.

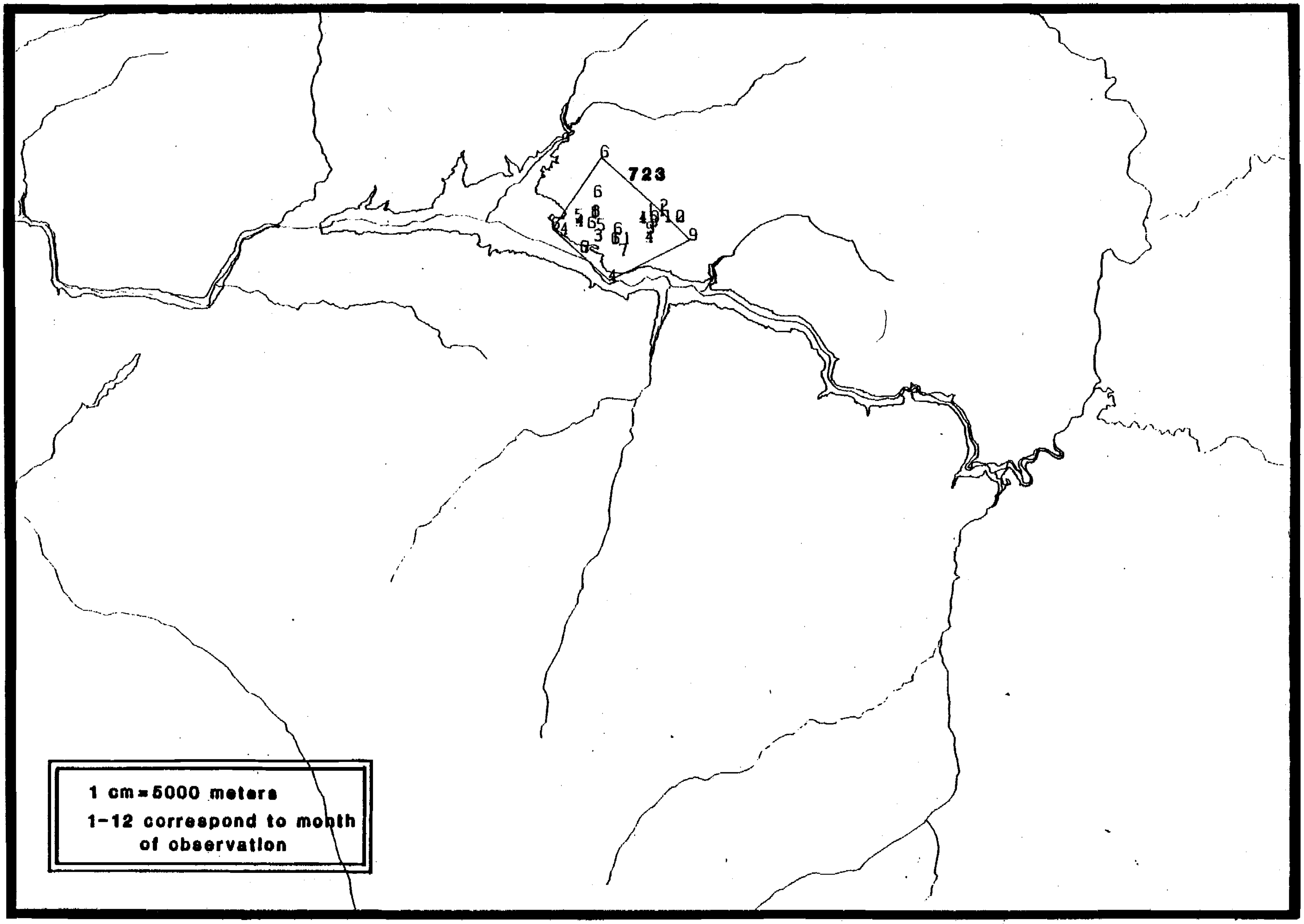


Figure 19. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 723.

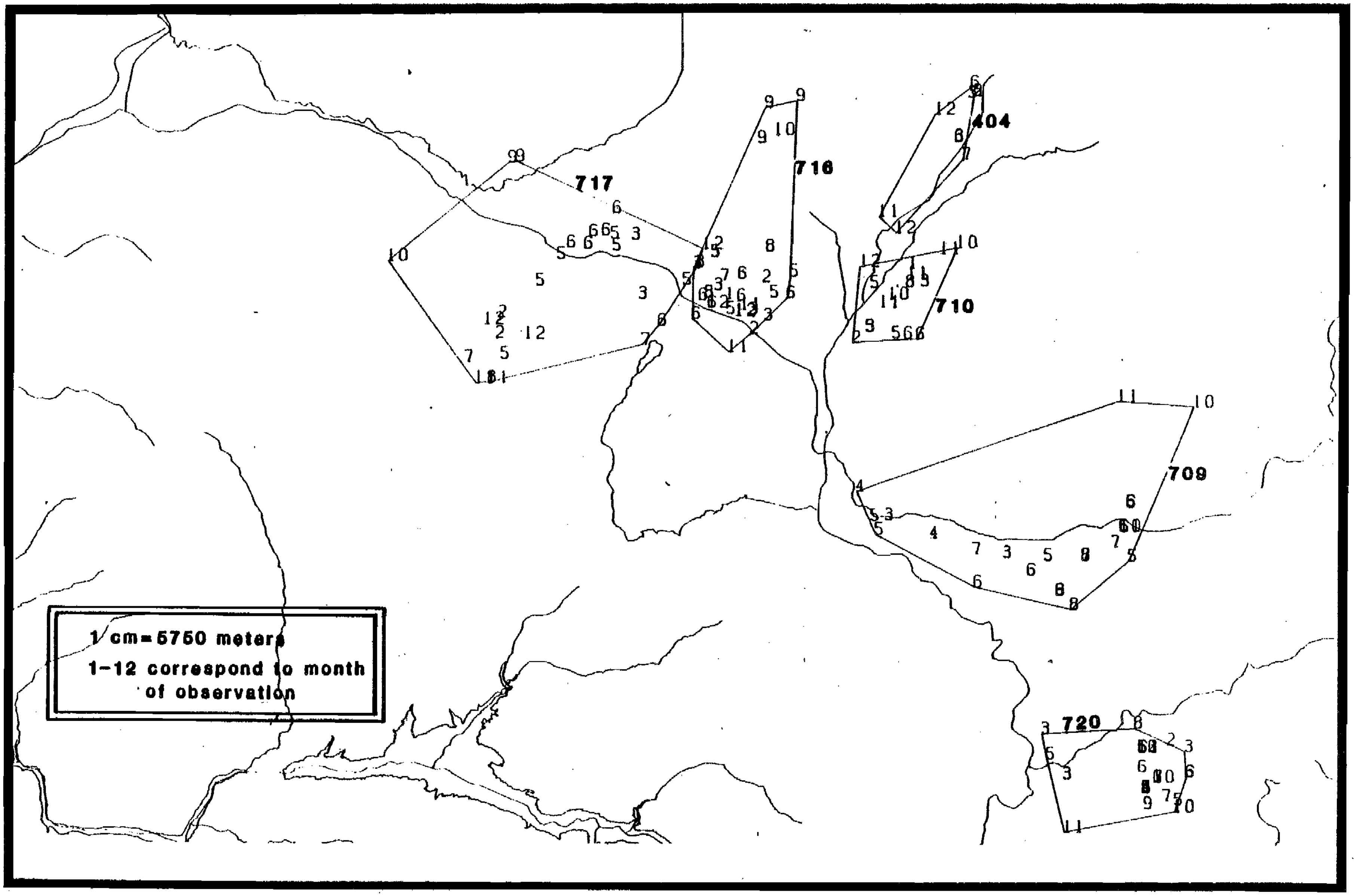


Figure 20. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 404, 709, 710, 716, 717 and 720.

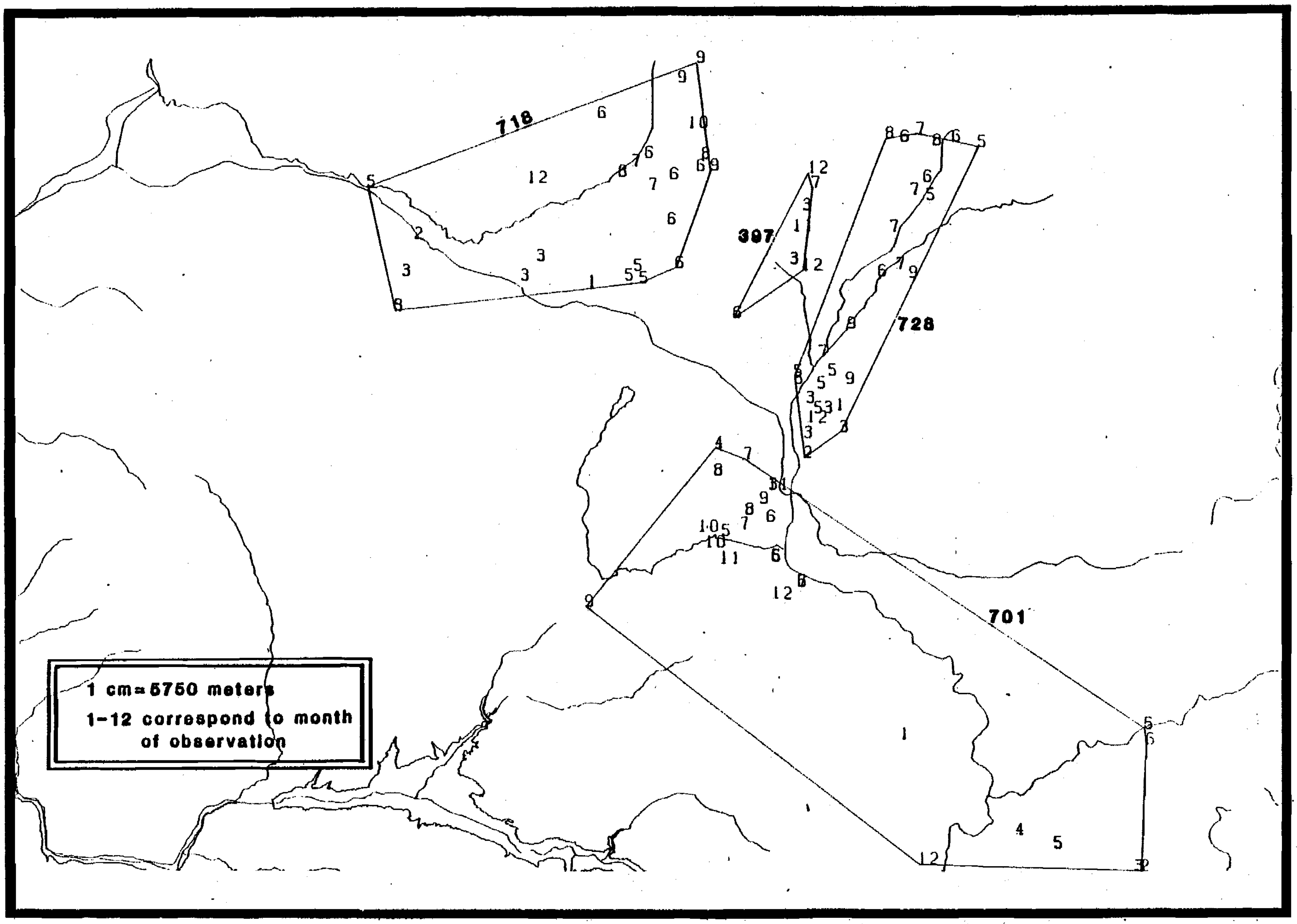


Figure 21. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 397, 701, 718 and 728.

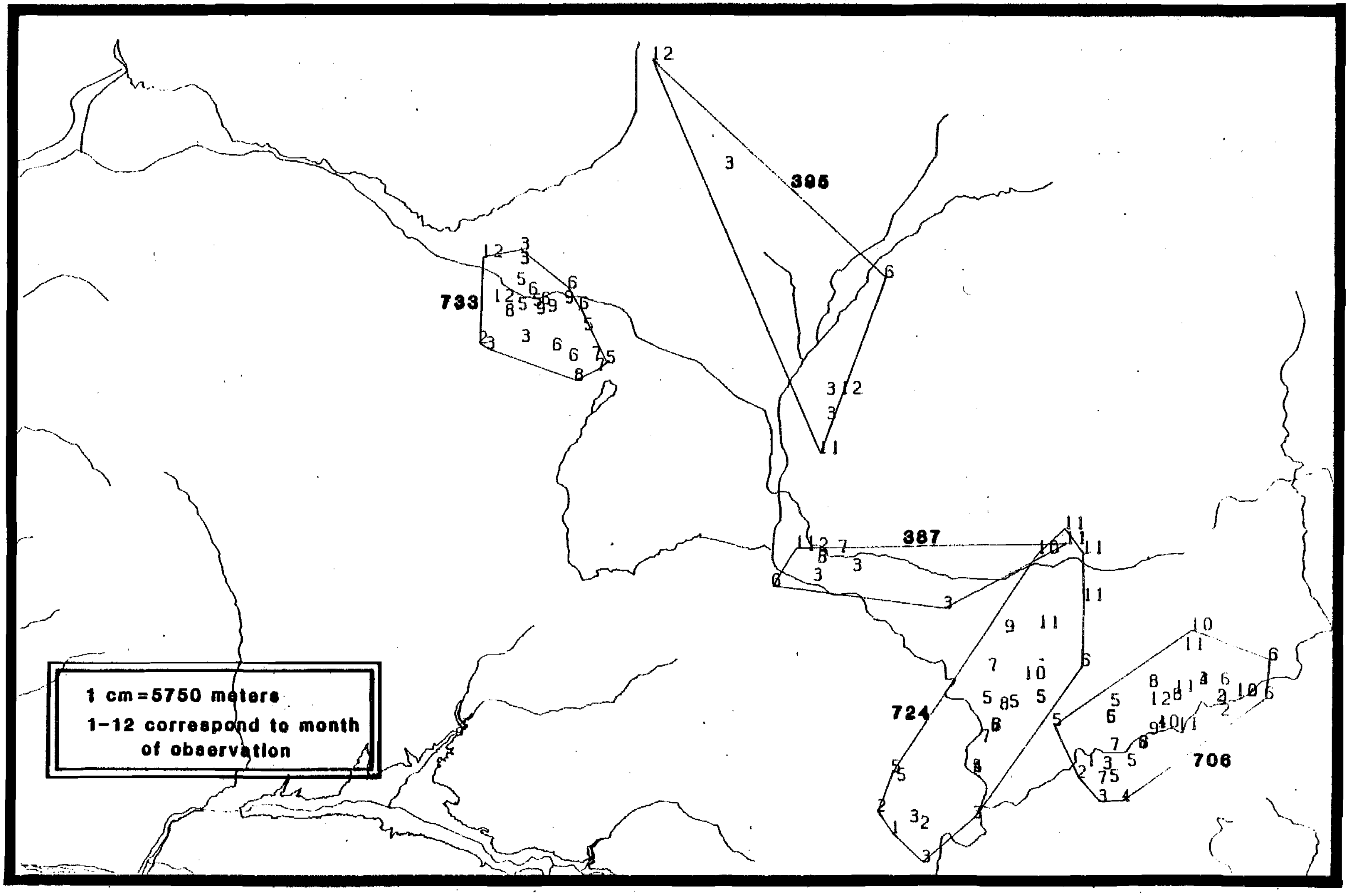


Figure 22. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 387, 395, 706, 724 and 733.

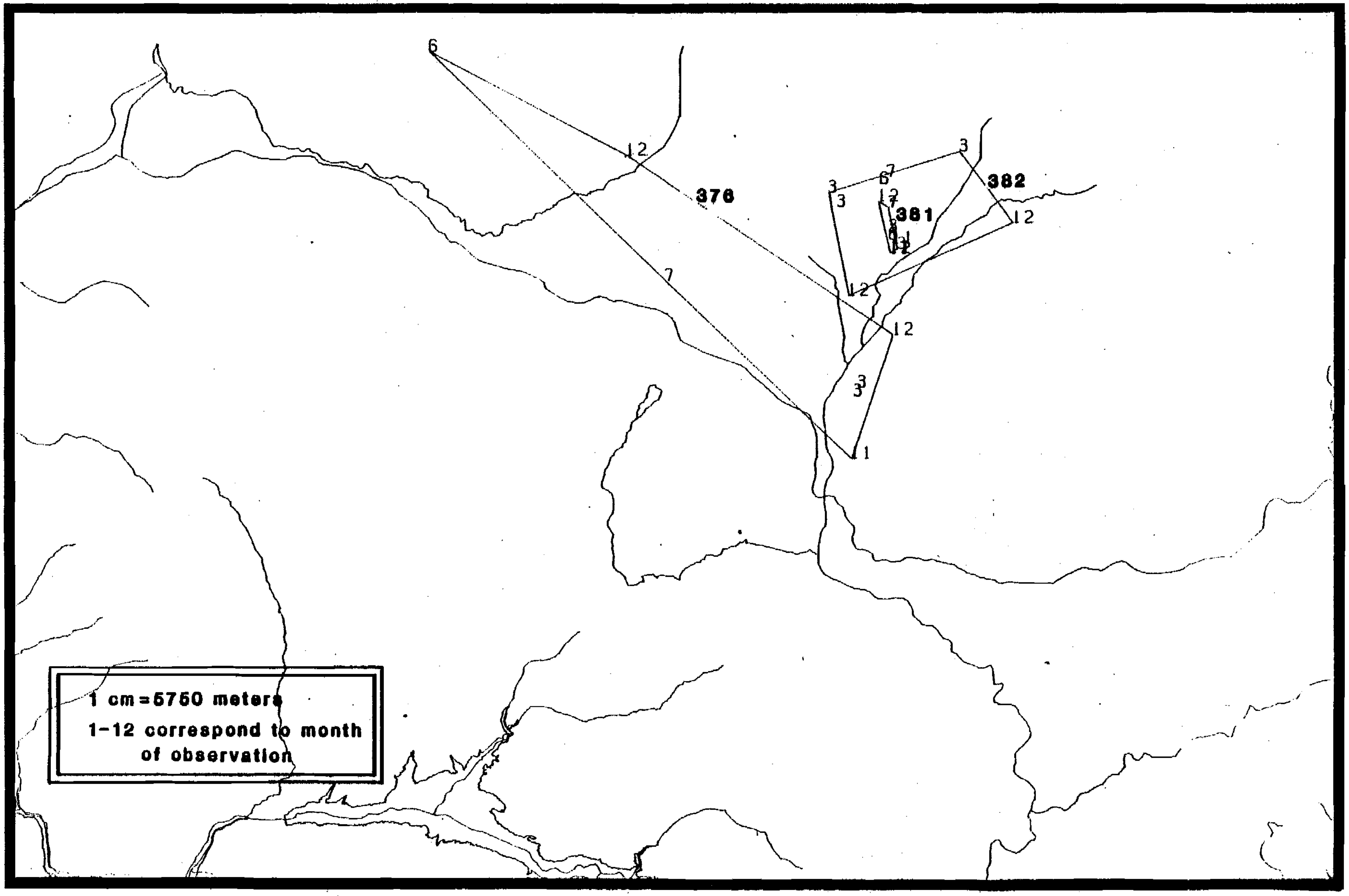


Figure 23. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 376, 381 and 382.

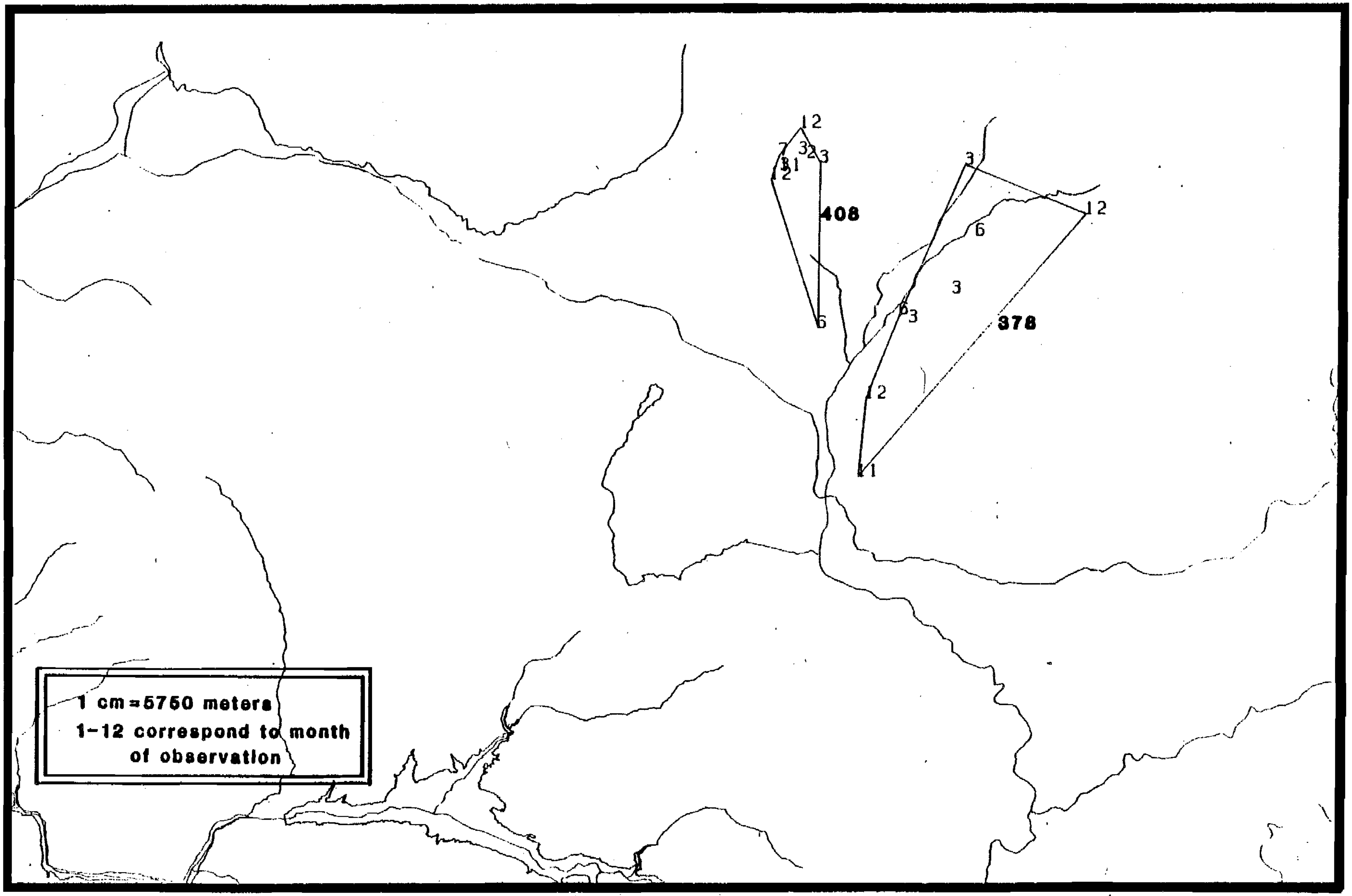
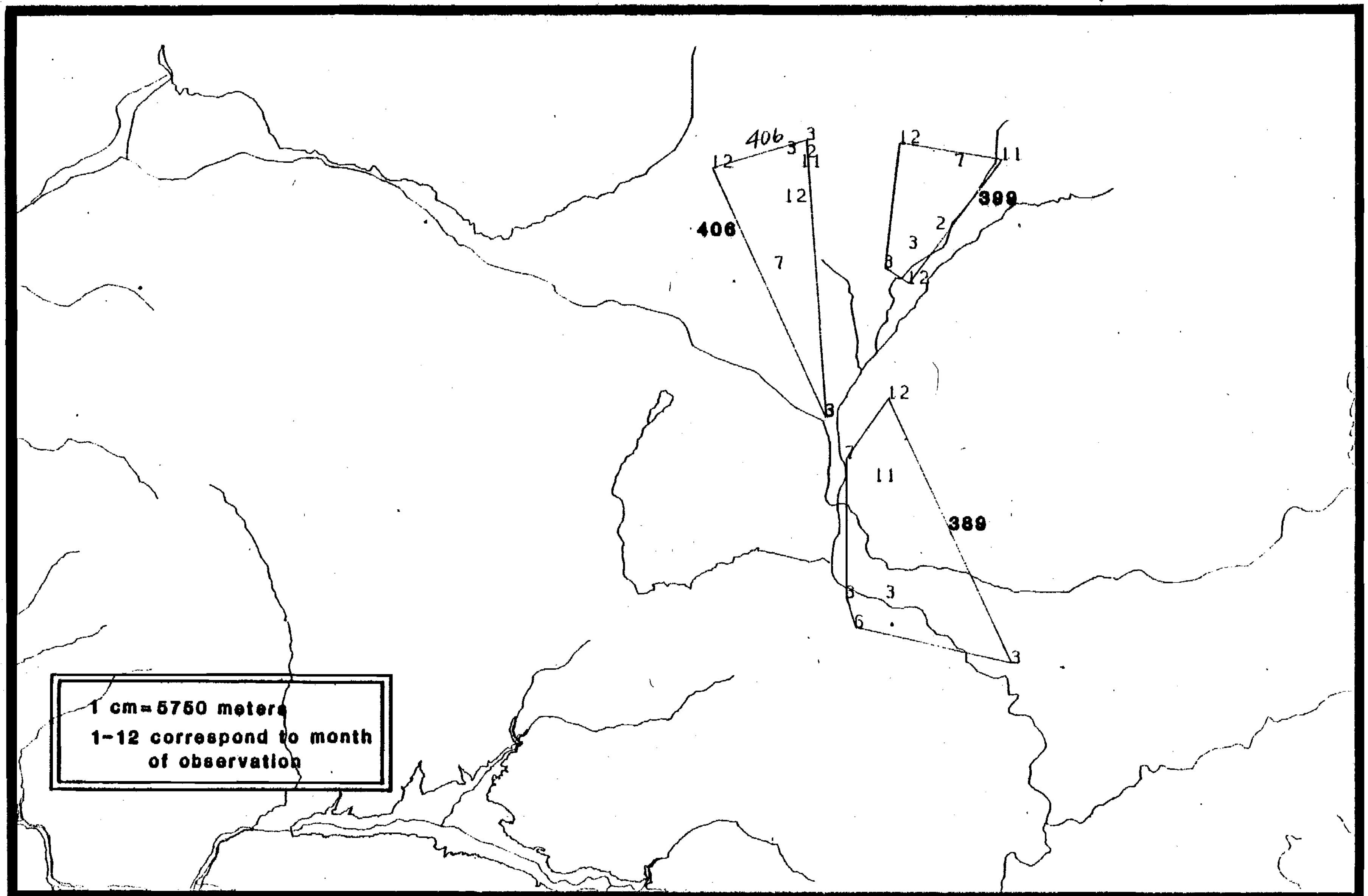


Figure 24. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 378 and 408.



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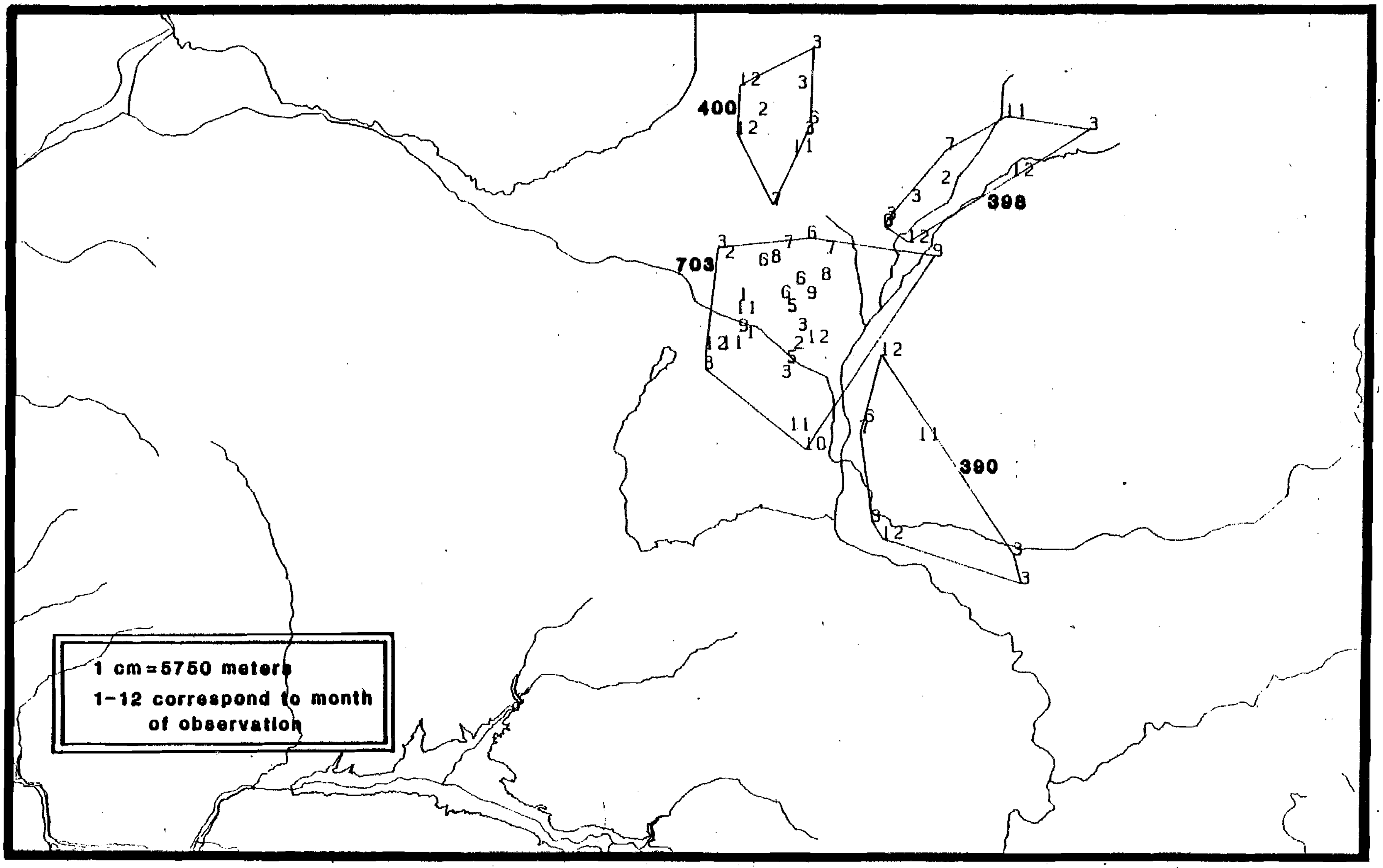

Figure 26. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 390, 398, 400 and 703.

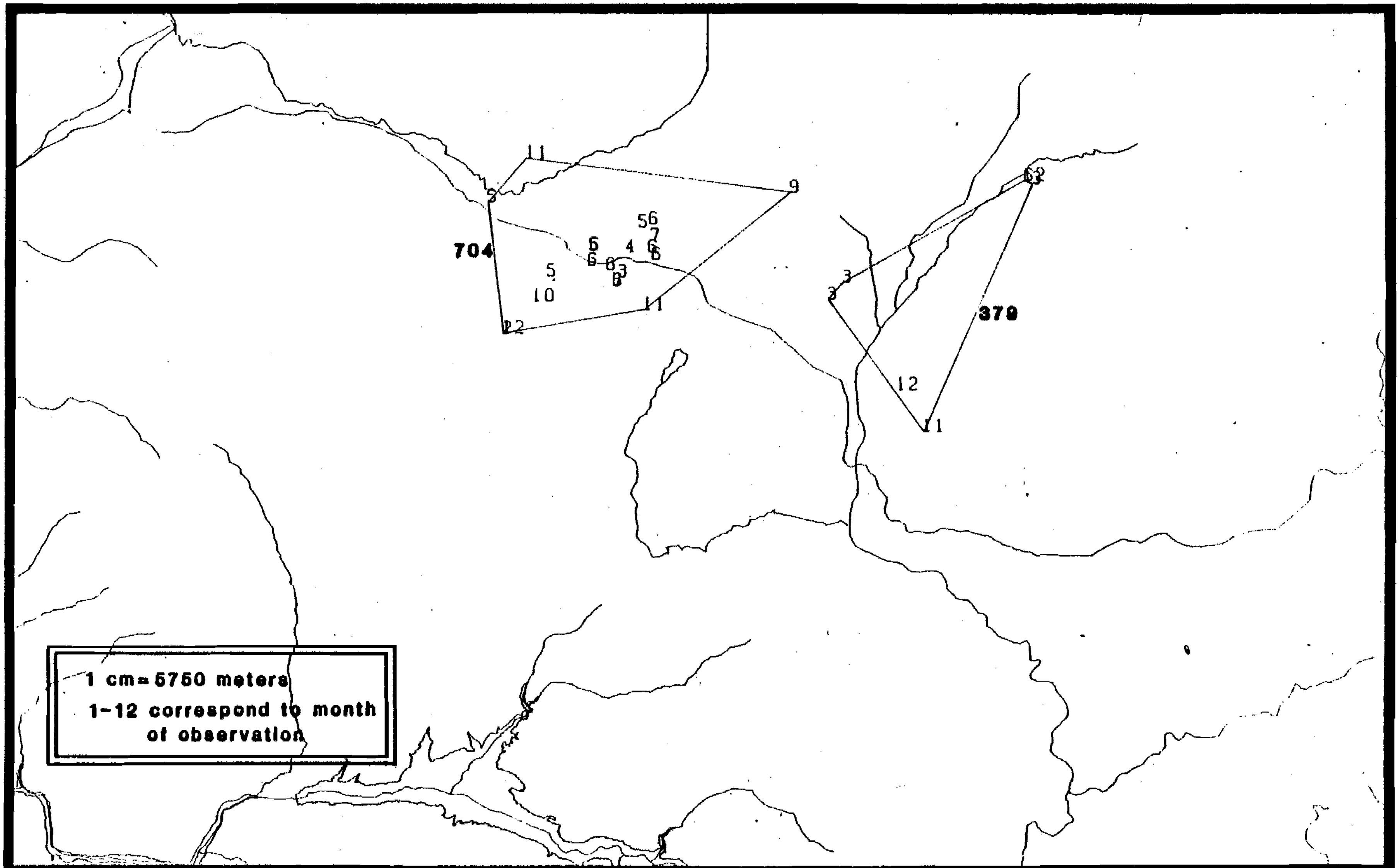

Figure 27. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 379 and 704.

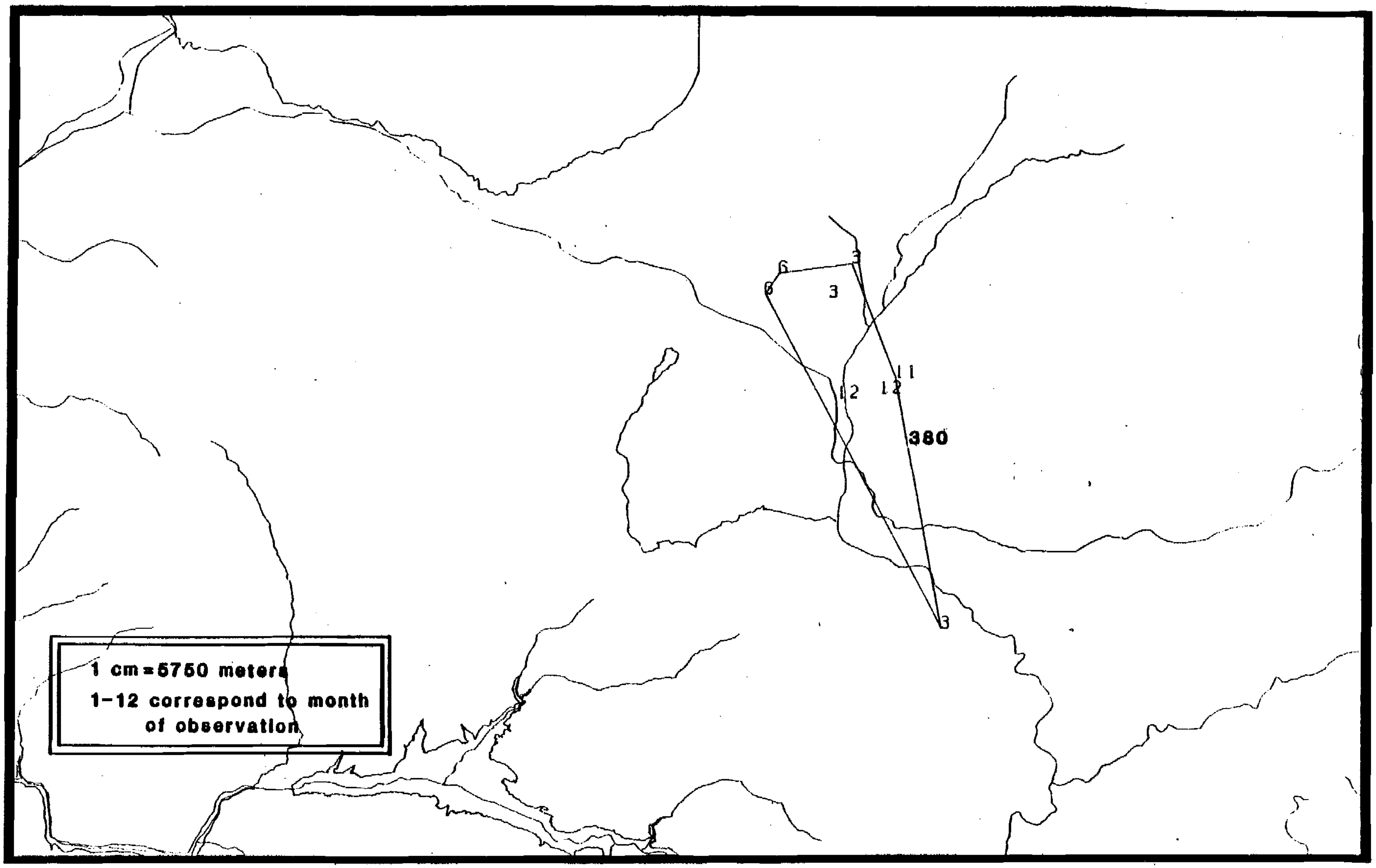

Figure 28. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 380.

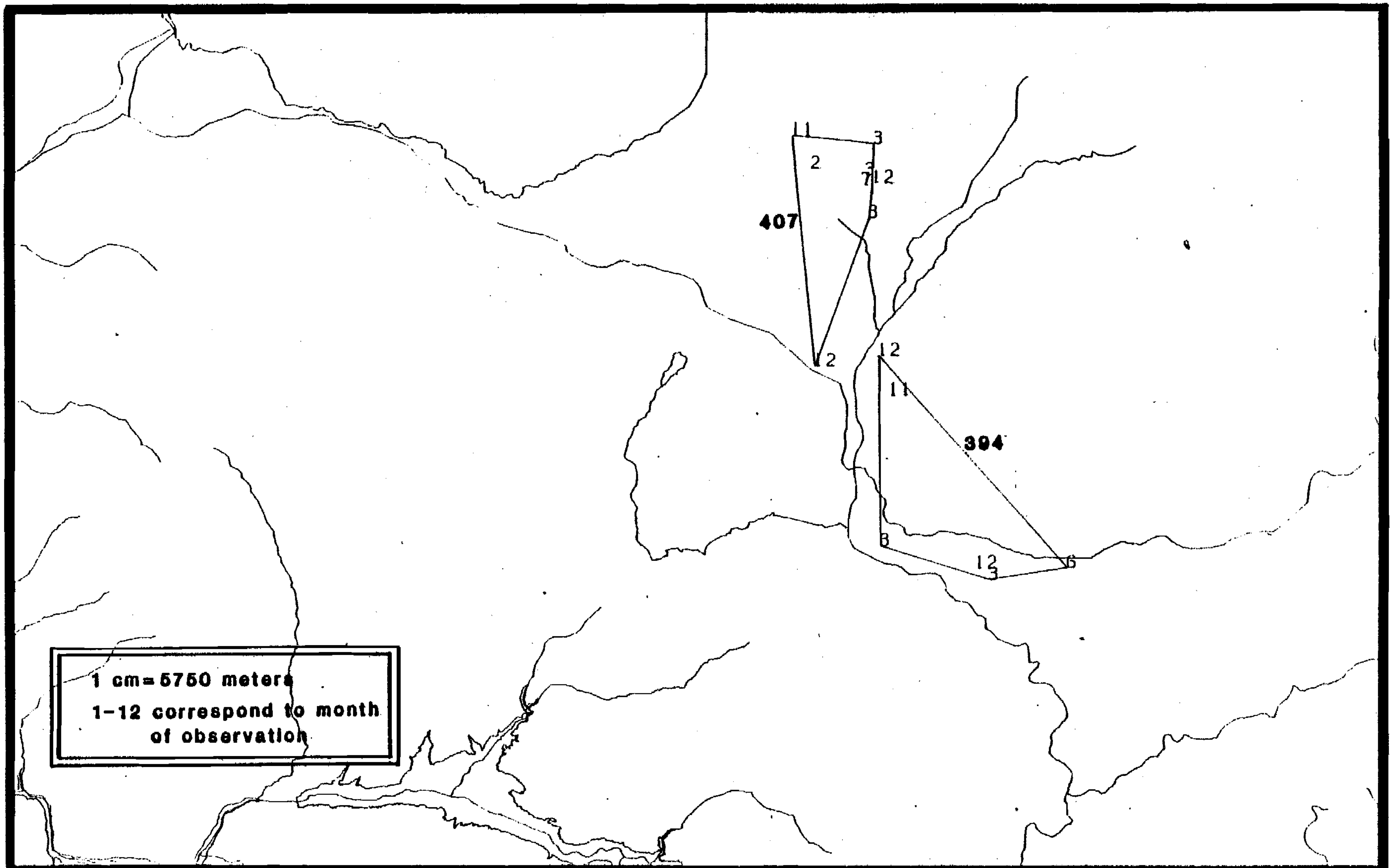

Figure 29. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 394 and 407.

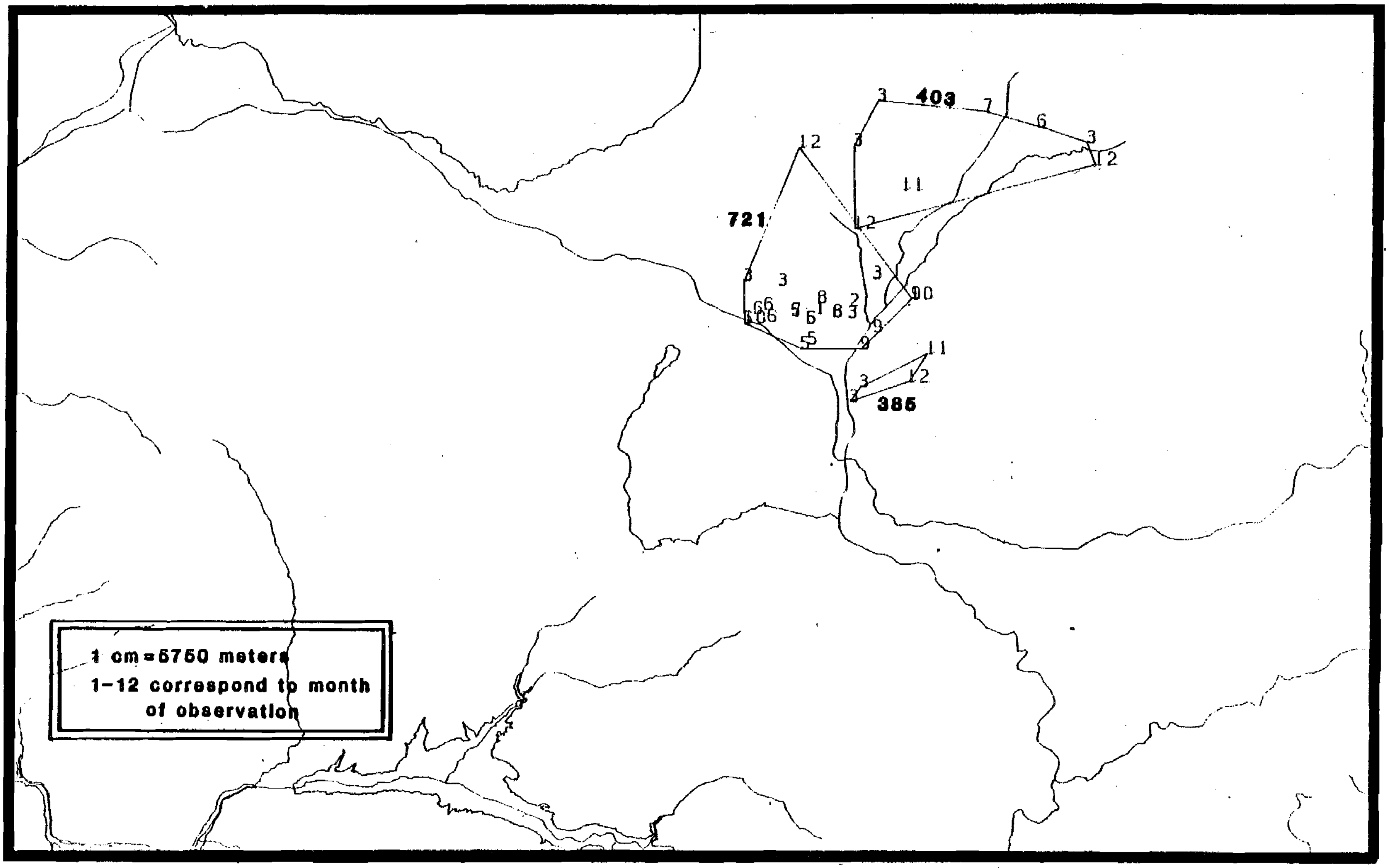

Figure 30. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 385, 403 and 721.

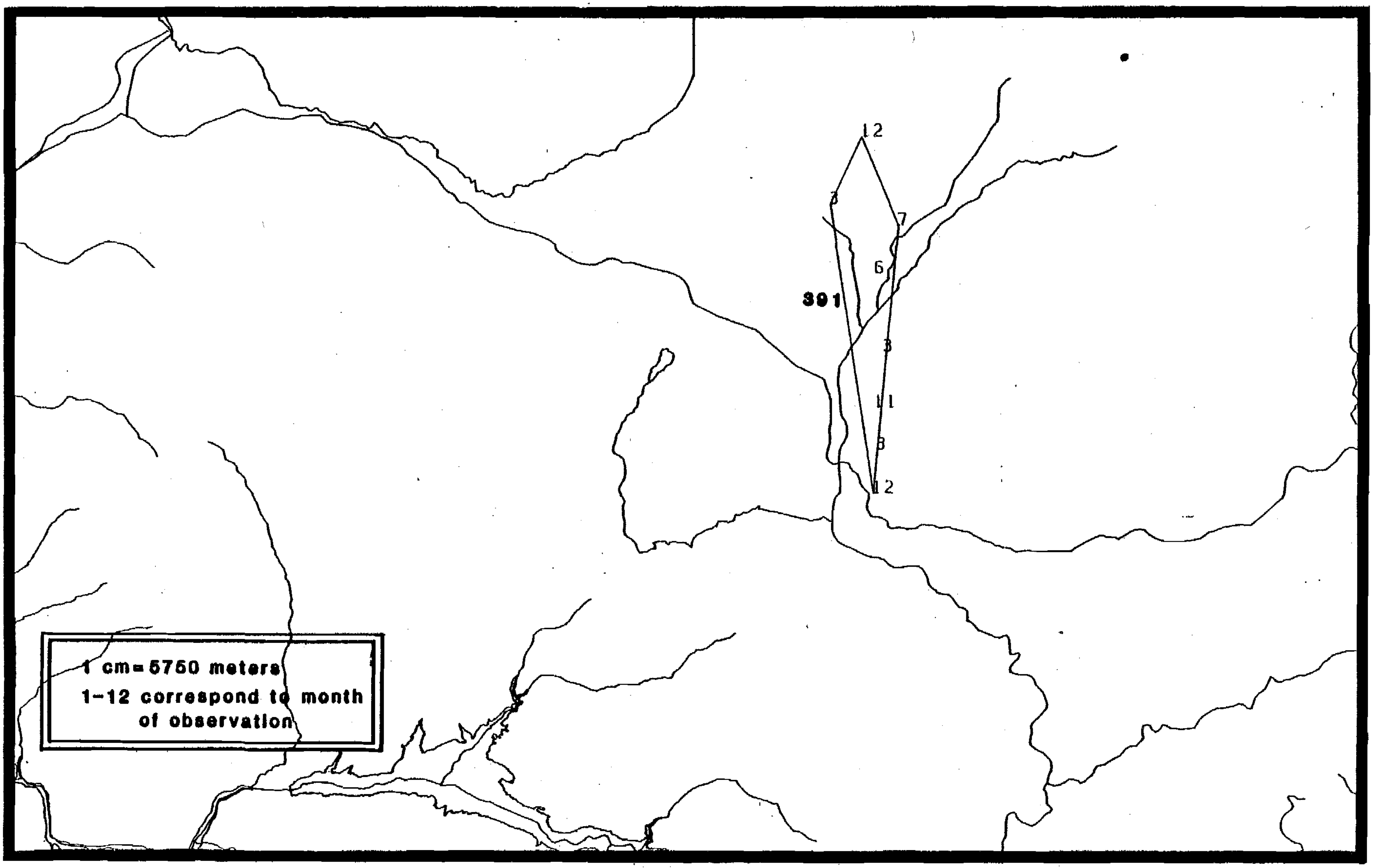

Figure 31. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 391.

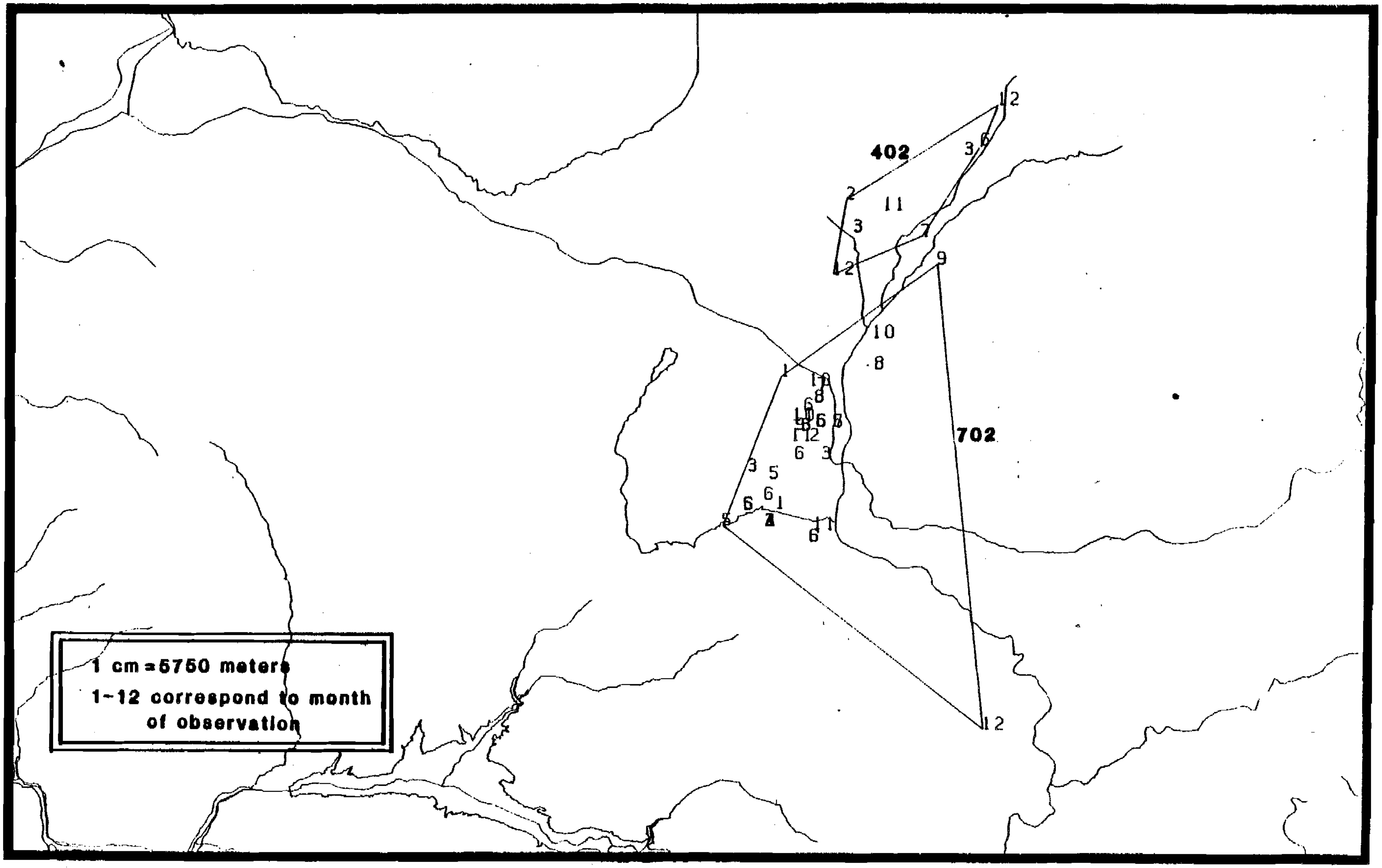

Figure 32. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 402 and 702.

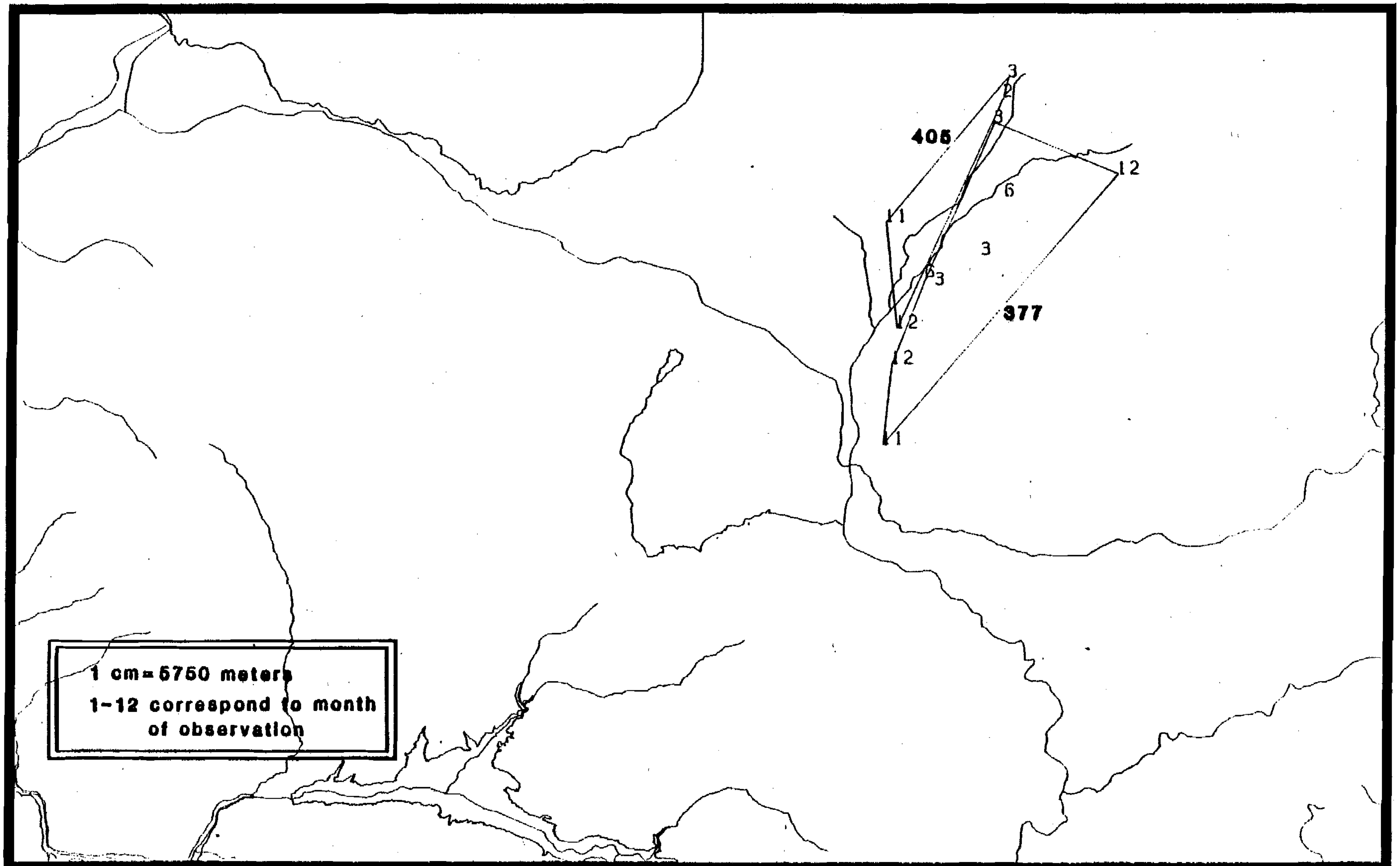

Figure 33. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 377 and 405.

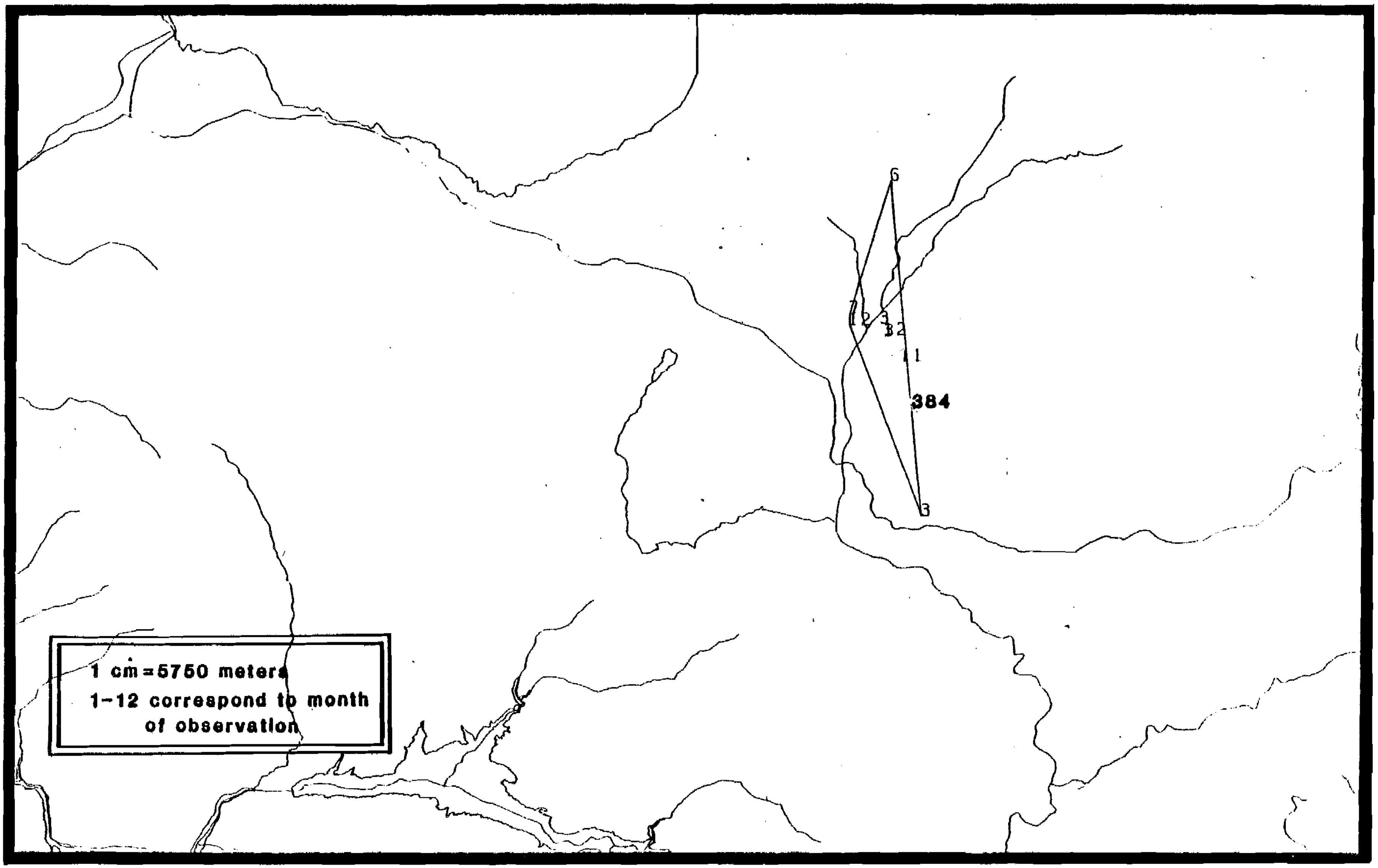

Figure 34. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 384.

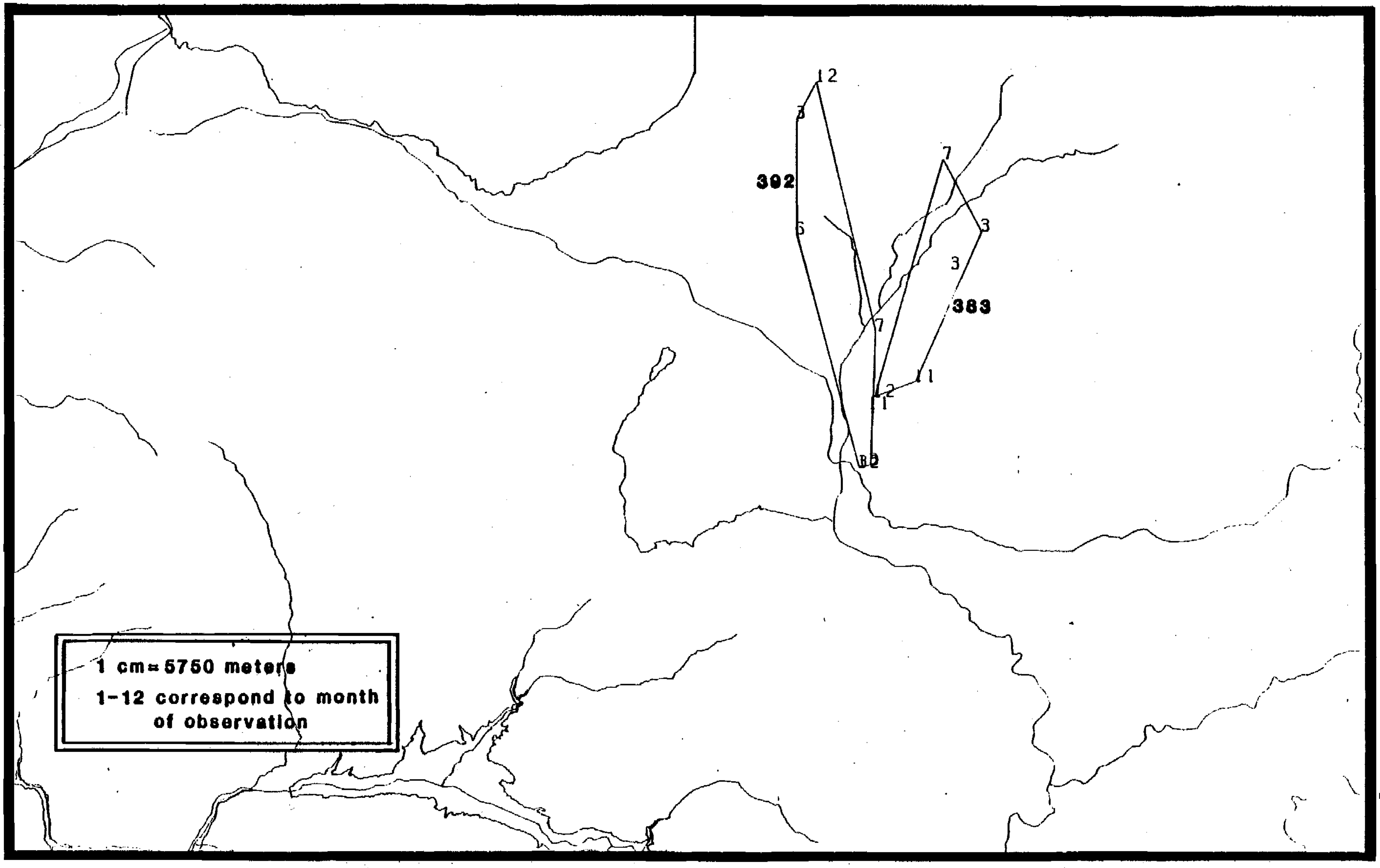

Figure 35. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 383 and 392.

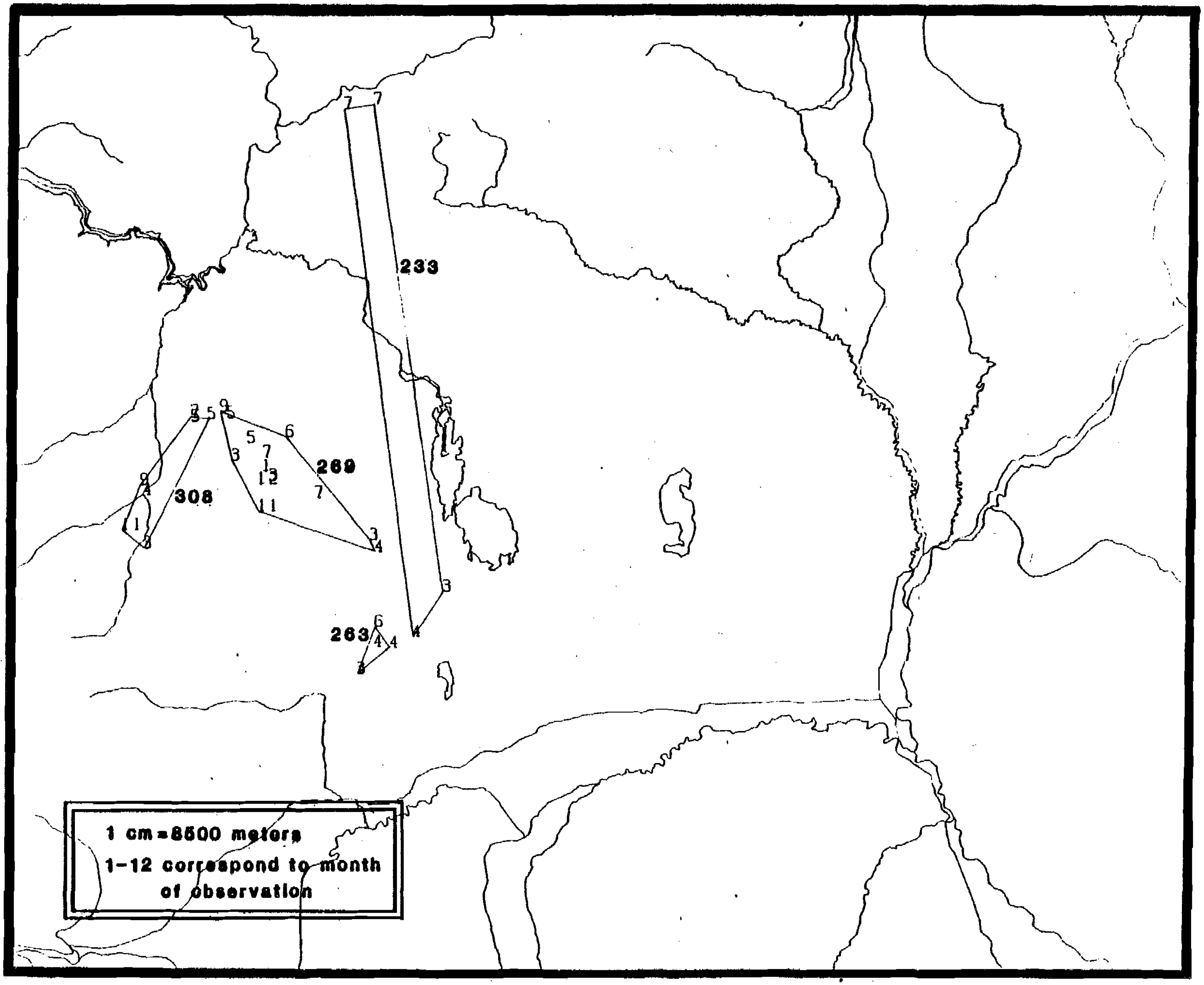

Figure 36. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 233, 263, 269 and 308.

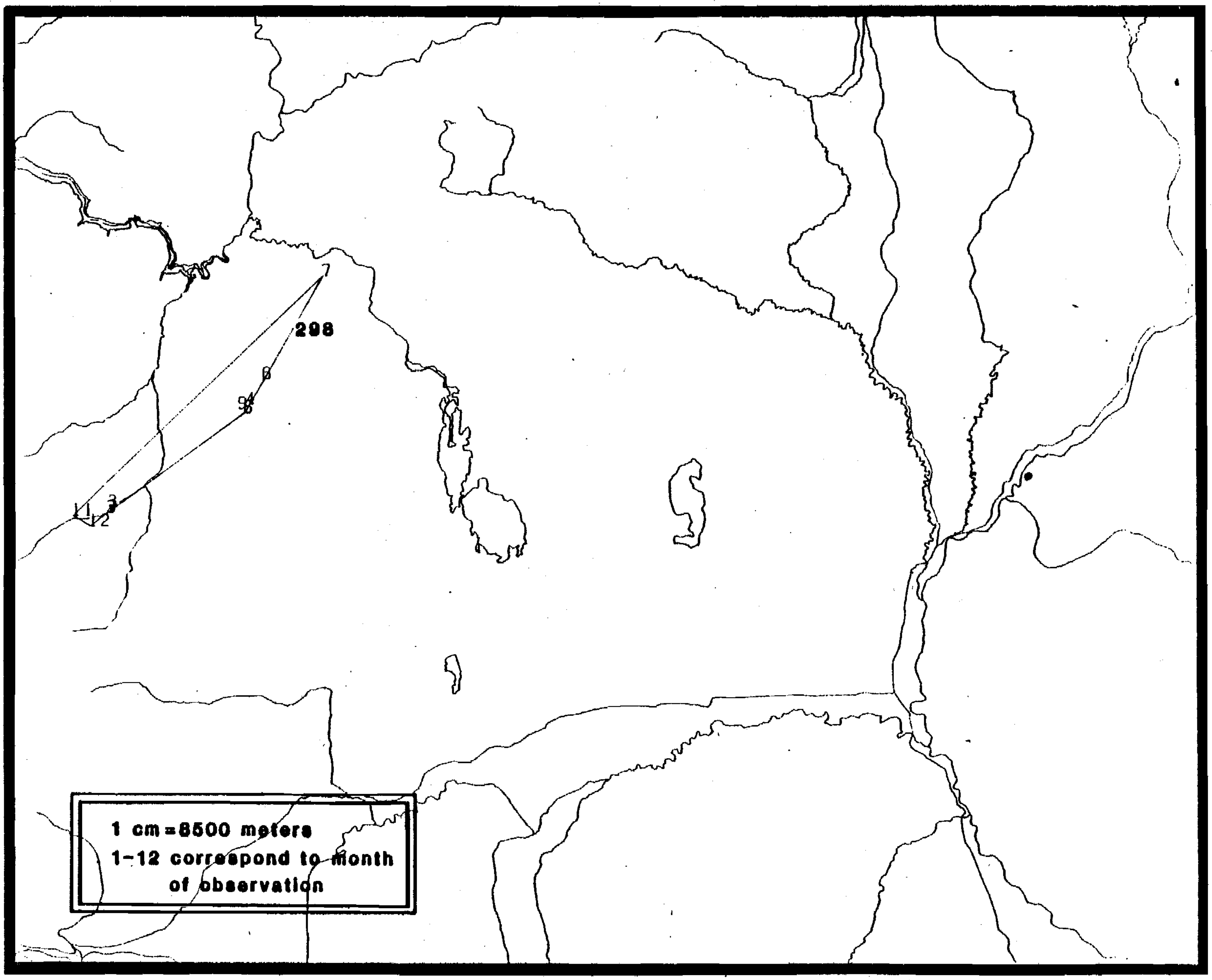

Figure 37. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 298.

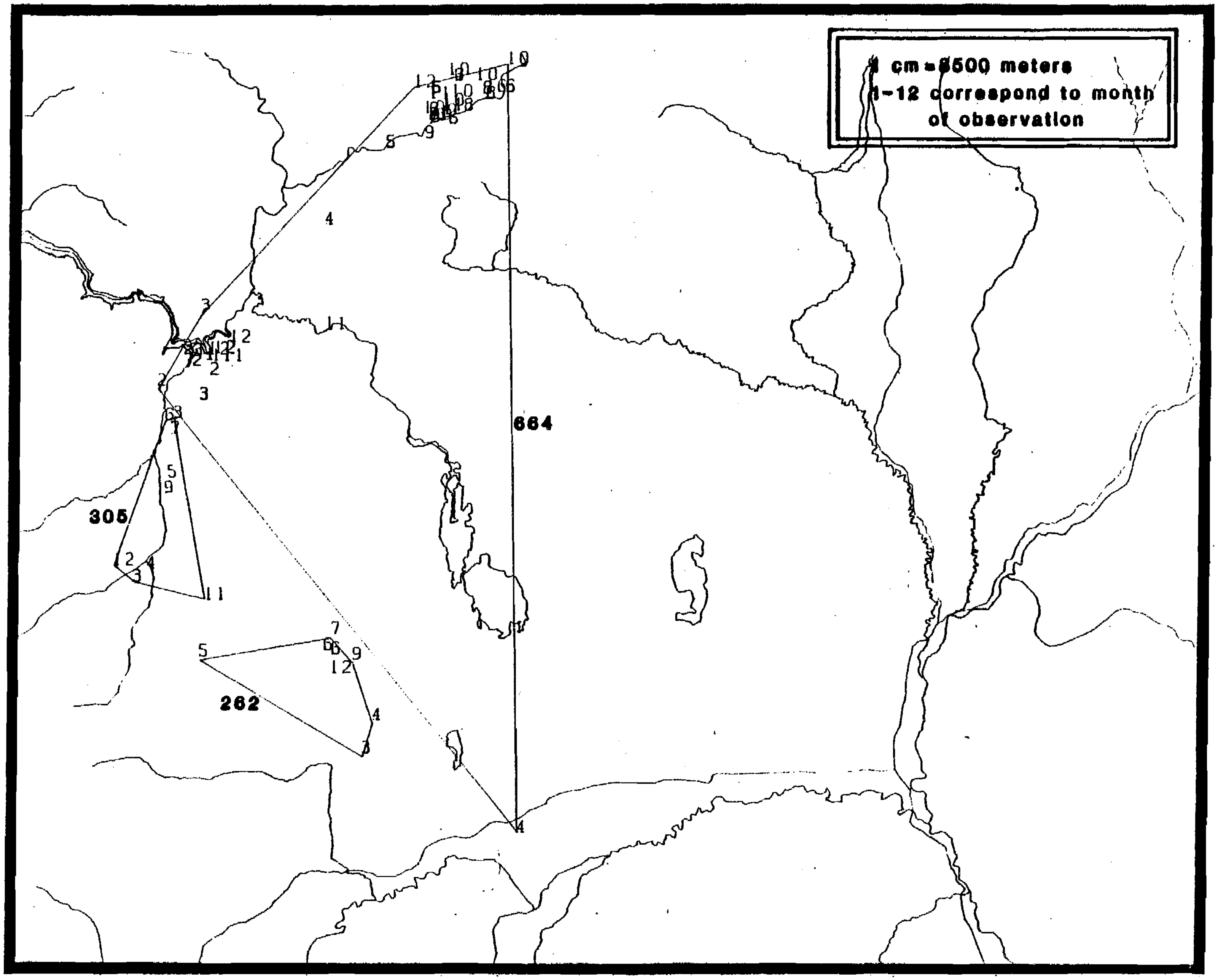

Figure 38. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 262, 305 and 664.

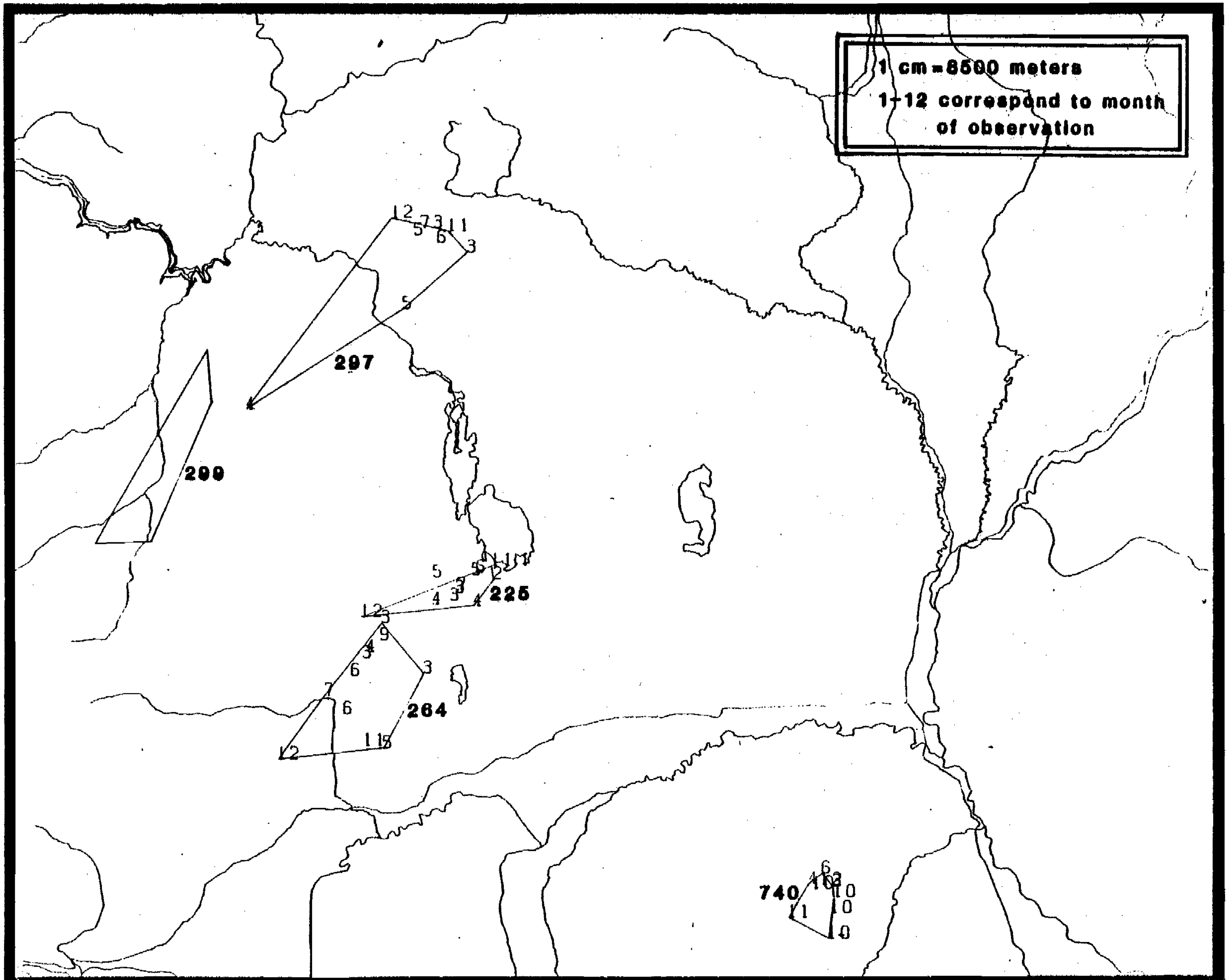

Figure 39. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 225, 264, 297, 299 and 740.

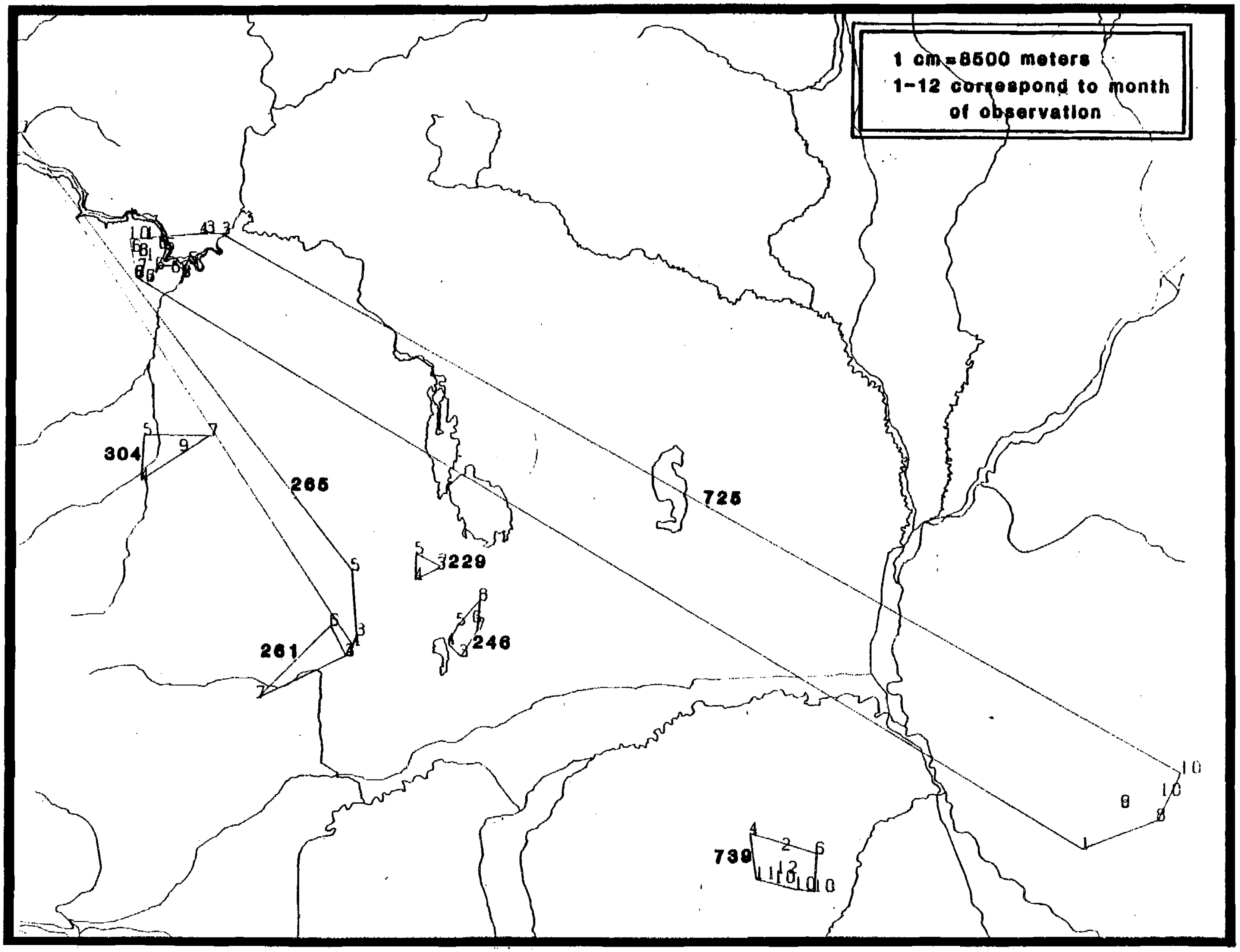

Figure 40. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 229, 246, 261, 265, 304, 725 and 739.

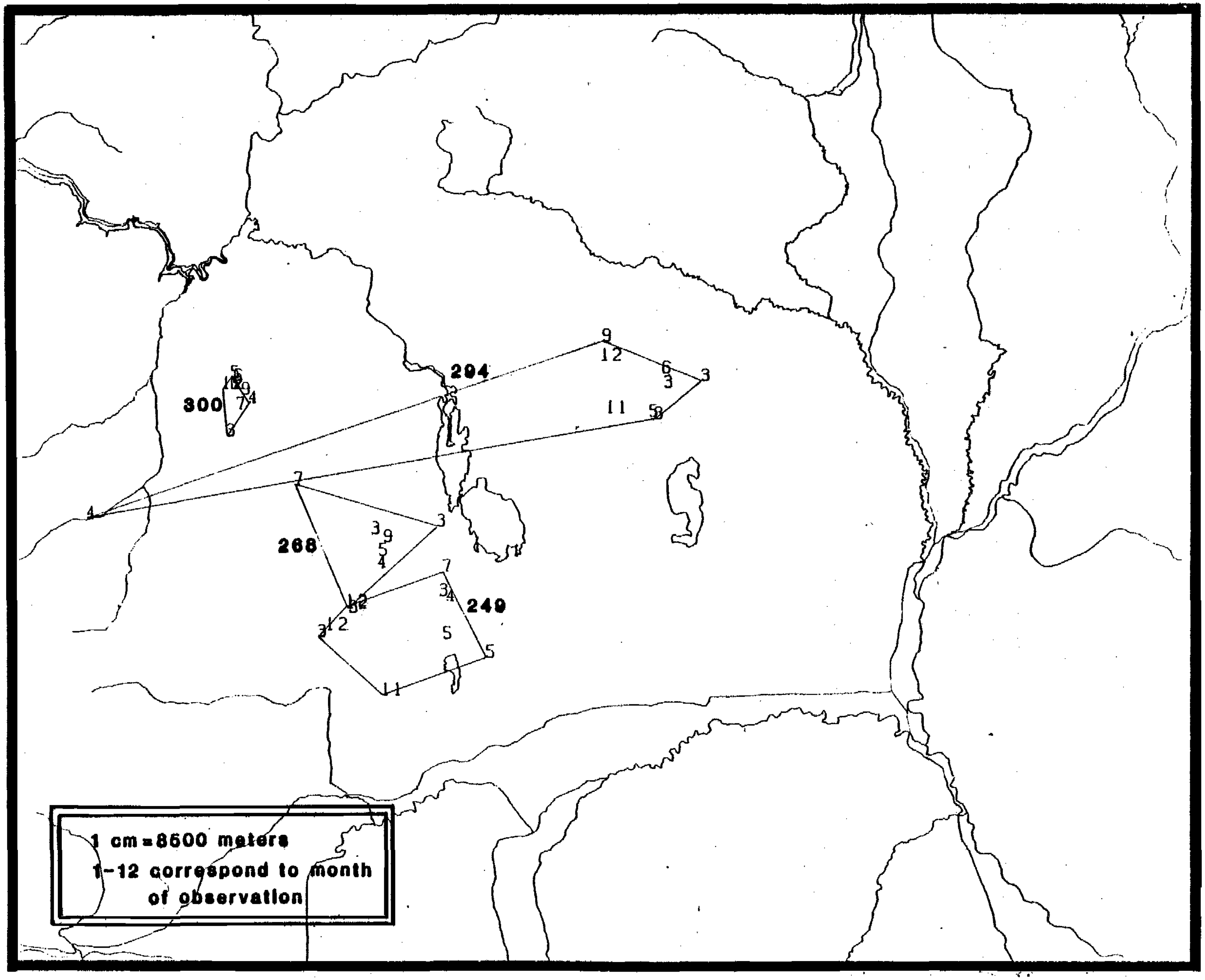

Figure 41. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 249, 268, 294 and 300.

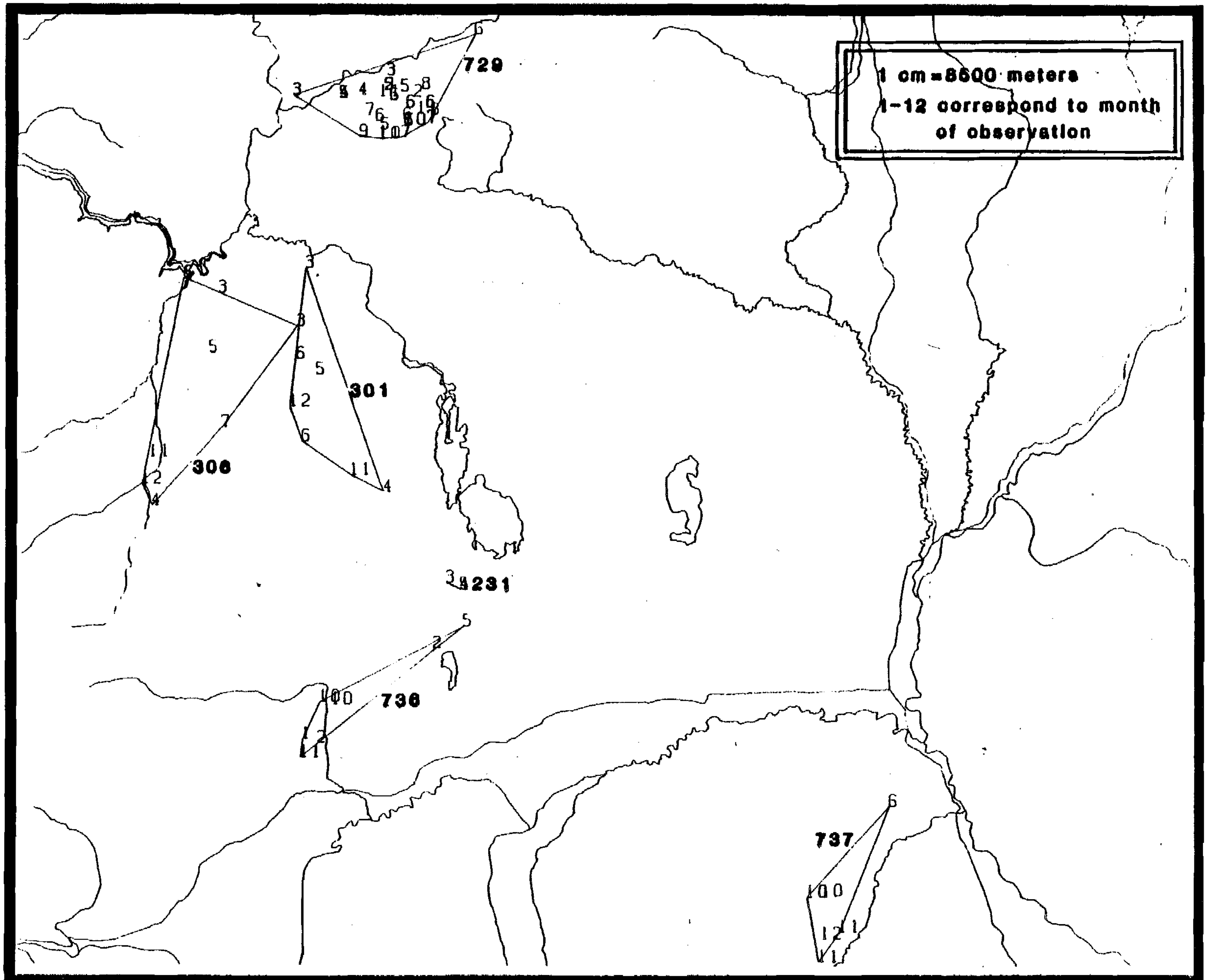

Figure 42. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 231, 301, 306, 729, 736 and 737.

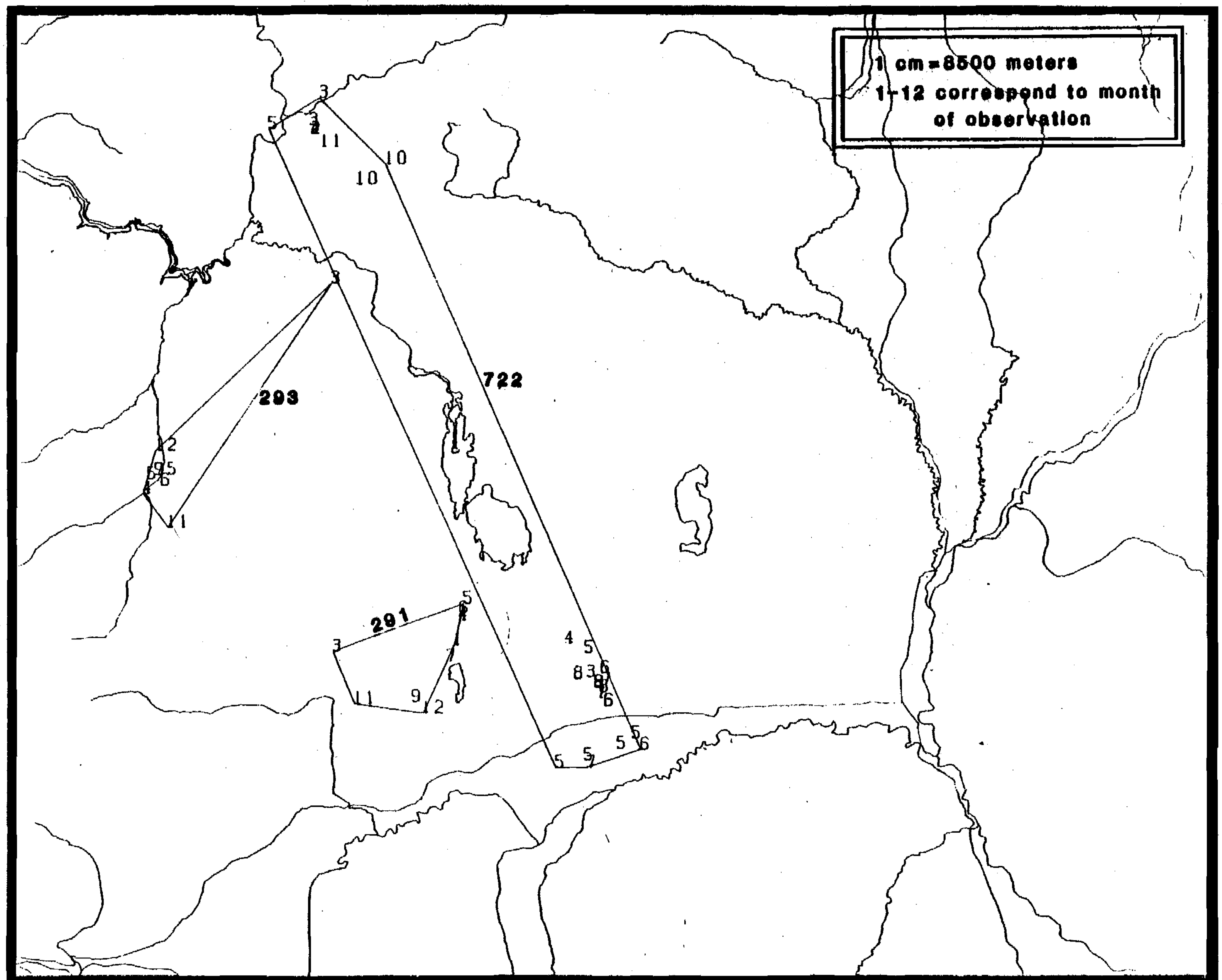

Figure 43. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 291, 293 and 722.

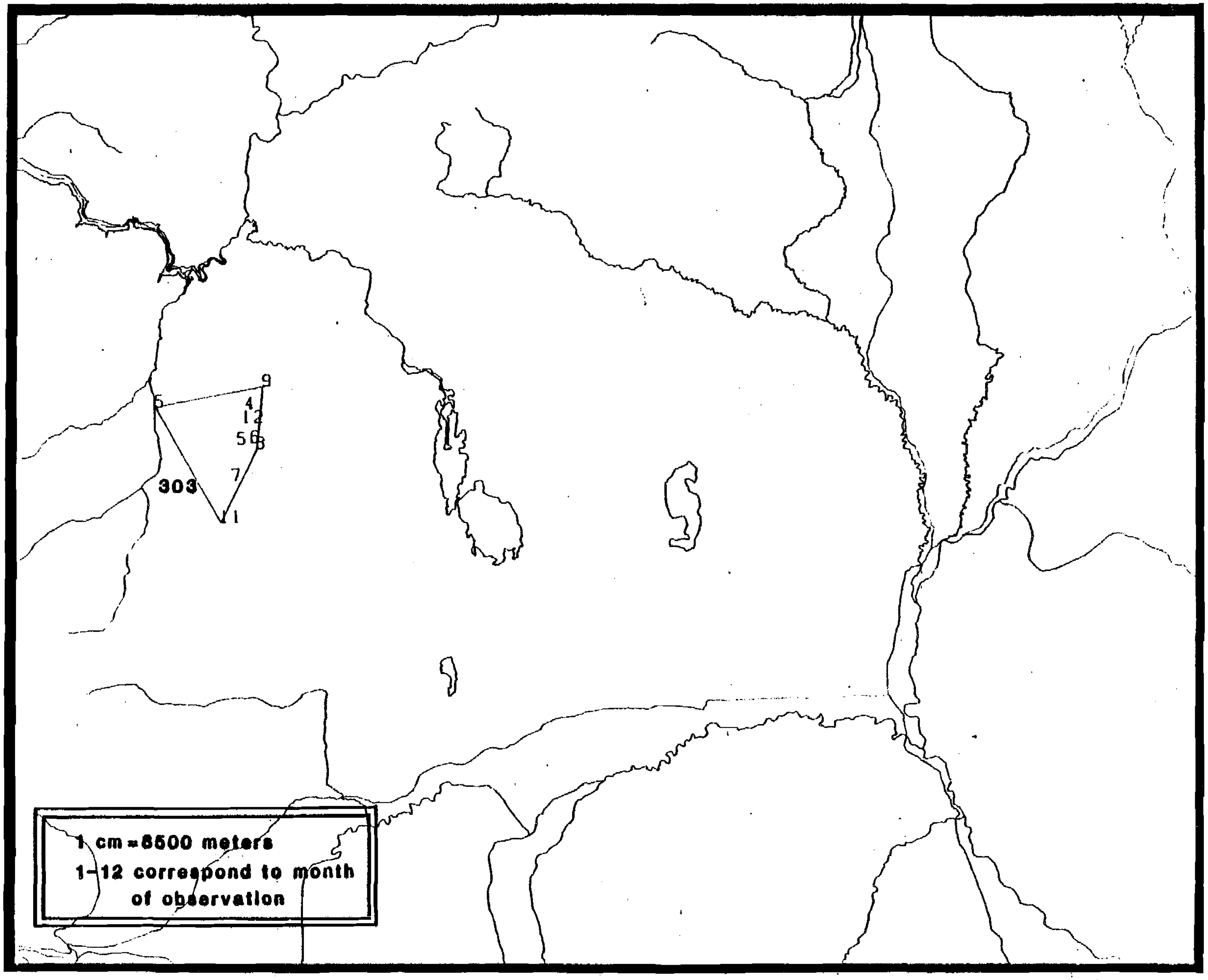

Figure 44. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 303.

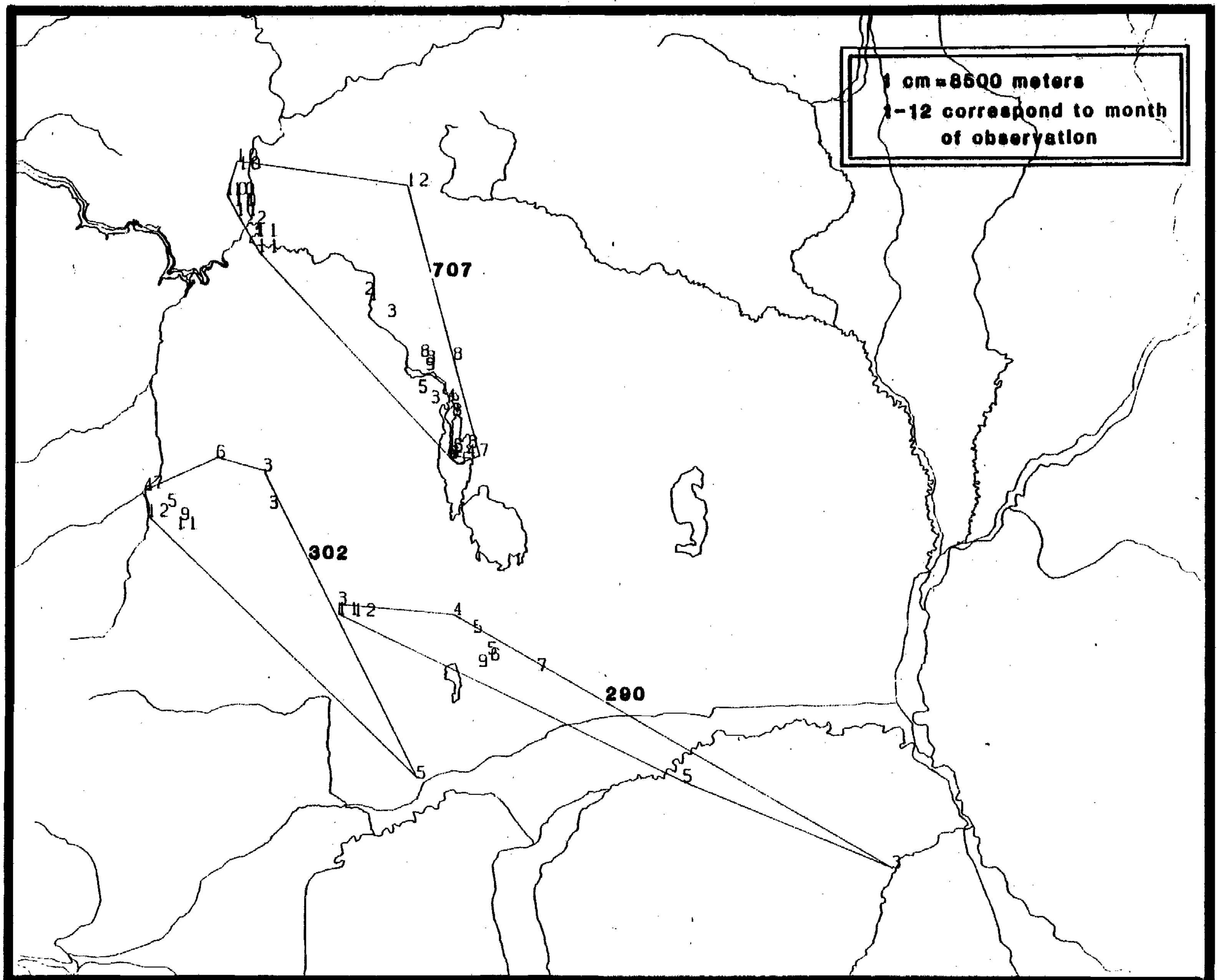

Figure 45. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 290, 302 and 707.

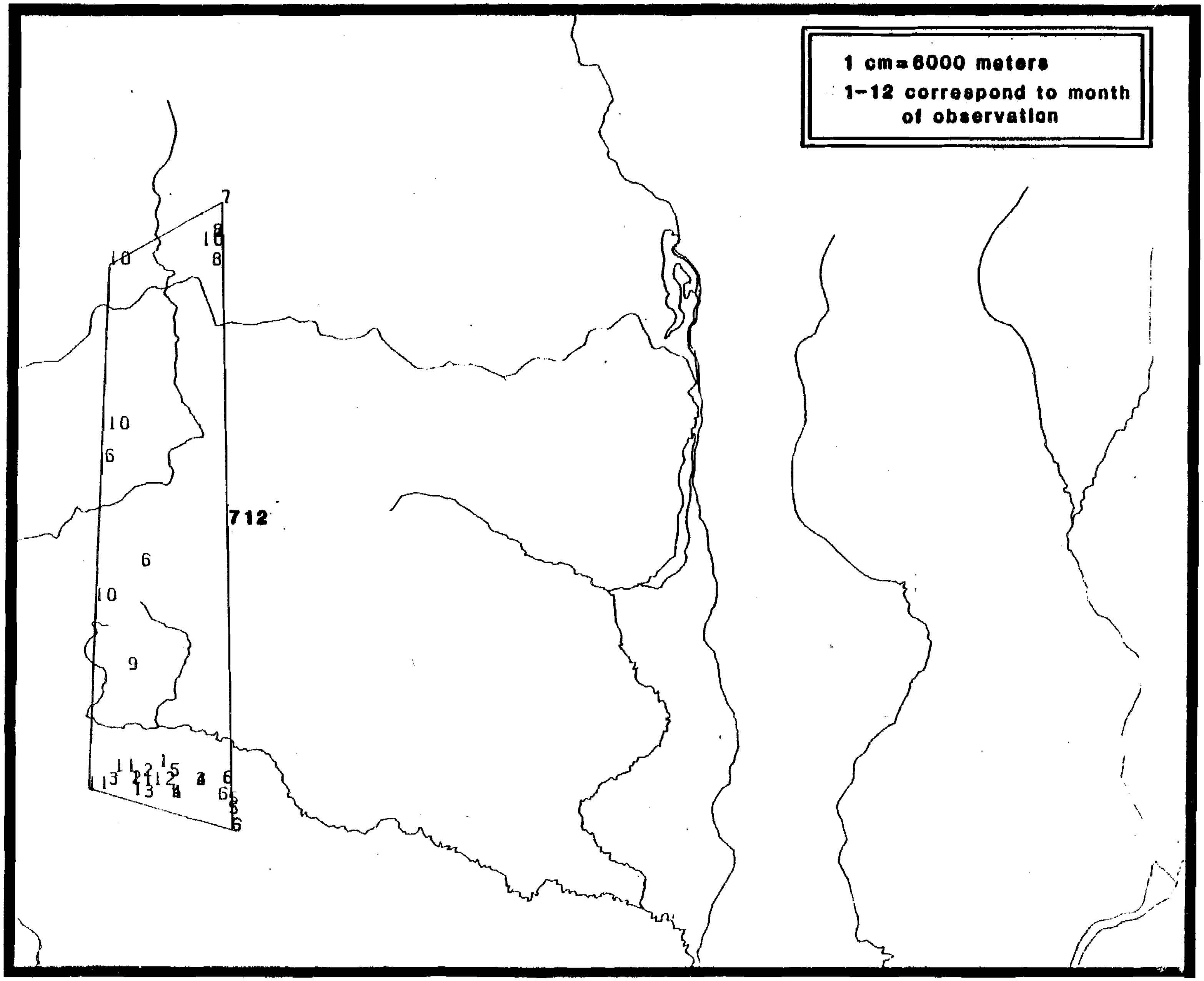

Figure 46. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 712.

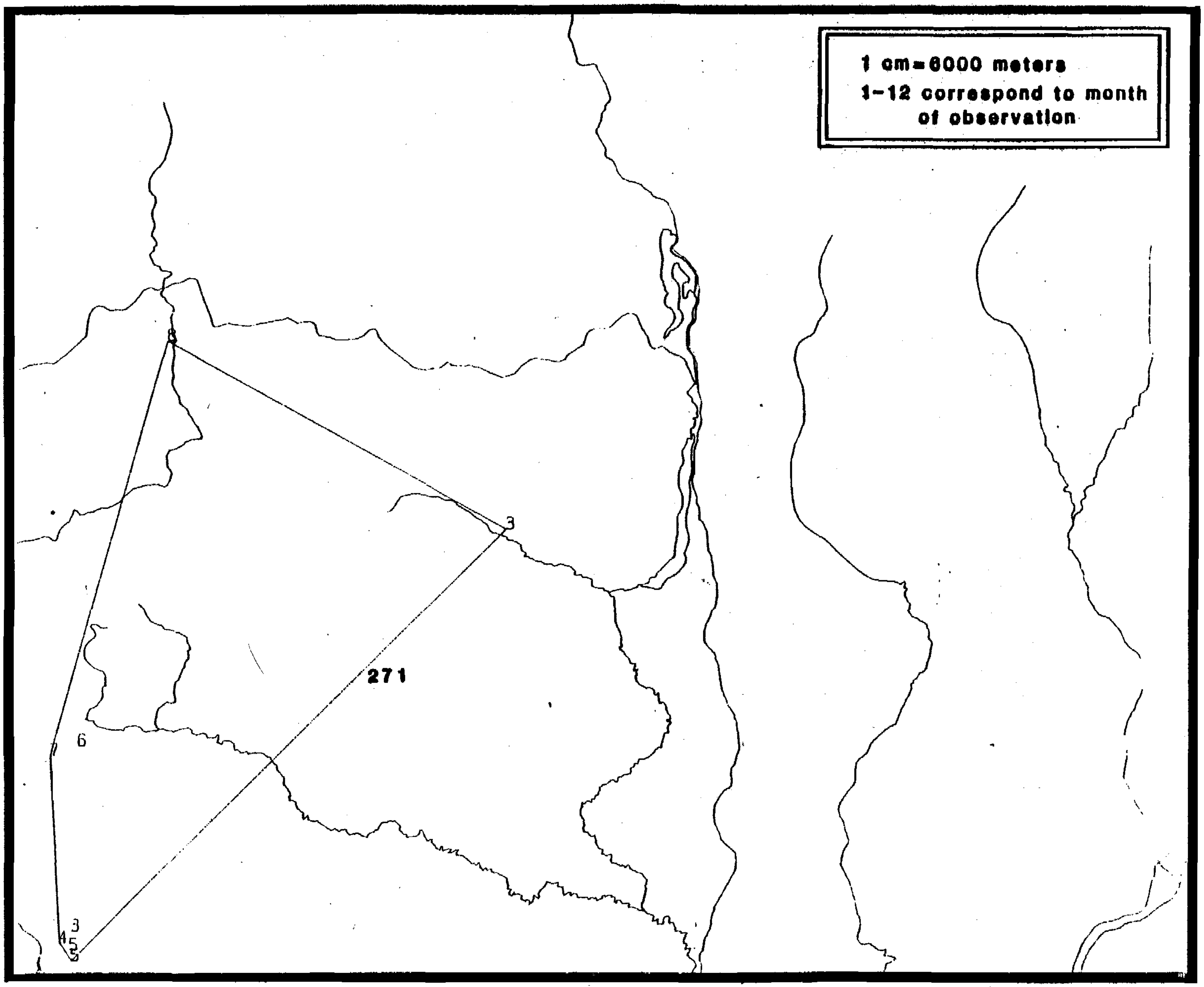

Figure 47. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 271.

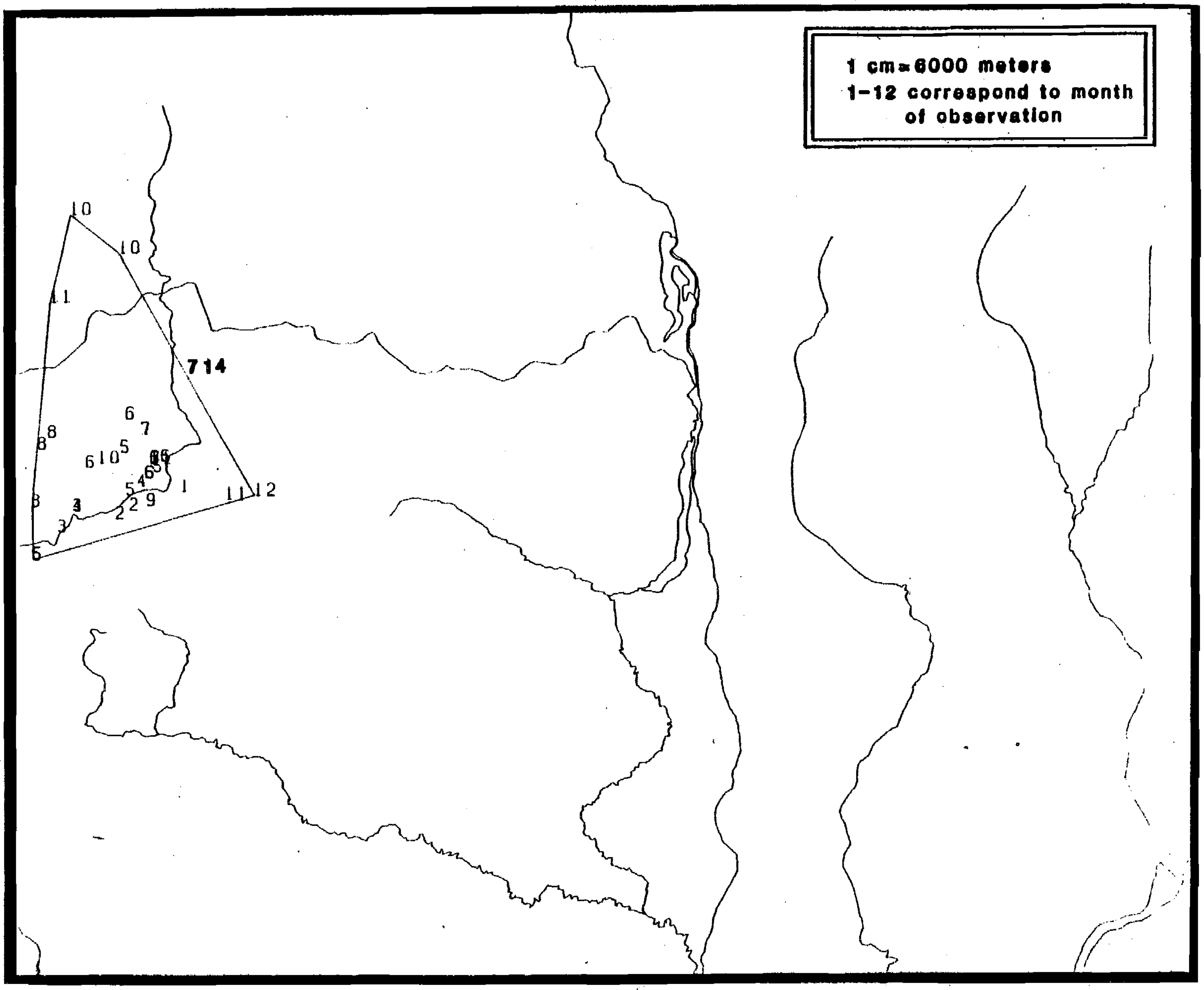

Figure 48. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 714.

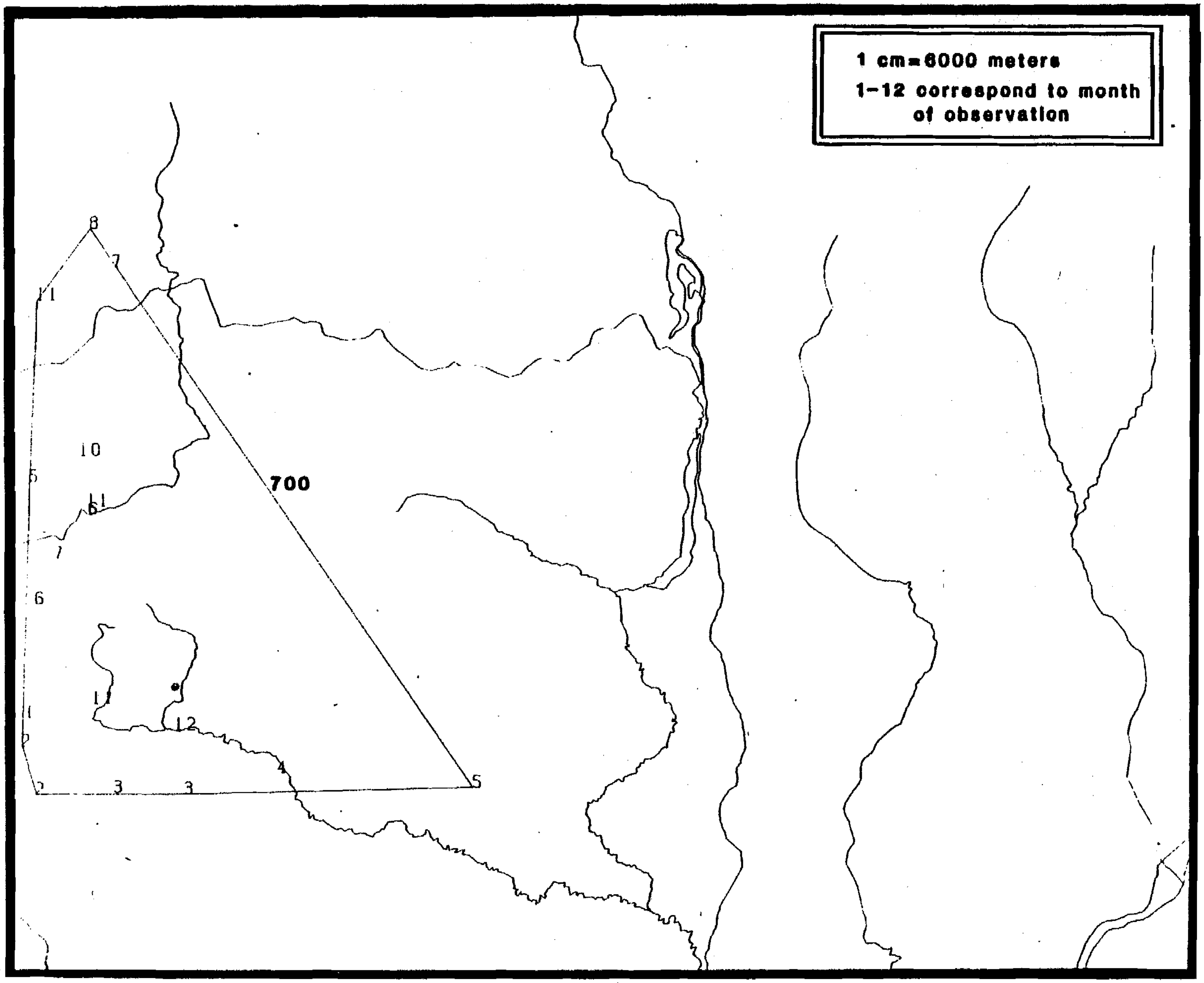

Figure 49. Monthly locations and total home range observed from October 1976 through mid-August 1981 in Game Management Unit 13 of Southcentral Alaska of moose 700.

Appendix B. Seasonal and total home range sizes of individual radio-collared moose studied in the Nelchina and Upper Susitna River Basins of Southcentral Alaska from October 1976 through mid-August 1981.

Moose ID #	Sex-Age at Capture	Period Monitored (mo., yr)	Total # locations	Summer 1/ Home Range km 2	Summer 1/ Home Range mi 2	Winter 1/ Home Range km 2	Winter 1/ Home Range mi 2	Total 2/ Home Range km 2	Total 2/ Home Range mi 2	Maximum length of km	Maximum length of mi
249	M-Calf	3/79-5/81	10	--	--	128.0	49.4	232.5	89.8	23.7	14.7
268	M-Calf	3/79-3/80	7	--	--	45.9	17.7	150.8	58.2	20.8	13.0
271	M-Calf	3/79-8/80	8	159.4	61.5	70.6	27.3	1252.9	483.8	60.8	37.8
294	M-Calf	4/79-5/81	9	32.2	12.4	322.9	124.7	537.6	207.6	88.5	55.0
301	M-Calf	4/79-5/81	7	--	--	151.3	58.4	163.9	63.3	32.9	20.5
375	M-Calf	11/79-5/81	8	--	--	14.9	5.8	285.4	110.2	37.4	23.3
376	M-Calf	11/79-5/81	7	--	--	186.8	72.1	358.5	138.4	56.3	35.0
379	M-Calf	11/79-5/81	7	--	--	177.5	68.5	177.5	68.5	25.1	15.6
381	M-Calf	11/79-5/81	8	--	--	2.0	0.8	3.8	1.5	5.1	3.1
382	M-Calf	11/79-5/81	8	--	--	138.3	53.4	138.3	53.4	18.0	11.2
388	M-Calf	11/79-5/81	9	--	--	438.0	169.1	583.5	225.3	50.2	31.2
391	M-Calf	11/79-6/81	8	--	--	79.2	30.6	108.8	42.0	33.6	20.9
392	M-Calf	11/79-5/81	8	--	--	72.7	28.1	134.2	51.8	36.4	22.6
393	M-Calf	11/79-3/81	7	--	--	37.0	14.3	37.0	14.3	12.1	7.5
395	M-Calf	11/79-5/81	7	--	--	103.3	40.0	256.8	99.2	41.1	25.5
396	M-Calf	11/79-6/81	8	--	--	35.2	13.6	44.4	16.0	16.0	10.0
398	M-Calf	11/79-9/81	9	--	--	74.4	28.7	85.2	32.9	21.4	13.3
399	M-Calf	11/79-12/80	7	--	--	78.6	30.3	78.6	30.3	15.1	9.4
400	M-Calf	11/79-6/81	9	--	--	46.9	18.1	64.5	24.9	15.2	9.4
402	M-Calf	11/79-6/81	8	--	--	56.3	21.7	86.7	33.5	22.2	13.8
408	M-Calf	11/79-5/81	9	--	--	9.4	3.6	48.0	18.5	19.2	11.9
672	M-Calf	3/81-8/81	5	--	--	-	-	198.4	76.6	38.5	23.9
674	M-Calf	3/81-8/81	7	27.7	10.7	-	-	84.0	32.4	27.5	17.1
675	M-Calf	3/81-8/81	6	10.2	4.0	-	-	161.6	62.4	38.5	23.9
676	M-Calf	3/81-8/81	7	20.1	7.8	-	-	20.7	8.0	16.3	10.1
677	M-Calf	3/81-8/81	9	1.6	0.6	-	-	7.4	2.9	14.3	8.9
690	M-Calf	3/81-7/81	6	--	--	-	-	5.9	2.3	5.8	3.6
Subtotal			(n=6) $\bar{x}$	41.9	(n=21)	108.1	(n=27)	196.4		29.3	(n=27)
			s	58.7		106.1		257.3		18.6	
667	M-2 yr.	3/81-8/81	7	65.6	25.3	-	-	147.9	57.1	31.3	19.4
Subtotal			$\bar{x}$	65.6							

Appendix B (cont'd)

Moose ID #	Sex-Age at Capture	Period Monitored (mo., yr)	Total # locations	Summer 1/ Home Range km 2	mi 2	Winter 1/ Home Range km 2	mi 2	Total 2/ Home Range km 2	mi 2	Maximum length of km	mi
626	M-5y.	4/80-8/81	19	91.1	35.2	21.0	8.1	91.1	35.2	16.2	10.1
627	M-4y.	4/80-9/80	12	50.7	19.6	--	-	127.6	49.3	22.4	13.9
642	M-4y.	4/80-7/81	20	35.8	13.8	49.1	19.0	94.1	36.3	21.4	13.3
682	M-Adult	3/81-5/81	5	--	--	5.5	2.1	75.7	29.2	14.4	9.0
Subtotal			(n=3) $\bar{x}$	59.2		25.2	(n=3)	97.1	(n=4)	18.6	(n=4)
			s	28.6		22.1		21.9		3.9	
225	F-Calf	3/79-11/80	7	--	--	43.3	16.7	43.3	16.7	19.3	12.0
262	F-Calf	3/79-11/80	8	36.7	14.2	--	-	189.7	73.3	26.5	16.4
264	F-Calf	3/79-5/81	11	58.9	22.7	153.1	59.1	174.2	67.3	23.4	14.5
269	F-Calf	3/79-5/81	13	40.2	15.5	70.6	27.3	166.2	64.2	29.6	18.4
274	F-Calf	3/79-7/79	5	--	--	--	--	97.0	37.5	37.0	23.0
290	F-Calf	4/79-5/81	11	75.6	29.2	846.2	326.7	1833.5	708.0	131.0	81.4
291	F-Calf	4/79-5/81	9	12.5	4.8	136.3	52.6	155.0	59.8	20.4	12.7
293	F-Calf	4/79-5/81	9	2.3	.9	161.5	62.4	161.6	62.4	40.5	25.2
297	F-Calf	4/79-5/81	9	18.8	7.3	191.1	73.8	213.9	82.6	37.2	23.1
298	F-Calf	4/79-5/81	9	10.7	4.1	37.5	14.5	186.9	72.2	48.4	30.1
299	F-Calf	4/79-5/81	8	12.7	4.9	82.5	31.8	136.2	52.6	30.8	19.2
300	F-Calf	4/79-5/81	8	3.2	1.2	--	--	16.1	6.2	8.2	5.1
302	F-Calf	4/79-5/81	10	258.5	99.8	91.7	35.4	462.6	178.6	54.9	34.1
303	F-Calf	4/79-5/81	9	99.4	38.4	22.5	8.7	152.5	58.9	19.8	12.3
305	F-Calf	4/79-3/81	9	5.3	2.0	162.0	62.5	172.6	66.6	25.5	15.9
306	F-Calf	4/79-12/81	8	-	-	227.2	87.7	312.1	120.5	32.3	20.1
307	F-Calf	4/79-5/81	8	7.2	2.8	96.3	37.2	201.7	77.9	58.8	36.5
308	F-Calf	4/79-5/81	7	13.5	5.2	-	-	73.0	28.2	20.5	12.7
377	F-Calf	11/79-6/81	8	-	-	221.8	85.6	224.4	86.6	33.2	20.6
378	F-Calf	11/79-5/81	8	-	-	223.2	86.2	225.1	86.9	33.2	20.6
380	F-Calf	11/79-5/81	8	-	-	112.5	43.5	183.9	71.0	36.7	22.8
383	F-Calf	11/79-7/80	5	-	-	26.9	10.4	85.0	32.8	23.2	14.4
384	F-Calf	11/79-5/81	8	-	-	37.9	14.6	83.5	32.3	31.6	19.6
386	F-Calf	11/79-5/81	8	-	-	186.9	72.1	257.1	99.3	68.8	42.7
387	F-Calf	11/79-5/81	9	-	-	96.8	37.4	112.1	43.3	28.7	17.8
389	F-Calf	11/79-5/81	7	-	-	161.1	62.2	206.7	79.8	27.6	17.1
390	F-Calf	11/79-5/81	8	-	-	131.2	50.7	143.8	55.5	25.2	15.7
394	F-Calf	11/79-5/81	6	-	-	88.7	34.2	169.8	65.6	26.4	16.4
397	F-Calf	11/79-9/81	8	-	-	7.5	2.9	34.4	13.3	16.3	10.1
403	F-Calf	11/79-5/81	8	-	-	156.3	60.4	167.1	64.5	23.5	14.5

Appendix B (cont'd)

Moose ID #	Sex-Age at Capture	Period Monitored (mo., yr)	Total # locations		Summer 1/ Home Range km 2	Summer 1/ Home Range mi 2	Winter 1/ Home Range km 2	Winter 1/ Home Range mi 2	Total 2/ Home Range km 2	Total 2/ Home Range mi 2	Maximum length of km	Maximum length of mi
404	F-Calf	11/79-5/81	10		-	-	34.9	13.5	47.8	18.4	15.7	9.8
406	F-Calf	11/79-6/81	9		-	-	119.4	46.1	121.1	46.8	26.2	16.3
407	F-Calf	11/79-5/81	8		-	-	95.8	37.0	95.8	37.0	21.4	13.3
669	F-Calf	3/81-8/81	6		-	-	-	-	22.4	8.6	13.6	8.4
678	F-Calf	3/81-8/81	7		34.4	13.3	-	-	116.5	45.0	27.8	17.2
679	F-Calf	3/81-8/81	8		13.5	5.2	1.1	0.4	40.4	15.6	11.7	7.3
685	F-Calf	3/81-8/81	6		3.9	1.5	-	-	106.0	40.9	50.5	31.4
686	F-Calf	3/81-7/81	6		-	-	-	-	39.3	15.2	18.9	11.8
689	F-Calf	3/81-7/81	5		-	-	-	-	148.9	57.5	52.4	32.6
693	F-Calf	3/81-7/81	5		-	-	-	-	120.8	46.6	31.0	19.3
Subtotal			n=18	$\bar{x}$	39.3	(n=30)	134.1	(n=40)	187.5		32.7	(n=40)
				s	61.1		149.8		280.2		20.7	
246	F-2 yr.	3/79-8/79	6		5.9	2.3	-	-	15.9	6.1	8.5	5.3
633	F-2 yr.	4/80-6/80	5		-	-	-	-	3.6	1.4	9.2	5.7
680	F-2 yr.	3/81-8/81	5		-	-	2.6	1.0	7.8	3.0	5.7	3.6
701	F-2 yr.	10/76-9/78	32		914.3	353.0	638.7	246.6	1321.8	510.4	66.6	41.4
726	F-2 yr.	3/77-4/79	28		409.4	158.1	237.3	91.6	539.0	208.1	47.2	29.3
Subtotal			n=8	$\bar{x}$	443.2		292.9		377.6		27.4	
				s	445.1		321.7		575.6		27.8	
617	F-Adult	4/80-8/81	28		40.4	15.6	35.5	13.7	57.4	22.1	11.3	7.0
618	F-13 yr.	3/77-5/79										
		4/80-8/81	47		78.4	30.3	59.6	23.0	112.4	43.4	22.8	14.2
619	F-9 yr.	4/80-7/81	23		41.1	15.9	30.3	11.7	108.2	41.8	23.9	14.8
622	F-12 yr.	4/80-8/81	25		84.2	32.5	65.0	25.1	101.3	39.1	16.1	10.0
623	F-8 yr.	8/78-12/78										
		4/80-8/81	17		917.4	354.2	334.6	129.2	1317.3	508.6	61.4	38.1
624	F-10 yr.	4/80-7/81	19		69.3	26.8	24.4	9.4	69.9	27.0	23.5	14.6
625	F-13 yr.	4/80-6/80	6		5.0	1.9	-	-	12.8	4.9	9.7	6.0
628	F-12 yr.	4/80-7/81	22		63.4	24.5	48.1	18.6	101.9	39.4	19.2	11.9
629	F-3 yr.	4/80-8/81	22		24.6	9.5	15.9	6.2	52.2	20.2	13.1	8.1
630	F-6 yr.	4/80-8/81	23		10.3	4.0	6.4	2.5	13.6	5.2	6.2	3.8
631	F-10 yr.	3/77-4/77										
		4/80-8/81	24		50.5	19.5	73.8	28.5	130.8	50.5	21.0	13.0
632	F-11 yr.	4/80-9/80	14		40.7	15.7	-	-	48.6	18.8	16.3	10.1

Appendix B (cont'd)

Moose ID #	Sex-Age at Capture	Period Monitored (mo., yr)	Total # locations	Summer 1/ Home Range km 2	mi 2	Winter 1/ Home Range km 2	mi 2	Total 2/ Home Range km 2	mi 2	Maximum length of km	mi
634	F-12 yr.	4/80-8/81	21	78.8	30.4	31.6	12.2	112.1	43.3	15.6	9.7
635	F-Adult	4/80-8/81	24	26.9	10.4	69.2	26.7	164.4	63.5	34.3	21.3
636	F-4 yr.	4/80-8/81	21	65.4	25.2	58.2	22.5	83.1	32.1	15.1	15.6
637	F-Adult	4/80-7/81	23	34.9	13.5	49.3	19.0	70.4	27.2	17.0	10.6
638	F-Adult	4/80-7/81	20	62.8	24.3	58.5	22.6	78.6	30.3	25.1	15.6
639	F-4 yr.	4/80-7/81	22	137.1	52.9	239.4	92.5	308.0	119.0	26.5	16.5
640	F-5 yr.	4/80-5/81	21	45.3	17.5	24.4	9.4	58.7	22.6	16.0	9.9
641	F-12 yr.	4/80-7/81	25	114.7	44.3	44.9	17.3	140.8	54.4	16.6	10.3
643	F-Adult	4/80-7/81	23	54.9	21.2	62.2	24.0	102.7	40.0	21.2	13.2
644	F-Adult	4/80-8/81	21	77.3	29.8	57.8	22.3	127.5	49.2	21.3	13.2
645	F-10 yr.	4/80-8/81	21	49.7	19.2	49.5	19.1	89.1	34.4	23.4	14.5
647	F-13 yr.	4/80-8/81	26	71.5	27.6	15.1	5.8	72.4	28.0	13.1	8.1
648	F-4 yr.	4/80-8/81	22	98.4	38.0	62.8	24.2	197.0	76.1	38.7	24.0
649	F-Adult	4/80-8/81	23	14.4	5.6	9.1	3.5	16.6	6.4	8.0	5.0
650	F-4 yr.	4/80-8/81	26	238.4	92.1	101.8	39.3	420.1	162.2	47.5	29.5
651	F-6 yr.	8/78-3/79									
		4/80-8/81	23	47.3	18.3	42.6	16.5	70.9	27.4	13.4	8.3
652	F-13 yr.	4/80-7/81	24	122.8	47.4	44.0	17.0	131.4	50.7	24.4	15.1
653	F-13 yr.	4/80-7/81	22	22.1	8.5	34.0	13.1	46.5	18.0	8.6	5.4
654	F-9 yr.	4/80-7/81	20	35.9	13.9	22.7	8.7	60.7	23.4	13.0	8.0
655	F-16 yr.	4/80-7/81	21	45.6	17.5	19.8	7.6	50.0	19.3	12.6	7.8
656	F-13 yr.	4/80-8/81	18	43.6	16.8	0.4	0.2	44.3	17.1	9.3	5.8
662	F-4 yr.	3/77-10/77									
		6/80-7/81	34	55.8	21.6	33.9	13.1	66.7	25.8	13.6	8.5
663	F-8 yr.	10/76-4/79									
		8/80-7/81	64	260.6	100.6	50.0	19.3	269.2	103.9	27.0	16.8
664	F-Adult	10/76-4/79									
		6/80-12/80	55	73.1	28.2	2388.9	922.4	2910.5	1123.8	106.3	66.1
666	F-9 yr.	3/81-8/81	7	1.3	0.5	-	-	22.0	8.5	11.7	7.3
668	F-8 yr.	3/81-8/81	7	3.3	1.3	-	-	24.8	9.6	13.5	8.4
671	F-4 yr.	3/81-8/81	5	-	-	-	-	198.1	76.5	38.4	23.8
683	F-9 yr.	3/81-8/81	7	8.6	3.3	-	-	25.6	9.9	10.6	6.6
684	F-8 yr.	3/81-7/81	6	-	-	-	-	5.8	2.2	5.8	3.6
687	F-4 yr.	3/81-8/81	5	-	-	10.1	3.9	209.5	80.9	49.0	30.4
688	F-Adult	3/81-7/81	6	-	-	2.1	0.8	56.0	21.6	33.2	20.7
691	F-9 yr.	3/81-7/81	6	-	-	-	-	23.2	8.9	15.5	9.6
692	F-9 yr.	3/81-8/81	6	2.9	1.1	-	-	15.8	61.2	51.1	31.7
694	F-13 yr.	3/81-7/81	7	-	-	2.4	0.9	7.2	2.8	5.6	3.5
697	F-Adult	3/81-7/81	5	20.4	7.9	-	-	20.4	7.9	12.4	7.7

Appendix B (cont'd)

Moose ID #	Sex-Age at Capture	Period Monitored (mo., yr)	Total # locations	Summer 1/ Home Range		Winter 1/ Home Range		Total 2/ Home Range		Maximum length of	
				km 2	mi 2	km 2	mi 2	km 2	mi 2	km	mi
698	F-8 yr.	3/77-11/78	21	38.3	14.8	68.9	26.6	90.9	35.1	20.0	12.4
700	F-7 yr.	10/76-11/77	21	880.6	340.0	627.1	242.1	1353.3	522.5	66.1	41.0
702	F-7 yr.	10/76-5/79	40	148.3	57.3	173.8	67.1	567.6	219.1	43.8	27.2
703	F-10 yr.	10/76-3/79	30	193.1	74.5	93.5	36.1	261.6	101.0	24.1	15.0
704	F-Adult	10/76-4/79	22	151.2	58.4	121.7	47.0	283.6	109.5	29.8	18.5
705	F-9 yr.	10/76-3/79	32	99.2	38.3	334.9	129.3	352.5	136.1	33.1	20.6
706	F-Adult	10/76-4/79	42	157.1	60.7	93.6	36.1	185.2	71.5	21.8	13.6
707	F-7 yr.	10/76-3/79	43	344.5	133.0	516.6	199.5	657.4	253.8	52.9	32.9
708	F-8 yr.	10/76-4/79	39	252.1	97.3	136.8	52.8	454.1	175.4	50.0	31.0
709	F-4 yr.	10/76-3/79	29	361.3	139.5	111.2	42.9	390.0	150.6	30.4	18.9
710	F-6 yr.	10/76-10/77	16	39.8	15.4	33.0	12.8	59.7	23.0	13.5	8.4
711	F-7 yr.	10/76-3/79	31	143.4	55.4	48.3	18.6	151.0	58.3	17.9	11.1
712	F-7 yr.	10/76-10/78	38	628.7	242.7	20.7	8.0	717.2	276.9	61.1	38.0
713	F-9 yr.	10/76-5/78	23	42.6	16.5	51.9	20.0	81.1	31.3	13.5	8.4
714	F-7 yr.	10/76-10/78	40	268.9	103.8	246.8	95.3	411.3	158.8	33.6	20.9
715	F-Adult	10/76-4/78	21	46.2	17.8	15.0	5.8	59.9	23.1	15.7	9.7
716	F-Adult	10/76-3/79	31	118.3	45.7	32.0	12.3	149.5	57.7	24.9	15.4
717	F-4 yr.	10/76-4/79	30	287.5	111.0	224.5	86.7	377.4	145.7	33.6	20.8
718	F-7 yr.	3/77-5/79	26	544.6	210.3	143.9	55.6	544.6	210.3	39.1	24.3
719	F-4 yr.	3/77-4/79	35	96.7	37.3	14.0	5.4	104.8	40.5	16.5	10.2
720	F-12 yr.	3/77-2/79	35	565	21.8	73.6	28.4	106.7	41.2	14.9	9.3
721	F-3 yr.	3/77-3/79	25	48.2	18.6	101.2	39.1	173.0	66.8	19.7	12.2
722	F-13 yr.	3/77-3/79	28	1131.3	436.8	155.8	60.2	1182.7	456.7	99.8	62.0
723	F-8 yr.	3/77-4/80	28	53.1	20.5	28.7	11.1	64.2	24.8	12.0	7.5
724	F-13 yr.	3/77-1/79	38	163.7	63.2	215.0	83.0	271.3	104.7	34.8	21.6
725	F-4 yr.	3/77-10/79	33	1139.1	439.8	725.4	280.1	2269.0	876.1	169.4	105.2
728	F-Adult	3/77-5/79	28	197.7	76.3	12.9	5.0	236.7	91.4	35.5	22.1
729	F-7 yr.	3/77-6/79	38	122.0	47.1	81.8	31.2	172.1	66.4	26.8	16.7
730	F-11 yr.	3/77-3/79	28	47.4	18.3	64.1	24.8	121.7	47.0	19.8	12.3
731	F-Adult	3/77-4/79	35	42.0	16.2	37.9	14.6	63.3	24.4	15.1	9.4
732	F-10 yr.	3/77-3/79	25	32.1	12.4	41.0	15.8	76.1	29.4	16.9	10.5
733	F-3 yr.	3/77-3/79	26	49.9	19.3	35.0	13.5	99.4	38.4	15.8	9.8
735	F-16 yr.	8/78-3/79	8	10.5	4.1	18.4	7.1	37.7	14.5	14.4	9.0
736	F-Adult	10/77-2/79	8	-	-	21.3	8.2	64.9	25.1	29.1	18.1
737	F-Adult	10/77-11/79	6	-	-	-	-	72.7	28.1	23.7	14.7
739	F-Adult	10/77-2/79	8	16.0	6.2	18.9	7.3	53.4	20.6	12.5	7.7

Appendix B (cont'd)

Moose ID #	Sex-Age at Capture	Period Monitored (mo., yr)	Total # locations	Summer 1/ Home Range		Winter 1/ Home Range		Total 2/ Home Range		Maximum length of	
				km 2	mi 2	km 2	mi 2	km 2	mi 2	km	mi
740	F-Adult	10/77-10/78	9	12.3	4.8	8.2	3.2	32.1	12.4	8.9	5.5
741	F-Adult	8/78-4/79	8	-	-	-	-	179.0	69.1	23.8	14.8
			n=76 $\bar{x}$	148.7	(n=73)	123.6	(n=85)	248.2	n=85	27.1	
				236.7		299.8		449.7		23.9	

1) Not determined if 3 or less observations; summer = months of May, June, July, August, September, and October; winter = months of November, December, January, February, March and April.

2) Not determined if 4 or less observations.