SUSITNA HYDROELECTRIC PROJECT

PHASE II PROGRESS REPORT

BIG GAME STUDIES

Volume IV CARIBOU

Kenneth W. Pitcher

ALASKA DEPARTMENT OF FISH AND GAME
Submitted to the Alaska Power Authority
April 1983

SUSITNA HYDROELECTRIC PROJECT

PHASE II

1982 ANNUAL REPORT

BIG GAME STUDIES

VOL. IV CARIBOU

by Kenneth W. Pitcher

ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the

Alaska Power Authority

April, 1983

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.

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. This included general studies of wildlife populations to determine how each species used the area and identify potential impact mechanisms. Phase II studies continued to provide additional information during the anticipated 2 to 3 year period between application and final FERC approval of the license. Belukha whales were added to the species being studied. During Phase II, we are narrowing the focus of our studies to evaluate specific impact mechanisms, quantify impacts and evaluate mitigation measures.

This is the first annual report of ongoing Phase II studies. In some cases, objectives of Phase I were continued to provide a more complete data base. Therefore, this report is not intended as a complete assessment of the impacts of the Susitna Hydroelectric Project on the selected wildlife species.

The information and conclusions contained in these reports are incomplete and preliminary in nature and subject to change with further study. Therefore, information contained in these reports is not to be quoted or used in any publication without the written permission of the authors.

The reports are organized into the following 9 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
Volume IX.	Belukha Whale

SUMMARY

Plans to construct a large hydroelectric project on the Susitna River within the western portion of the Nelchina caribou range have raised concerns about the welfare of this important caribou herd. Impact studies, which began in early 1980, continue with the basic objectives of monitoring herd status, determining range use and migratory routes and delineating subherds. The results of these studies are being used to evaluate potential impacts of project construction, to make recommendations to minimize adverse impacts and to evaluate mitigation measures. Extensive use of historical records of the Nelchina herd has been made in the analyses because of the changeable nature of caribou movement patterns. Primary methodology for the study was the repetitive relocation of radio-collared caribou. Population estimates were made with a modified version of the aerial photo-direct count-extrapolation census procedure and by direct count.

During the winters of 1980-81 and 1981-82 the main Nelchina herd wintered primarily on the northeastern Lake Louise Flat eastward through the middle portion of the Gakona and Chistochina River drainages to Slana.

During spring migration females moved across the Lake Louise Flat onto the calving grounds in the foothills of the eastern Talkeetna Mountains on a broad front from Lone Butte to Kosina Creek. Significant numbers of female caribou (probably over 50% in 1982) passed through the upper Watana impoundment area enroute to the calving grounds. Most males remained on winter range during this period.

Calving occurred primarily in drainages of Kosina Creek although some occurred along Goose Creek and the lower reaches of the Black and Oshetna Rivers. Nelchina bulls were found scattered throughout the Nelchina range during this time mostly in transit to summer range.

Summer range for Nelchina females was the northern and eastern slopes of the Talkeetna Mountains. Bulls were found scattered in "bull pastures" throughout the high country of the Nelchina range.

During autumn considerable dispersal occurred from the Talkeetna Mountains across the Lake Louise Flat. In 1982, perhaps 10% of the female segment crossed the Susitna River and moved onto the Jay Creek-Coal Creek plateau.

During the rut the herd appeared well mixed and moved eastward from the Talkeetna Mountains across the Lake Louise Flat. In mid-October 1982 about 10% of the herd crossed the Susitna River in the area of Watana Creek, migrated across the Jay Creek-Coal Creek plateau and moved eastward to winter range.

Historically, Nelchina caribou have used the same calving grounds however considerable variation in summer and winter ranges has been noted. Migratory routes, although somewhat traditional, have varied depending on the geographic relationship of the calving grounds to summer and winter ranges.

The Nelchina herd was estimated to contain 18,713 caribou in October 1980, 20,730 in 1981 and 21,162 in 1982. Herd composition in October 1982 was estimated at 47.7% females ≥1 year, 26.5% males ≥1 year and 25.8% calves.

Calf survival from birth to 10.5 months of age was estimated at 0.58. Average annual survival for caribou ≥1 year was estimated 0.88 for females and 0.92 for males (0.89 sexes combined). Reported hunter kill of Nelchina caribou for the 1981-82 regulatory year was 863 animals.

Observations of radio-collared (and non-collared) caribou indicated the existence of a discrete subherd resident in the upper drainages of the Susitna, Nenana and Chulitna Rivers (upper

Susitna-Nenana subherd). Although overlap with animals from the main Nelchina herd occured during winter, summer and fall they were separated during calving. An initial census (direct count) of this subherd was attempted in October 1982 and 2,077 caribou were counted. Complications in evaluating the count resulting from delays from weather and movement of mainherd animals through the area make it desireable to repeat the census.

It is apparent, that even though the massive crossings of the Susitna River in the area of Watana Creek have not occurred in recent years, that significant numbers of Nelchina caribou migrate through the upper portion of the proposed Watana impoundment. This occurs during both spring and fall. While it is not possible to predict the impacts of the Watana impoundment on migrating caribou it does appear that the greatest potential for deleterious impacts occurs during spring migration to the calving grounds. Pregnant females are often in the poorest condition of the year at this time and might be particularly vulnerable to an extended migration or a hazardous reservoir crossing. The proposed Denali Route access road passes through the range of the upper Susitna-Nenana subherd and historical summer and winter range of the main Nelchina herd. Potential impacts include increased mortality from vehicle collisions, impeded east-west movements, increased hunter access and possibly increased predation.

The Susitna hydroelectric project should be viewed as one of a number of probable developments which will occur on the Nelchina caribou range. While no one action may have catastrophic results the cumulative impact will likely be a reduced ability for the Nelchina range to support large numbers of caribou.

It is recommended that range use and migratory routes be monitored by periodic relocations of radio-collared caribou. Population status should be monitored with annual censuses and sex and age composition sampling. Increased emphasis should be placed on studying the upper Susitna-Nenana subherd.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

INTRODUCTION

Plans to construct a large hydroelectric project on the Susitna River within the western reaches of the Nelchina caribou range have raised concerns about impacts of the development on this important caribou herd. Impact studies were begun in early 1980 and a comprehensive report on the results published in March 1982 (Pitcher 1982). Considerable background material was also presented in that report; primarily historical range use, movement patterns and population levels. Following is a summary of background material, methodology, results, possible impacts and recommendations from that report.

The Nelchina caribou herd which has occupied a range of about 20,000 mi^2 in southcentral Alaska has been important to hunters because of its size and proximity to population centers. Currently, a proposal is being studied to construct a large hydroelectric project on the Susitna River in the western portion of the Nelchina range. The proposed impoundments would inundate a very small portion of apparent low quality caribou habitat. Concern has been expressed however, that the impoundments and associated development might serve as barriers to caribou movement, increase mortality, decrease use of nearby areas and tend to isolate "subherds." Overall objectives of this study were to evaluate potential impacts of the proposed hydroelectric project on Nelchina caribou and to suggest possible mitigating measures. Because of the changeable nature of caribou movement patterns short-term studies of distribution and movements must be tempered with historical perspective. Fortunately, the Nelchina herd has been studied continuously since about 1948 and records previous to that time have been reviewed. The primary methodology for this study was the repetitive relocation of radio-collared caribou. Population estimates were made with a modified version of the aerial photo-direct count-extrapolation census procedure.

Caribou from the main Nelchina herd were found during winter primarily on the Lake Louise Flat, foothills of the Alphabet Hills and middle portions of the Gakona and Chistochina River drainages areas distant from the proposed hydroelectric development. Caribou primarily utilized open spruce forest during this period at elevations ranging from 2,100 to 4,300 feet ($\bar{x}$=2,779).

During spring migration females moved across the Lake Louise Flat onto the calving grounds in the eastern Talkeetna Mountains on a broad front from Lone Butte to Kosina Creek. Some caribou utilized the Susitna River in the area of the proposed Watana impoundment as a travel route. A small portion of the herd appeared to migrate across the plateau north of the Susitna River

crossing the Susitna between Deadman Creek and Jay Creek enroute to the calving grounds. Open spruce forest was still the primary vegetation type utilized, however, shrublands and tundra-herbaceous types became increasingly important. Females were found at elevations ranging from 1,900 to 5,600 feet ($\bar{x}$=2,886). Males lagged behind females during spring migration using mostly spruce forests. Elevations averaged 2,280 feet, ranging from 2,000 to 3,100.

During the calving period, virtually all females from the main Nelchina herd were found from Kosina Creek into the Oshetna River in the eastern Talkeetna Mountains. Tundra-herbaceous vegetation accounted for 75% of the sightings and shrublands for 25%. Elevations for females ranged from 2,400 to 5,400 feet ($\bar{x}$=3,871). Nelchina bulls were found scattered throughout the range during calving mostly in transit to summer ranges. Spruce forest was still the primary vegetation type used by bulls. Elevations averaged 2,872 feet (range 2,100 - 4,400).

Summer range for Nelchina females was the northern and eastern slopes of the Talkeetna Mountains between 3,300 and 6,000 feet elevation ($\bar{x}$=4,250). Tundra-herbaceous was the dominant vegetative type utilized followed by shrublands. Bulls were scattered in "bull pastures" in the high country throughout the Nelchina range. Shrublands and tundra-herbaceous were the main vegetative types utilized. Elevations ranged from 2,200 to 4,600 feet ($\bar{x}$=3,572).

During autumn considerable dispersal, particularly of females, occurred as caribou moved out of the Talkeetna Mountains across the Lake Louise Flat into the Alphabet Hills then back to the west. Limited use of the Watana impoundment area was documented during this period. The sexes became mixed particularly late in September. Uses of vegetative types and elevations of relocations were the most varied of any seasonal period.

During the rut males and females appeared to be well mixed and the herd moved from the foothills of the Talkeetna Mountains eastward across the Lake Louise Flat. Spruce forest was the principal vegetative type used during this period while shrublands received minor use. Caribou ranged in elevation from 2,200 to 3,900 feet ($\bar{x}$=2,832).

Historically, Nelchina caribou have used the same calving grounds however considerable variation in summer and winter range use has been noted. Migratory routes, although somewhat traditional, have varied depending on the geographic relationship of the calving grounds to summer and winter ranges.

On a year around basis habitat use by Nelchina bulls and cows was significantly different. Use of shrublands and bare substrate were similar while bulls occurred more frequently in spruce forest and at lower elevations while cows were found more frequently in tundra-herbaceous vegetation and at higher elevations.

It appeared (based on the year around relocations of radio-collared caribou) that at least three distinct subherds with separate calving areas existed in addition to the main Nelchina herd. These included the upper Talkeetna River (<400 animals), Chunilna Hills (<350 animals) and upper Susitna-Nenana (<1000 animals) subherds. Another subherd probably occurs in the upper Gakona River and others may exist in the Alaska Range and western Talkeetna Mountains.

In October 1980, the Nelchina herd was estimated to contain 18,713 caribou and in October 1981, the herd was estimated at 20,730. Herd composition in October 1981 was estimated at 49% females ≥1 year, 30% males ≥1 year and 21% calves.

Calf survival to 11 months of age (May 1980 to April 1981) was estimated at 0.43. Average annual natural mortality for caribou one year old and older was estimated at 0.07 for females and 0.14 for males. Reported hunter harvest of Nelchina caribou averaged 670 animals between 1972 and 1981.

It was apparent from historical records (and to a lesser extent from movements of radio-collared animals) that the proposed Watana impoundment would intersect a major migratory route. Crossings of the impoundment area and use of range to the northwest will probably increase as herd size increases. It is not known precisely how project construction will affect the caribou. The impoundment could prove to be a barrier to movement causing abandonment of a portion of the range or dividing of the herd. The migratory route could be changed by extending it around the eastern end of the reservoir. Caribou could continue to cross at traditional points and could experience increased mortality because of hazards such as ice shelving, ice sheets, overflow and wind-blown glare ice, particularly during spring migration. Developments and activities associated with project construction and operation such as roads, railroads, airfields and recreational activities of project personnel would undoubtedly negatively impact Nelchina caribou although the extent is unknown. The proximity of the calving grounds to the Watana impoundment and the probability of increased human access is of concern. The Susitna hydroelectric project should be viewed as one of a number of probable developments which will occur on the Nelchina caribou range. While no single action may have catastrophic results the cumulative impact will likely be a reduced ability for the Nelchina range to support large numbers of caribou.

It is recommended that in Phase II a pool of radio-collared caribou be maintained to monitor caribou use of the impoundment area. Population status should be monitored with annual censuses and composition sampling. A study of causes and extent of mortality of caribou calves should be considered.

The remainder of this report consists of methodology, results obtained since preparation of the Phase I Final Report (1 November 1981-31 October 1982) and a discussion of the significance of these results to project construction.

METHODS

Data on movement patterns, migration routes, timing of major movements, subherd status and habitat use were collected by periodic relocations of radio-collared animals. It was assumed that the behavior of radio-collared caribou was representative of the herd in general and I did not make observations indicating otherwise. Caribou were captured by use of immobilizing drugs [etorphine (M-99) and xylazine (Rompun)] administered with projectile syringes (Cap-Chur equipment) shot from a helicopter. Radio-collars in the 150.000-154.000 MHz range, purchased from Telonics Inc., were used. Radio-collared caribou were relocated from a fixed-wing aircraft (Cessna 180, 185 or PA-18-150) equipped with two Yagi antennas, one attached to wing struts on each side of the aircraft. Antenna leads were attached to a right/left switch box coupled to a radio-tracking receiver/scanner. Animals were located by balancing the transmitter signal between the two antennas through use of the left/right switch and orientation of the aircraft and following the signal. As of 5 October 1982 a total of 40 radio-collared animals were being monitored including 34 females and 6 males.

A modified version of the aerial photo-direct count-extrapolation census procedure (Hemming and Glenn 1969, Davis et al. 1979, Doerr 1979) was used to estimate the size of the Nelchina herd. This technique is composed of three separate procedures: (1) a complete count of all animals in the post-calving aggregation; (2) composition sampling of these same animals to determine the proportion of adult females; and (3) representative fall composition sampling of the entire herd to determine the proportions of females, males and calves (Doerr 1979). Acceptance of four assumptions is necessary for the APDCE technique: (1) all females in the herd are present in the post-calving aggregations; (2) adult females are randomly distributed throughout the post-calving aggregations; (3) the sex and age cohorts are randomly distributed throughout the herd during fall; and (4) mortality of

adult females from the time of post-calving aggregation to the fall composition counts is zero (Davis et al. 1979) or is accounted for. An evaluation of these assumptions by Davis et al. (1979) indicated that all but assumption #3 were valid and that the collection of representative fall composition data was the most difficult procedure.

The fall population estimate is calculated from the following equation.

$$FP = N_a \times P_f - M_f \times (1 + R)$$

where

- FP = estimated fall population;
- N_a = number of animals in the postcalving aggregation;
- P_f = proportion of females in post-calving aggregation;
- M_f = mortality of females from the time of post-calving counts until the fall; and
- R = ratio of caribou other than females to females in the fall.

Reconnaissance flights were made in a C-180 to determine when caribou were suitably aggregated to census. PA-18-150 Super Cubs were used to survey the aggregations and the caribou herds were either photographed or directly counted. Hand-held, motor driven, 35 mm cameras were used to photograph caribou groups. The 35 mm color slides of caribou groups were projected on a paper screen and caribou images marked. The number of images were then counted.

A helicopter (Bell 206B) was used to sample the post-calving aggregations, the herd during the breeding season and the herd in April to estimate proportions of females, males and calves. Groups of caribou were approached from the rear until the sex of each animal older than calves could be determined from the external genitalia (presence or absence of the vulva).

Methodology for data storage, retrieval and analysis was included in the 1980 report for data management:biometrics (wildlife ecology/big game).

The study area consisted of the entire range of the Nelchina caribou herd (Fig. 1). However, monitoring frequency of radio-collared animals was much more frequent when they were in the vicinity of the proposed impoundments.

Estimates of mean annual adult survival rates were made from radio-collared animals using a formula provided by Trent and Rongstad (1974) which is based on the number of mortalities detected and the period of time the radio-collared animals were monitored.

Estimates of calf survival to 11 months of age were made by multiplying the calf to female ratio obtained in April by the estimate for annual survival of females ≥1 year then dividing by the ratio of calves to females ≥1 year at birth (Fuller and Keith 1981).

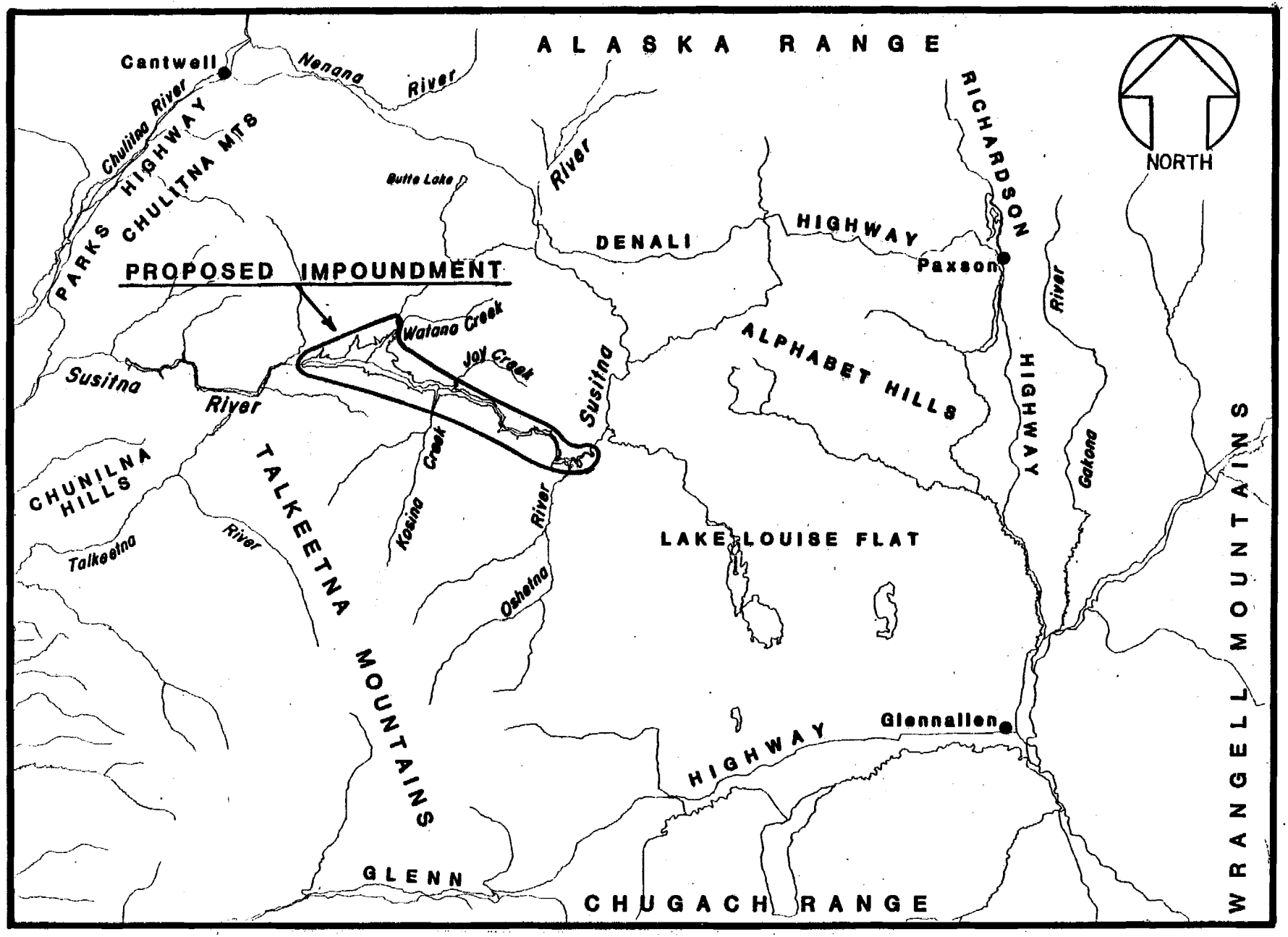

Figure 1. Nelchina caribou range with basic geographic features.

RESULTS AND DISCUSSION

Distribution and Movements: Main Nelchina Herd

Winter: between 1 December 1981 and 31 March 1982 the Nelchina herd was located on the northeastern Lake Louise Flat eastward to Slana (Fig. 2). This was similar to the winter distribution of 1980-81. During both years the entire herd wintered far from the proposed impoundments (Fig. 3).

Spring Migration: directed movement towards the calving area by the female segment of the herd was not apparent until late April in 1982. The migratory route was along and to the west of Lake Susitna, Lake Tyone and Tyone River to the big bend of the Susitna River (Fig. 4). From the big bend the majority of the female segment moved into the Talkeetna Mountain foothills via the lower Oshetna River and Goose Creek. A smaller segment (perhaps 10%) crossed the Susitna River and traversed the peninsula north of the big bend and then recrossed the Susitna River near the gaging station. It appeared that probably over 50% of the female segment was in the upper reaches of the Watana impoundment area during spring migration in 1982. The migration seemed to be about a week later than in 1981. The Susitna River was open in 1982 while in 1981 it was frozen and used as a major travel route. Radio-collared males lagged far behind the females during spring migration.

Calving Period: observations of radio-collared females during the calving period (15 May - 10 June) indicated that calving occurred primarily in drainages of Kosina Creek although some calving also took place along Goose Creek and the lower reaches of the Black and Oshetna Rivers, similar to previous years (Fig. 5). Calving occurred at lower elevations in 1982 than in 1981 and 1980 ($\bar{x}$ elevation: 1982 = 3,039, 1981 = 4,356, 1980 = 3,649; $P<0.01$). This was likely caused by the late snow melt which resulted from a record snowpack in the eastern Talkeetna Mountains.

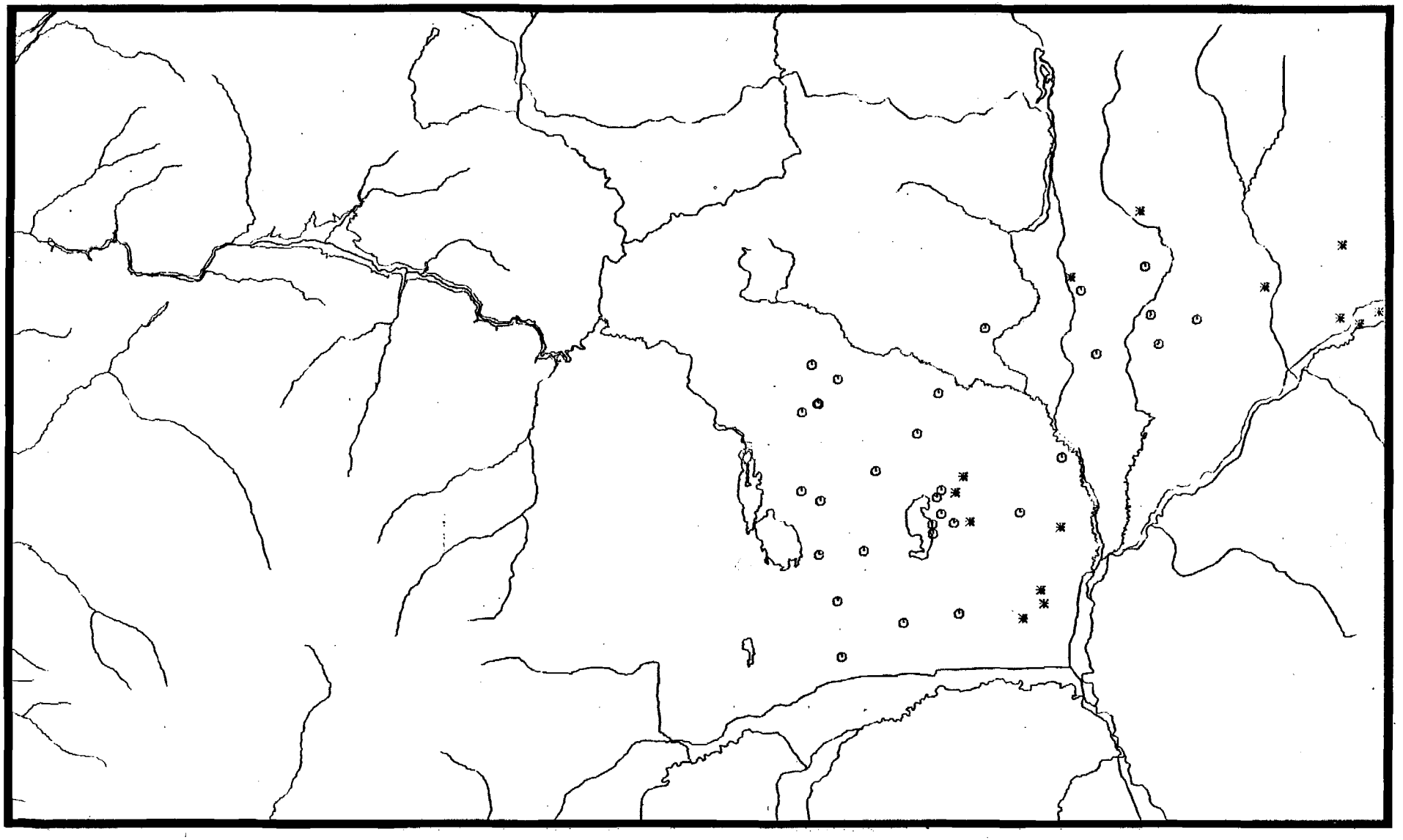

Figure 2. Distribution of Nelchina radio-collared caribou during winter, 1 December, 1981 - 31 March, 1982.
⊙ = females, ✳ = males.

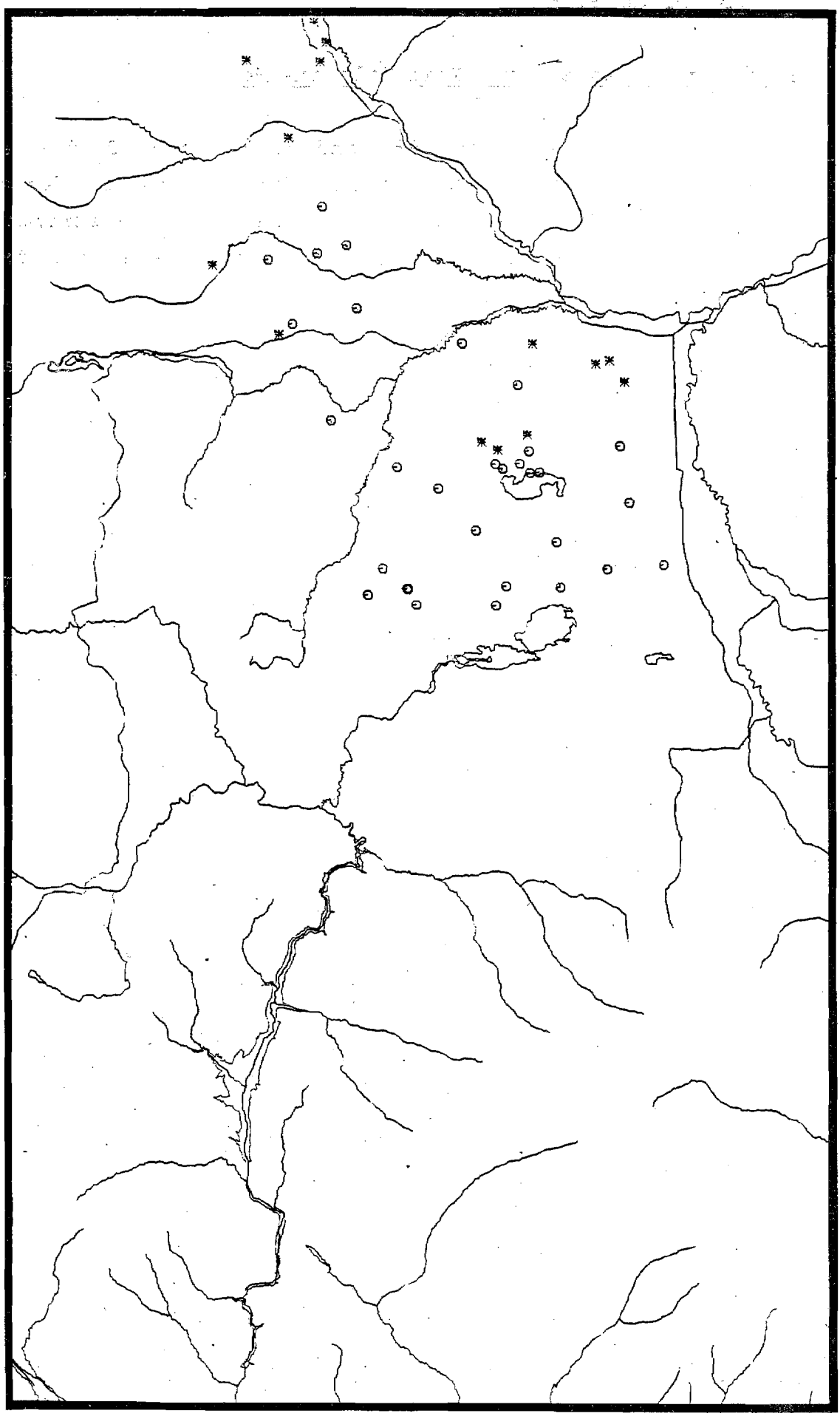

Figure 2. Distribution of Nelchina radio-collared caribou during winter, 1 December, 1981 – 31 March, 1982. ⊙ = females, ✱ = males.

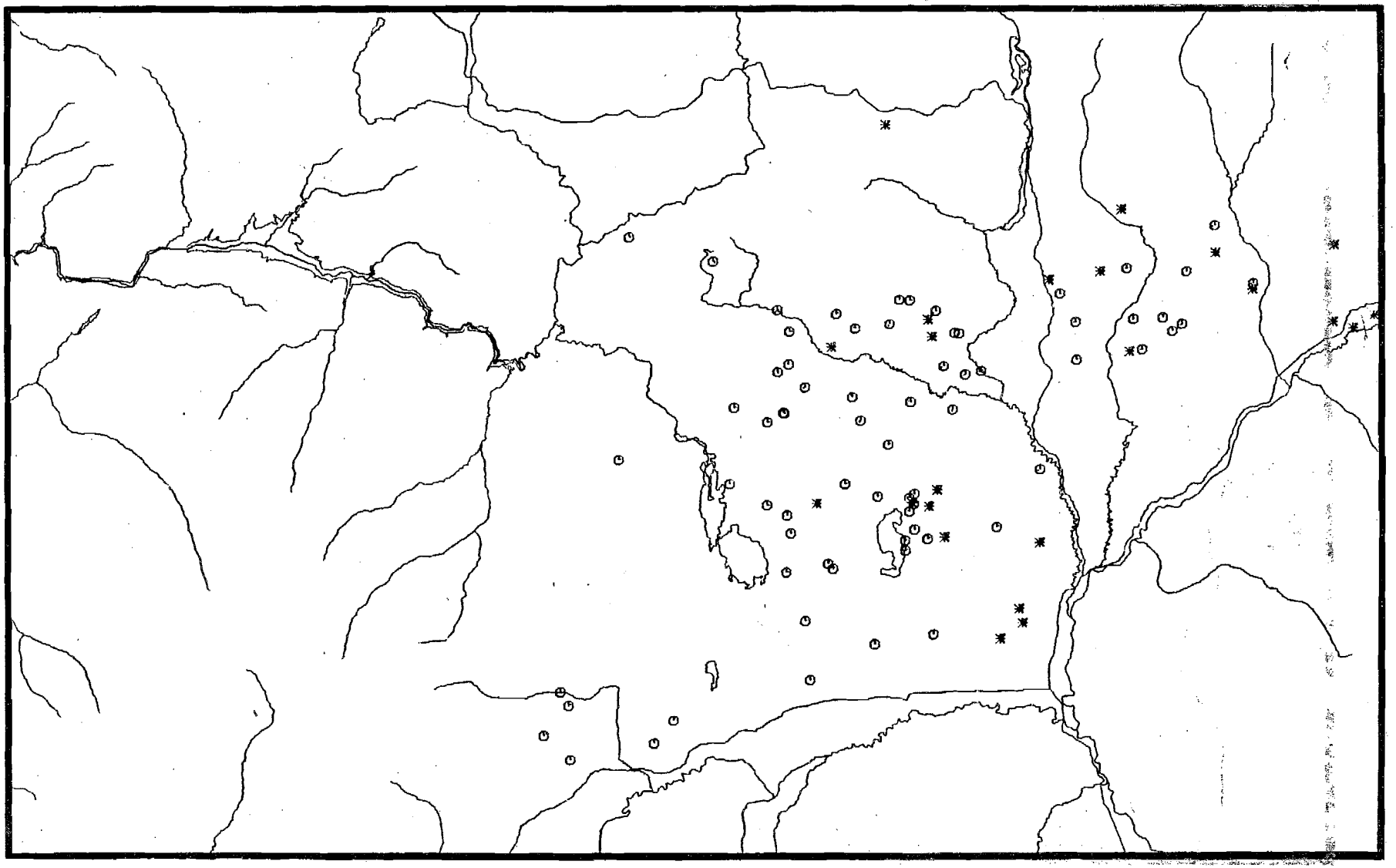

Figure 3. Distribution of Neichina radio-collared caribou during winter, 1 December - 31 March, 1980-81 and 1981-82. ⊙ = females, ✳ = males.

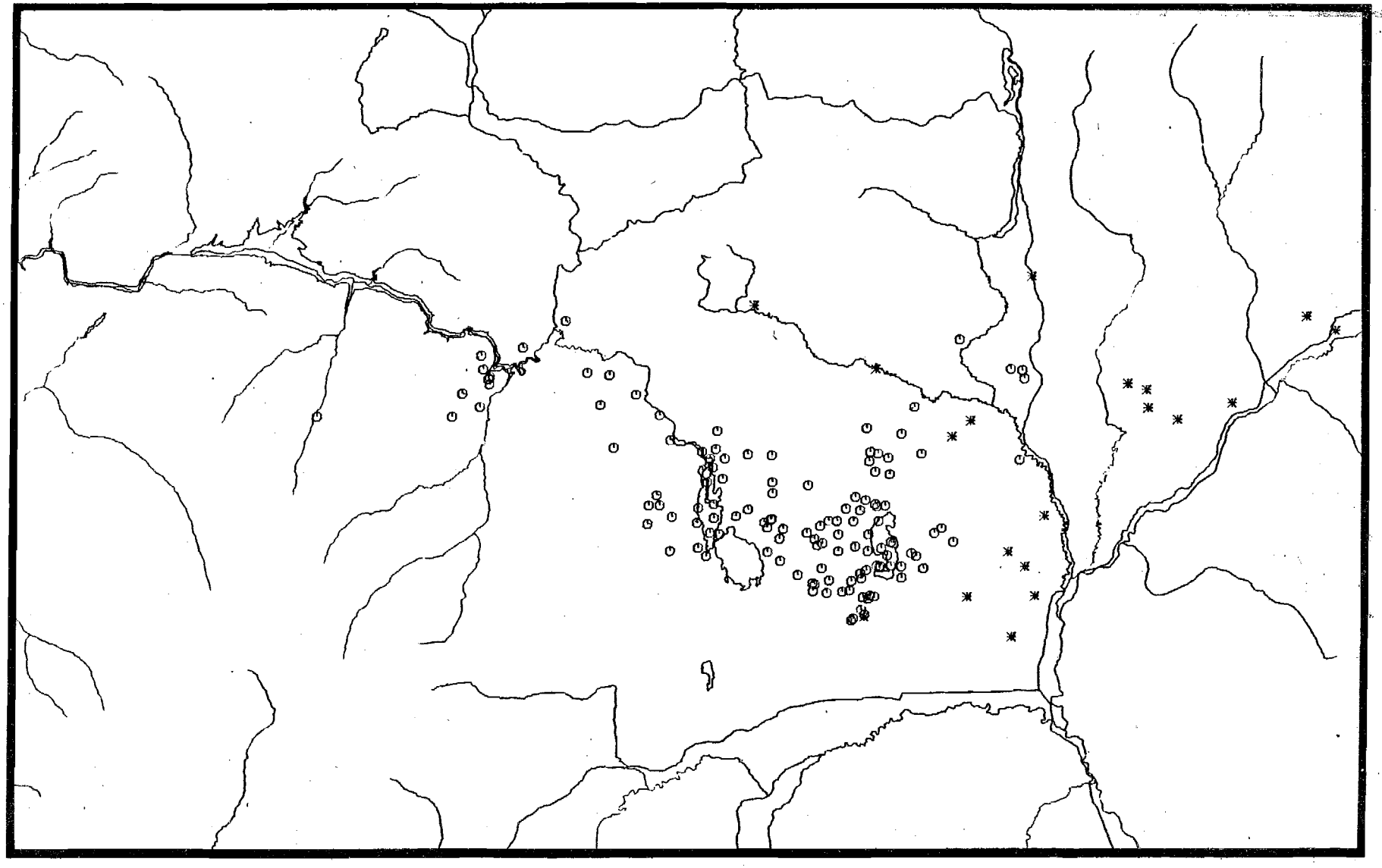

Figure 4. Distribution of Neichina radio-collared caribou during spring migration, 1 April - 14 May, 1982. ⊙ = females, ✳ = males.

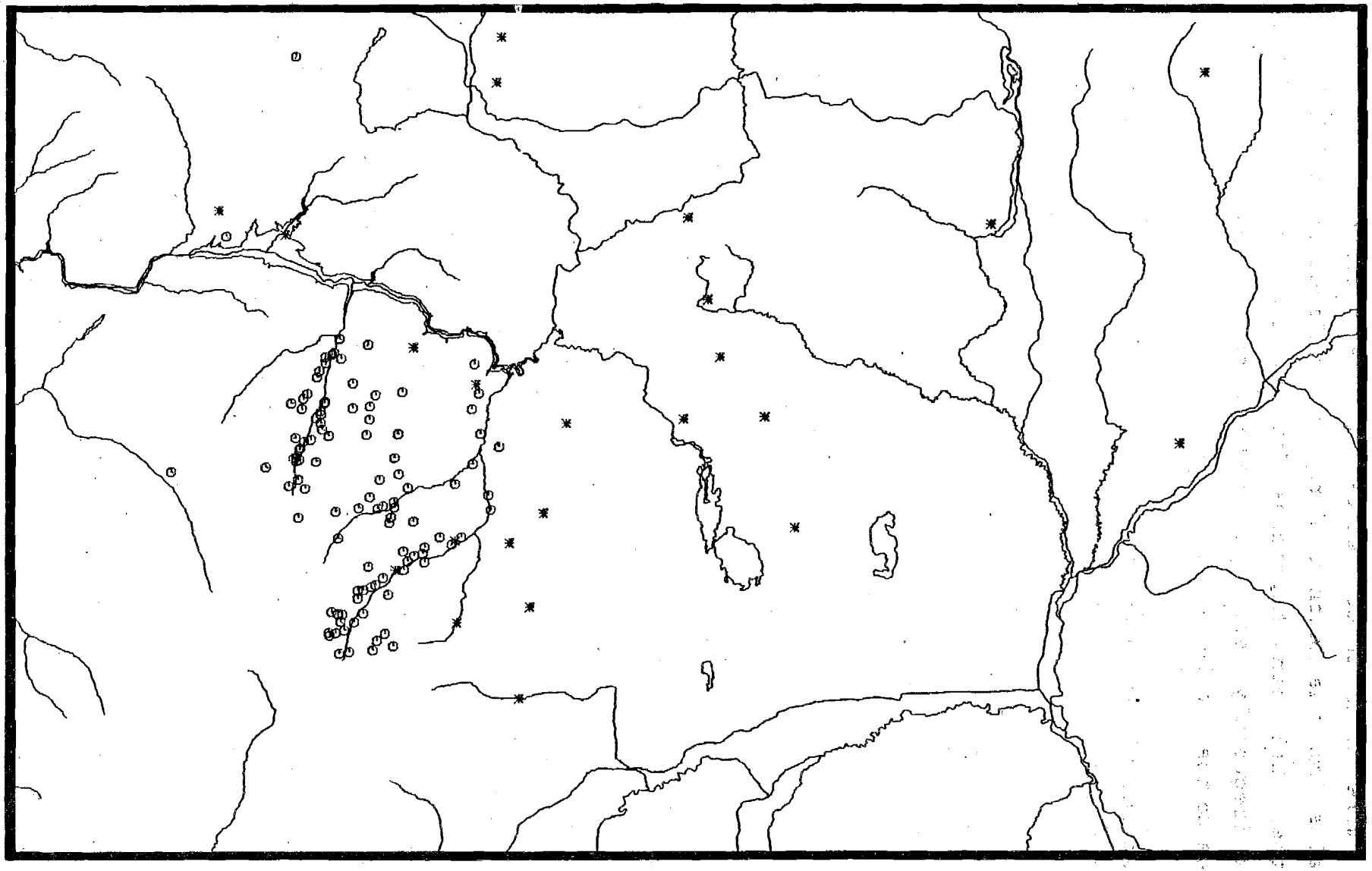

Figure 5. Distribution of Nelchina radio-collared caribou during calving, 15 May - 10 June, 1980, 1981 and 1982.
⊙ = females, ✳ = males.

For more than three decades (since records have been kept) females from the Nelchina herd have utilized the foothills of the northern Talkeetna Mountains for calving. Kosina Creek was the most frequently used area, however calving has ranged from Fog Lakes to the Little Nelchina River.

Locations of radio-collared Nelchina bulls were widespread during this period as they were enroute to summer ranges.

Summer: the female-calf segment of the Nelchina herd spent the summer period (11 June - 31 July) in the northern and eastern Talkeetna Mountains. Observations of radio-collared females during this period ranged from Tsisi Creek and Talkeetna River drainages west of Kosina Creek south to the Little Nelchina River and Caribou Creek. Summering radio-collared bulls were found in widespread locations throughout the high country of the Nelchina basin including Caribou Creek, Hicks Creek, the Little Nelchina River, Tyone Creek, Oshetna River, Fog Creek, Jack River and the upper Gakona River. Summer distribution was similar during all three years of the study (Fig. 6).

Autumn: again as in 1980 and 1981 this period (1 August - 30 September) was a time of movement and dispersal by both sexes (Fig. 7). In early August the herd was still on summer range but by 24 August perhaps 20% of the female segment had moved out of the Talkeetna Mountains onto the Jay Creek-Coal Creek plateau or onto the Lake Louise Flat. This move entailed a crossing of the Susitna in the upper Watana impoundment area by perhaps 15% of the female segment. On 22 September still about 60% of the female segment remained in the Talkeetna Mountains.

Rut: considerable west to east movement took place during the rut in 1982. When the composition counts were done on 6 October about 75% of the herd was in the area from Fish Lake to Hogan Hill while the rest were scattered across the Flat, down the

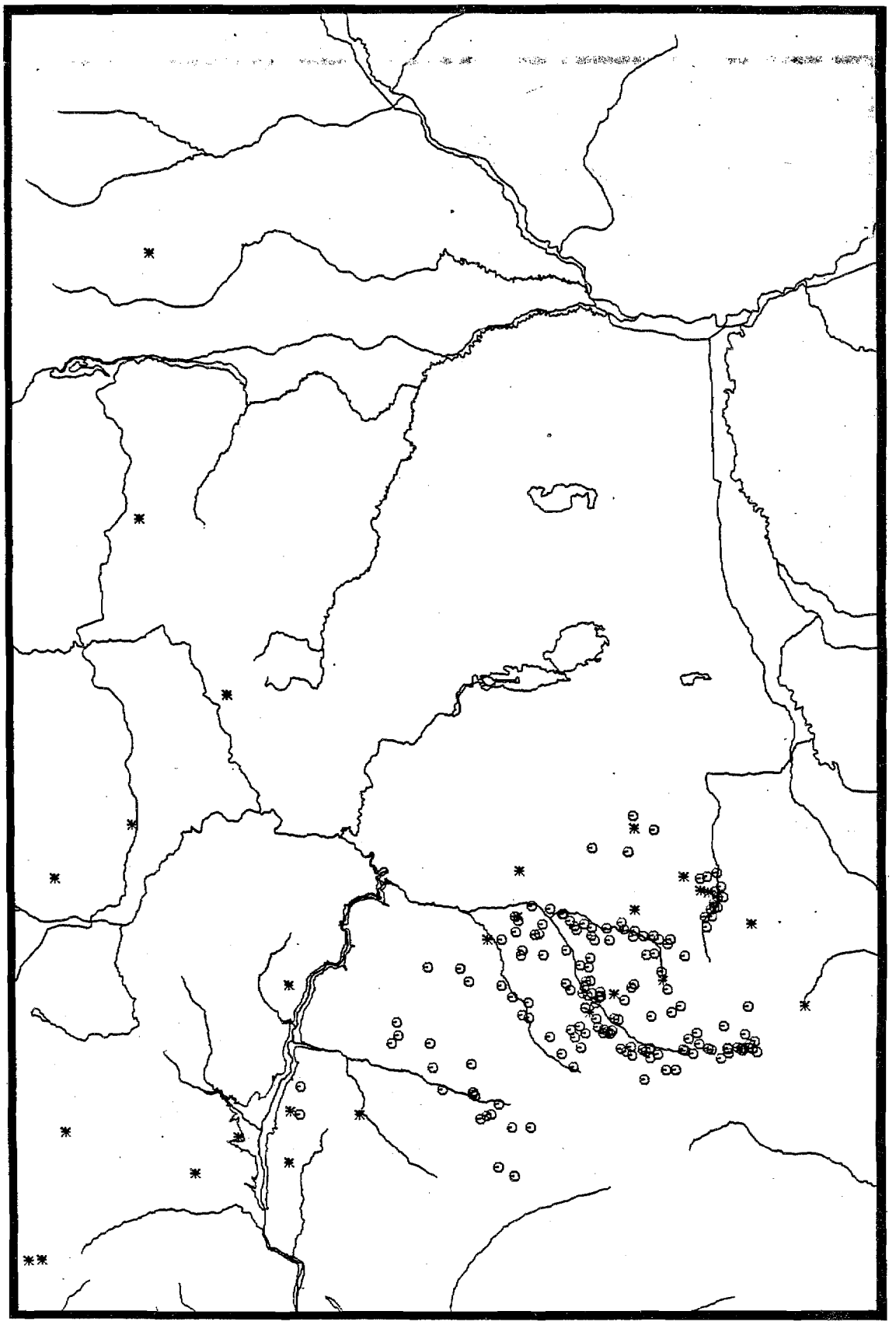

Figure 6. Distribution of Nelchina radio-collared caribou during summer, 11 June - 31 July, 1980, 1981 and 1982. ⊙ = females, ✱ = males.

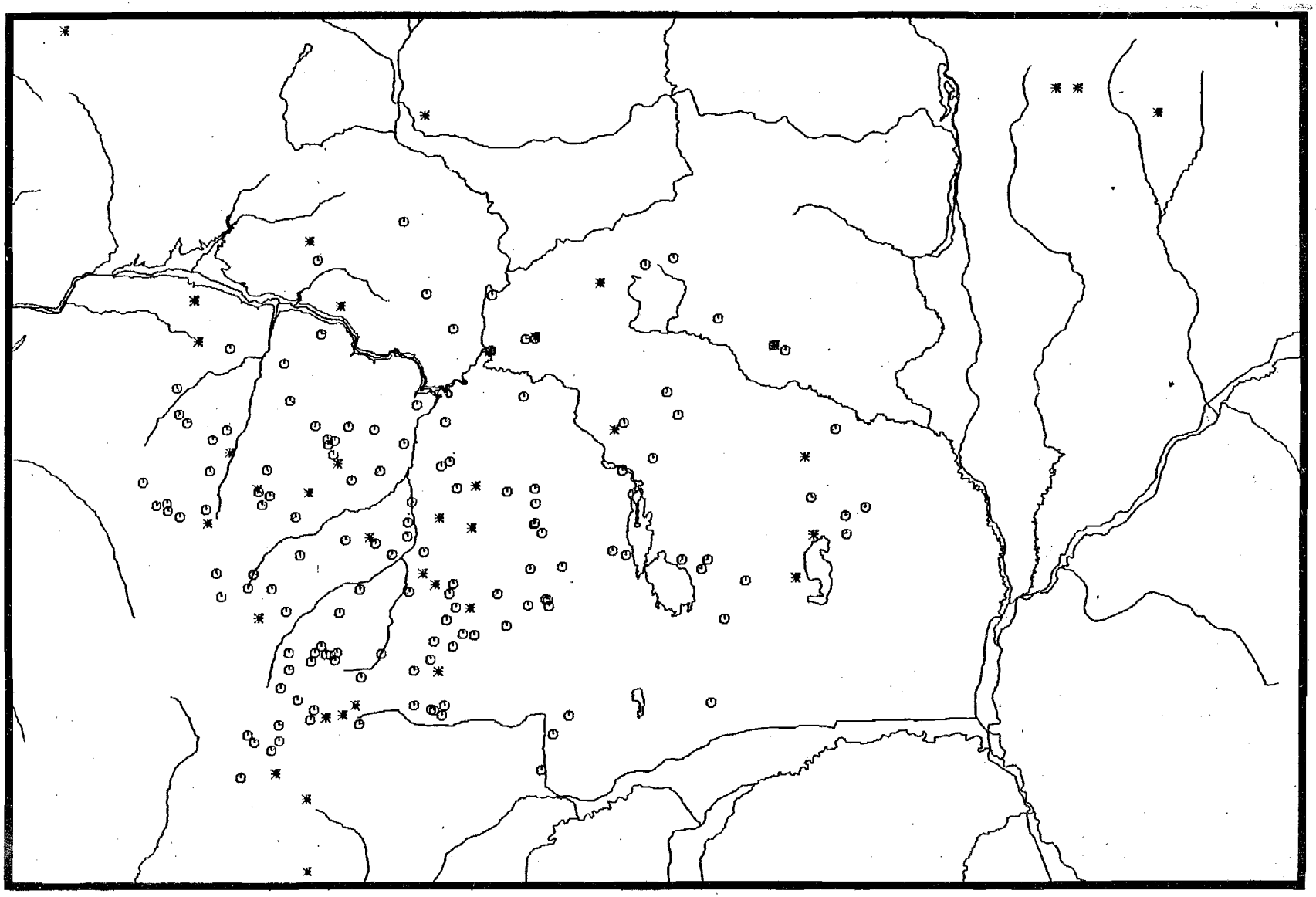

Figure 7. Distribution of Nelchina radio-collared caribou during autumn, 1 August - 31 September, 1980, 1981 and 1982. ⊙ = females, ✳ = males.

Tyone River and into the foothills of the Talkeetna Mountains from Fog Lakes to the Oshetna River. In mid-October perhaps 10% of the herd crossed the Susitna River in the area of Watana Creek, migrated across the Jay Creek - Coal Creek plateau, and then recrossed the Susitna River enroute to winter range to the east. During the entire study period rutting caribou have been spread from the Talkeetna Mountains eastward to the Chistochina River (Fig. 8).

Current distribution: year around use of the Nelchina range by radio-collared caribou from the main herd during this study is protrayed by Fig. 9 and encompassed an area of about 7,000 mi^2. Two major areas which were used extensively at times in the past received minimal use during the study period. These areas were the northwestern portion of the range including drainages of the Chulitna, Nenana and upper Susitna Rivers and the far eastern portion of the range including the Mentasta and Wrangell Mountains.

Subsequent to this reporting period substantial numbers of Nelchina caribou (perhaps 25%-40% of the herd) moved northeast of the Mentasta Mountains into the general area of Tok, Tetlin and Northway. Nelchina caribou are known to have used this area only three times in the past 30 years. This demonstrates the changeable nature of caribou movement patterns and shows that somewhat erratic movements take place even at moderate population levels.

Population Size and Composition: Main Nelchina Herd

During 1982, census activities were conducted from 6 to 8 July. Reconnaissance flights on 6 July showed groups of females and calves spread from upper Caribou Creek, the Oshetna River, Black River, upper Kosina Creek to several Talkeetna River drainages west of Kosina Creek an area of about 250 mi^2. All but one of the 25 radio-collared females from the main Nelchina herd were found in this area. The area was divided into four subareas

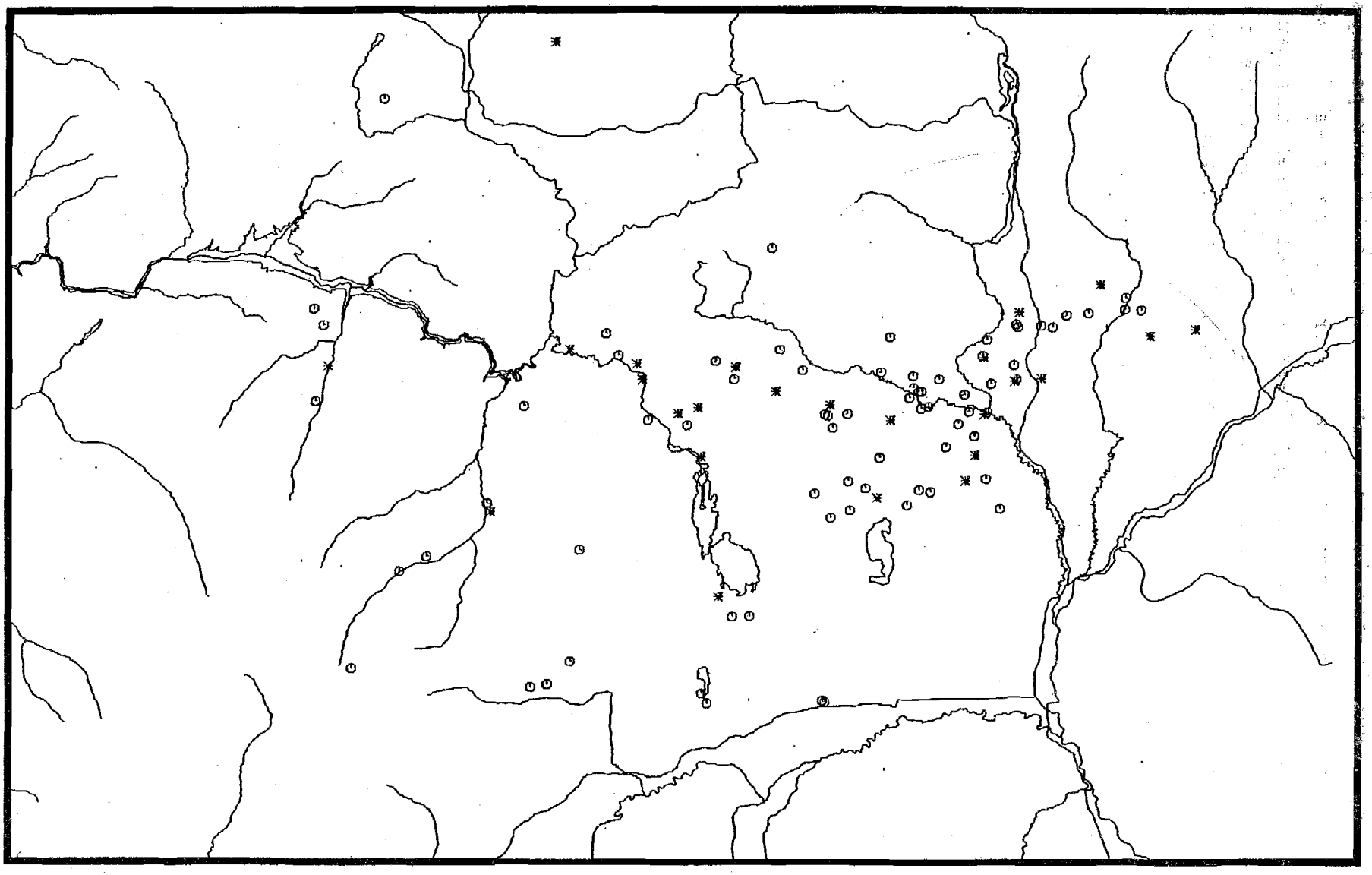

Figure 8. Distribution of main Nelchina radio-collared caribou during the rut, 1 - 31 October, 1980, 1981 and 1982. ⊙ = females, ✳ = males.

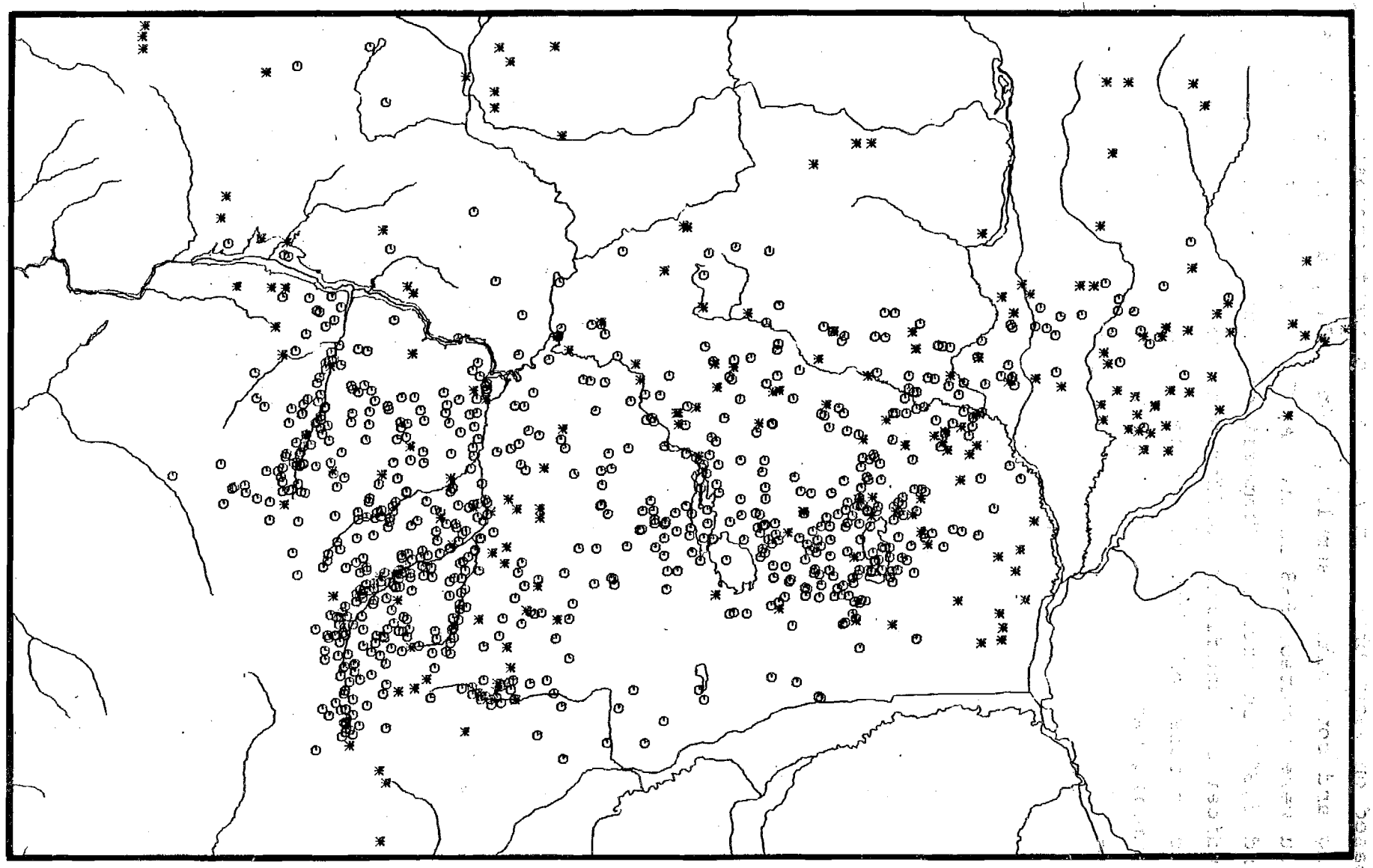

Figure 9. Distribution of main herd Nelchina radio-collared caribou during entire study period, 14 April, 1980 – 15 October, 1982. ⊙ = females, ✱ = males.

based on geographic features and apparent composition for counting and composition sampling. On 7 July a total of 18,161 caribou were counted; 888 in area A, 7,956 in area B, 3,319 in area C and 5,998 in area D. Composition sampling from the four areas indicated significant differences (x^2=135.22, P<0.001) in the proportions of females, males and calves. The composition sampling was not directly proportional to the numbers in each of the subareas therefore the data were weighted (Table 1). The estimate of the post-calving aggregation was 18,161 caribou with 10,398 females ≥ 1 year, 1,852 males ≥ 1 year and 5,911 calves.

Table 1. Nelchina caribou post-calving sex and age composition data, 8 July 1982.

Area	MM per 100 FF ≥1 year	Calves per 100 FF ≥1 year	Calves		Cows ≥ 1 Year		Bulls ≥ 1 Year	
			N	%	N	%	N	%
A	118.2	38.2	21	14.9	55	39.0	65	46.1
B	23.2	59.2	184	32.5	311	54.9	72	12.7
C	5.4	55.4	103	34.4	186	62.2	10	3.3
D	8.9	56.6	179	34.2	316	60.4	28	5.4
weighed*	17.8	56.8		32.5		57.3		10.2

* Weighting was based on composition samples and numbers of caribou counted (see text) in each of the subareas.

Fall composition sampling (Table 2) was conducted on 6 October primarily between Fish Lake and Hogan Hill. The ratio of males ≥ 1 year per 100 females ≥ 1 year (55.4) was not significantly different (P > 0.1) than last years ratio of 60.9. The ratio of calves per 100 cows ≥ 1 year (54.0) was significantly higher (P<0.05) than the 1981 ratio of 42.9 and was the highest recorded in the last decade.

Table 2. Nelchina caribou fall sex and age composition data, 6 October 1982.

MM per 100 FF ≥1 year	Calves per 100 FF ≥1 year	Calves N	Calves %	Cows ≥ 1 Year N	Cows ≥ 1 Year %	Bulls ≥ 1 Year N	Bulls ≥ 1 Year %
55.4	54.0	223	25.8	413	47.7	229	26.5

The estimated 1982 fall population was 21,162 calculated as follows: (18,161 x 0.573) - 300 x (1+1.094) where 18,161 = the number of caribou counted in the post-calving aggregation, 0.573 = the proportion of females in the post-calving aggregation, 300 = a preliminary estimate of hunter harvest of females and a 1% estimate for natural mortality of females ≥ 1 year between the time of the census and the fall composition counts and 1.094 = ratio of bulls and calves to cows in the fall.

I felt that the 1982 census was the least accurate of the three censuses conducted during the Susitna studies. The female-calf segment of the herd was dispersed over a larger area during the 1982 census than during the prior two years increasing the likelihood of missing animals. One radio-collared female was not located during reconnaissance flights prior to the census. Subsequently she was found west of the census area. Therefore, it is likely that some unknown number of caribou was outside the census area when the counts were made. Composition sampling conducted on 8 July was hampered by the molt which made it difficult to distinguish males from females from genital characteristics.

In 1980 the fall population estimate was 18,713; in 1981 the estimate was 20,694 and in 1982 the estimate was 21,162.

Mortality

Natural mortality: four radio-collared caribou, all females, died of apparent natural causes between 1 October 1981 and 30 September 1982. Two of these were probable wolf kills. Causes of death of the other two were uncertain although one was almost certainly not predation as it was seen bedded in a local area for several weeks prior to death and the carcass was intact.

Estimates of x annual survival rates for the entire study period were 0.88 (0.81-0.94; 80% confidence interval) for females ≥ 1 year and 0.92 (0.73-0.99; 80% confidence interval) for males ≥ 1 year based on the number of observed natural mortalities of radio-collared caribou and number of animal months monitored (Trent and Rongstad 1974). Combining males and females ≥ 1 year produced an estimate of 0.89 (0.83-0.94; 80% confidence interval). One radio-collared female has not been found since March 1982. If it is assumed that she died of natural causes rather than her radio failing or movement out of the study area it reduces the estimate of female survival to 0.86 (0.79-0.93; 80% confidence interval).

Calf survival from birth to about 10.5 months of age (20 May 1981 to 6 April 1982) was estimated from a theoretical birth rate of 0.66 calves per cow ≥ 1 year, an observed ratio of 0.424 calves per cow in April and estimated survival of females (0.90) between 20 May and 6 April (Fuller and Keith 1981). Estimated calf survival was $\frac{0.424 \times 0.90}{0.66} = 0.58$.

Hunting mortality: the reported sport and subsistence hunter kill of caribou from the Nelchina herd in regulatory year 1981-82 was 901 animals; 705 males, 156 females and 40 for which the sex was not specified. These figures do not include illegal or non-reported kills nor are they adjusted for crippling loss.

Preliminary returns for the 1982-83 season indicate a harvest of similar magnitude. Hunter numbers have been controlled by permit since 1977.

Upper Susitna-Nenana Subherd

Information collected during Phase I indicated the existence of a resident subherd in the northwestern corner of the Nelchina range and observations made since that time further support this concept (Fig. 10). In 1982, all six radio-collared females from this subherd calved in the area. In contrast to the main herd, this group of caribou did not use a discrete calving ground but rather appeared to calve in three general regions (Fig. 11): headwaters of the Susitna River; the Butte Lake, Deadman Lake, Brushkana Creek area; and the Chulitna Mountains. Summer range was similar to calving range (Fig. 12) although higher elevations were sometimes used. During winter, caribou were mostly found in the Butte Lake-Brushkana Creek area, Monahan Flat and along the Susitna River above the Denali Highway (Fig. 13). A few caribou wintered in the Chulitna Mountains. Several hundred caribou wintered in the foothills adjacent to the lower Jack River in 1981-82. Movement of caribou between summer range in the Chulitna Mountains and winter range in the Butte Lake, Brushkana Creek, Monahan Flat area was noted and involved three of seven radio-collared caribou (Figs. 14-20).

In the Phase I final report (Pitcher 1982) I estimated the size of this group of caribou at about 1,000 animals based largely on nonsystematic observations of caribou made during radio-tracking surveys. From 8 through 11 October 1982 a total count was attempted of caribou in the area north and west of the Susitna River above Gold Creek (including the Clearwater Mountains). The western and northern boundaries were the Parks Highway and the Alaska Range. Modest snow cover enabled us to concentrate our efforts in areas where tracks were present and increased sightability of animals. The counts took place during the rut when

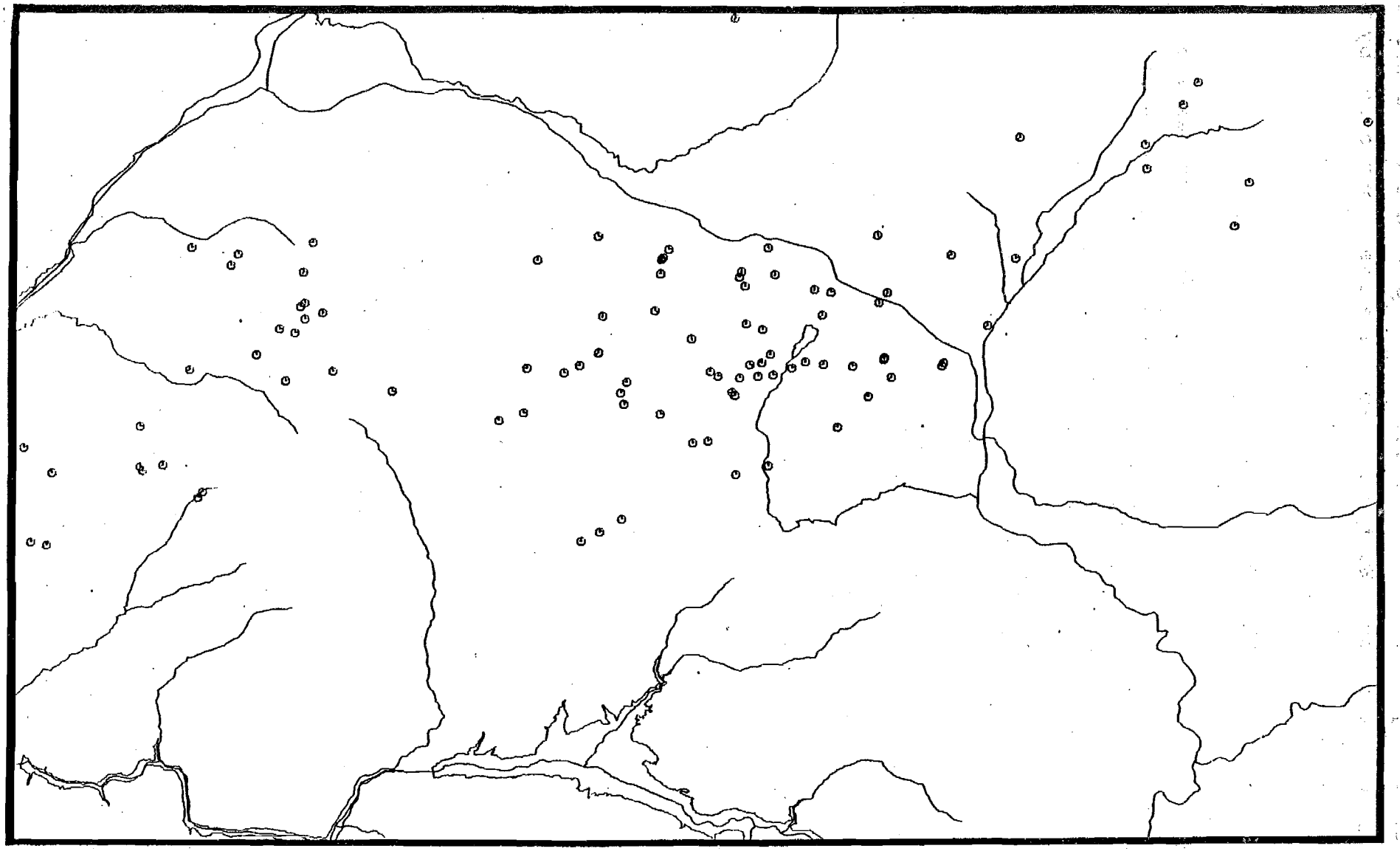

Figure 10. Distribution of Upper Susitna – Nenana subherd radio-collared caribou, 9 May, 1980 through 15 October, 1982. ⊙ = females, ✳ = males.

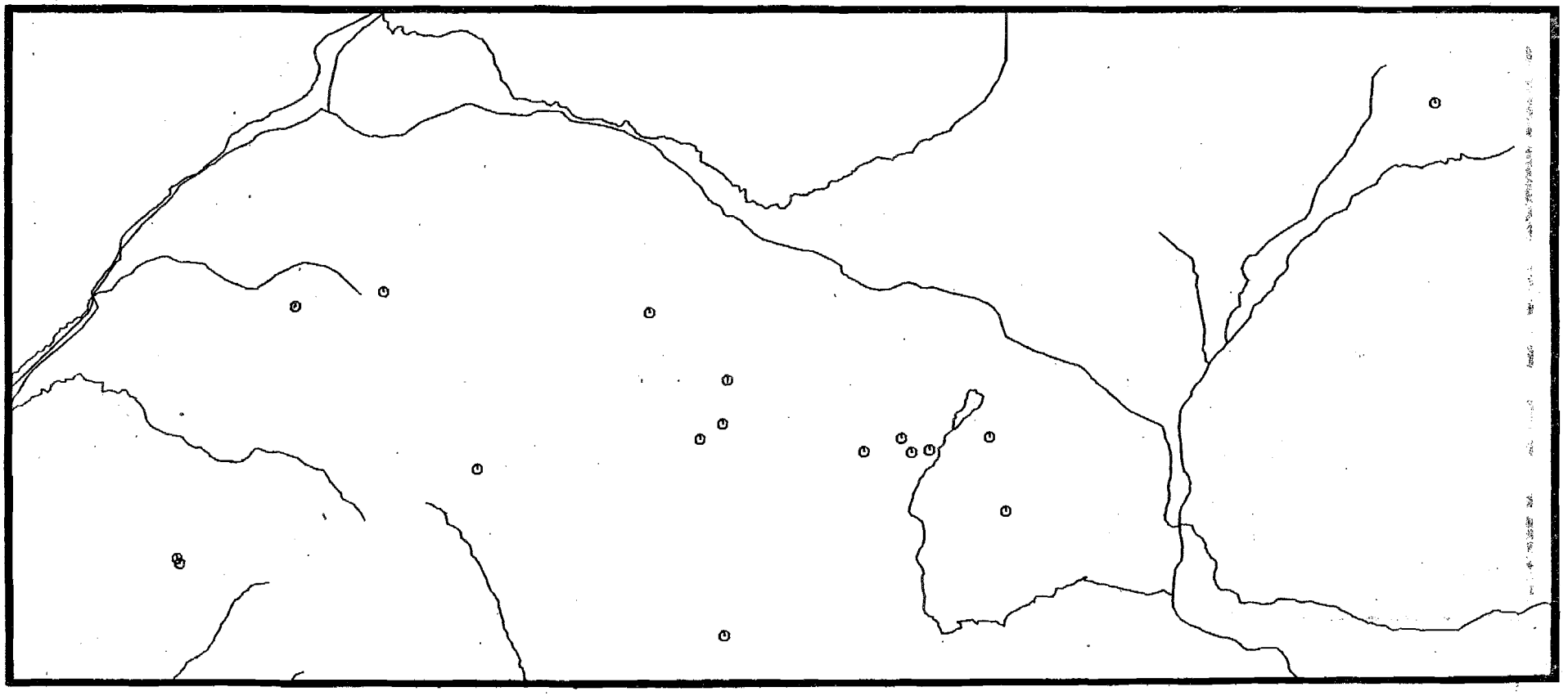

Figure 11. Distribution of Upper Susitna – Nenana radio-collared caribou during calving, 15 May – 10 June, 1980, 1981 and 1982. ⊙ females, * males.

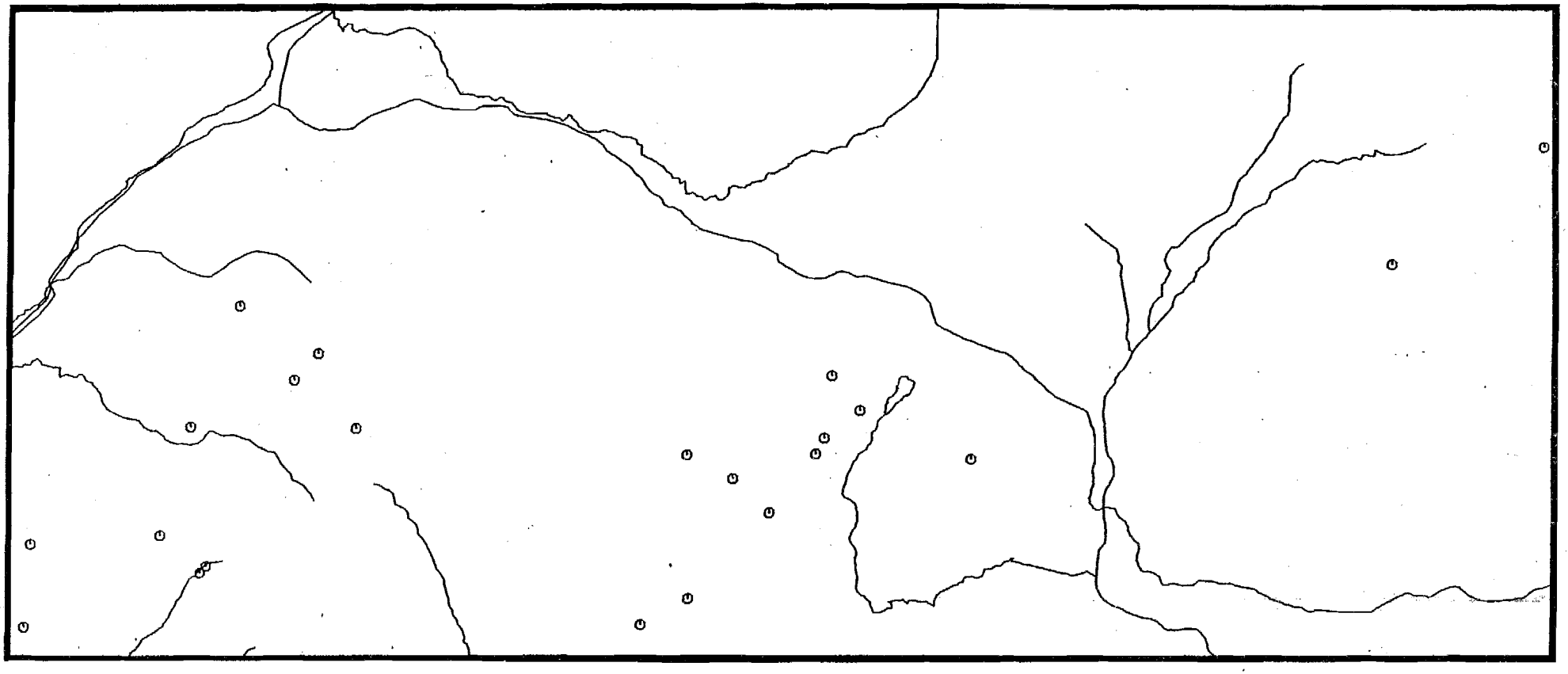

Figure 12. Distribution of Upper Susitna – Nenana radio-collared caribou during summer, 11 June – 31 July, 1980, 1981 and 1982. ⊙ = females, ✱ = males.

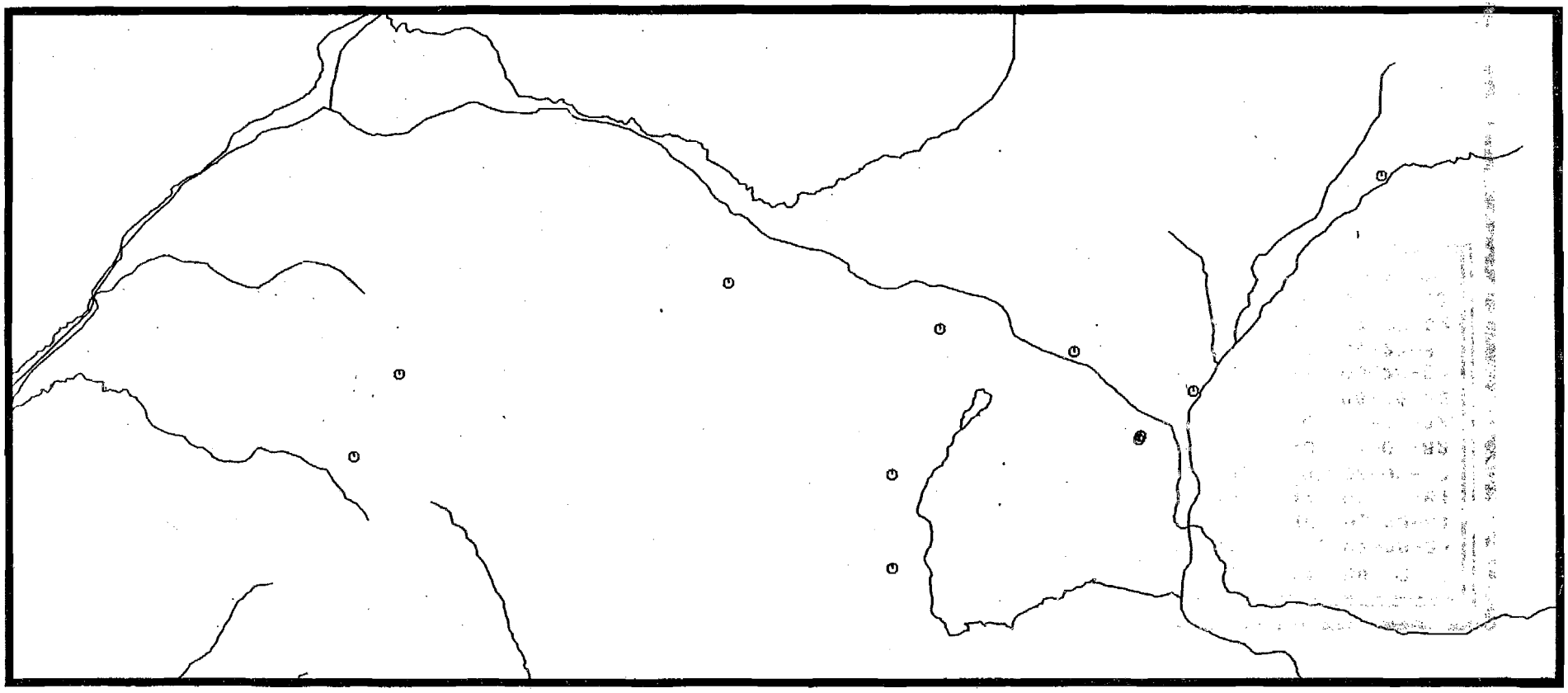

Figure 13. Distribution of Upper Susitna - Nenana radio-collared caribou during winter, 1 December - 31 March, 1980-81 and 1981-82. ⊕ = females, ✱ = males.

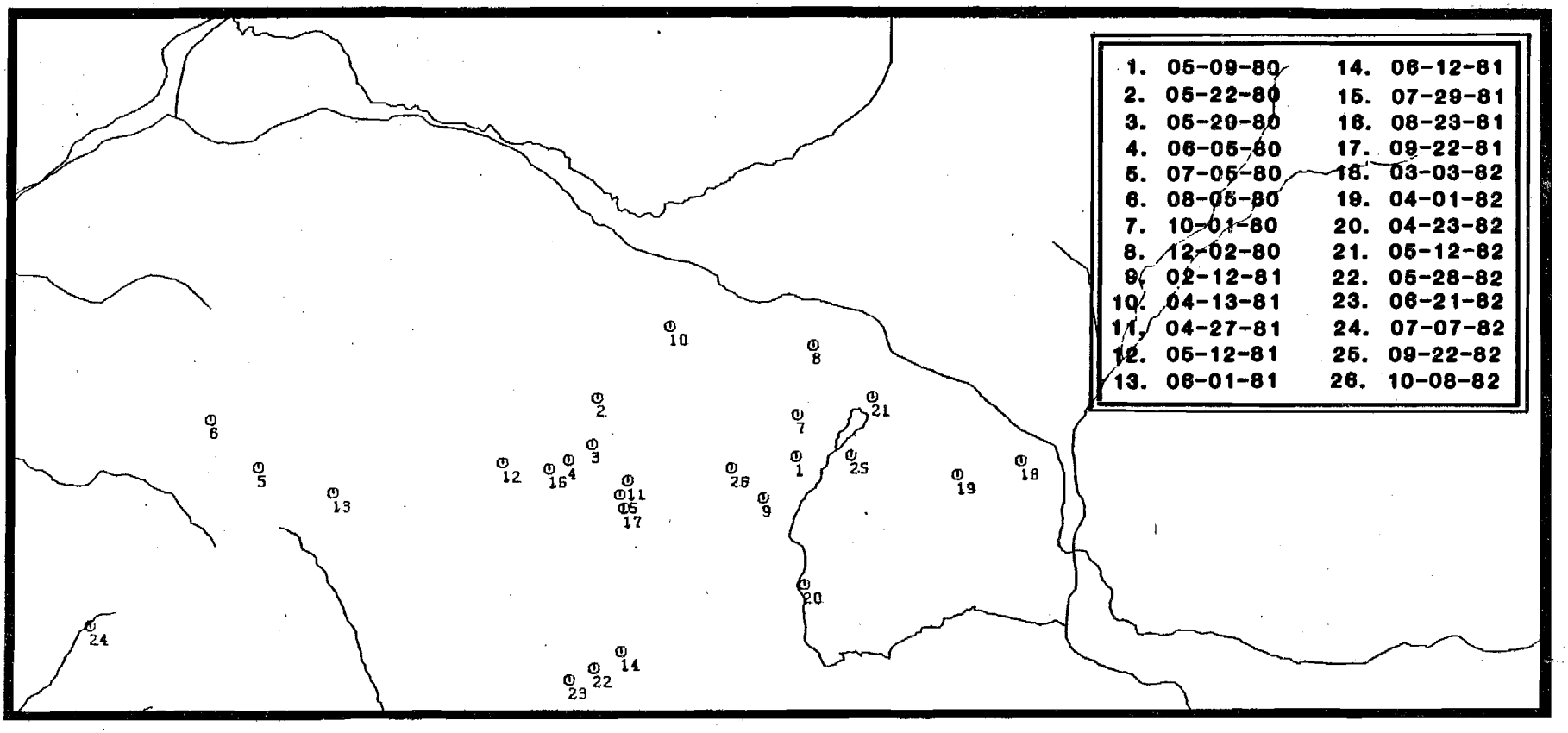

Figure 14. Sequential sightings of radio-collared caribou 023 (female).

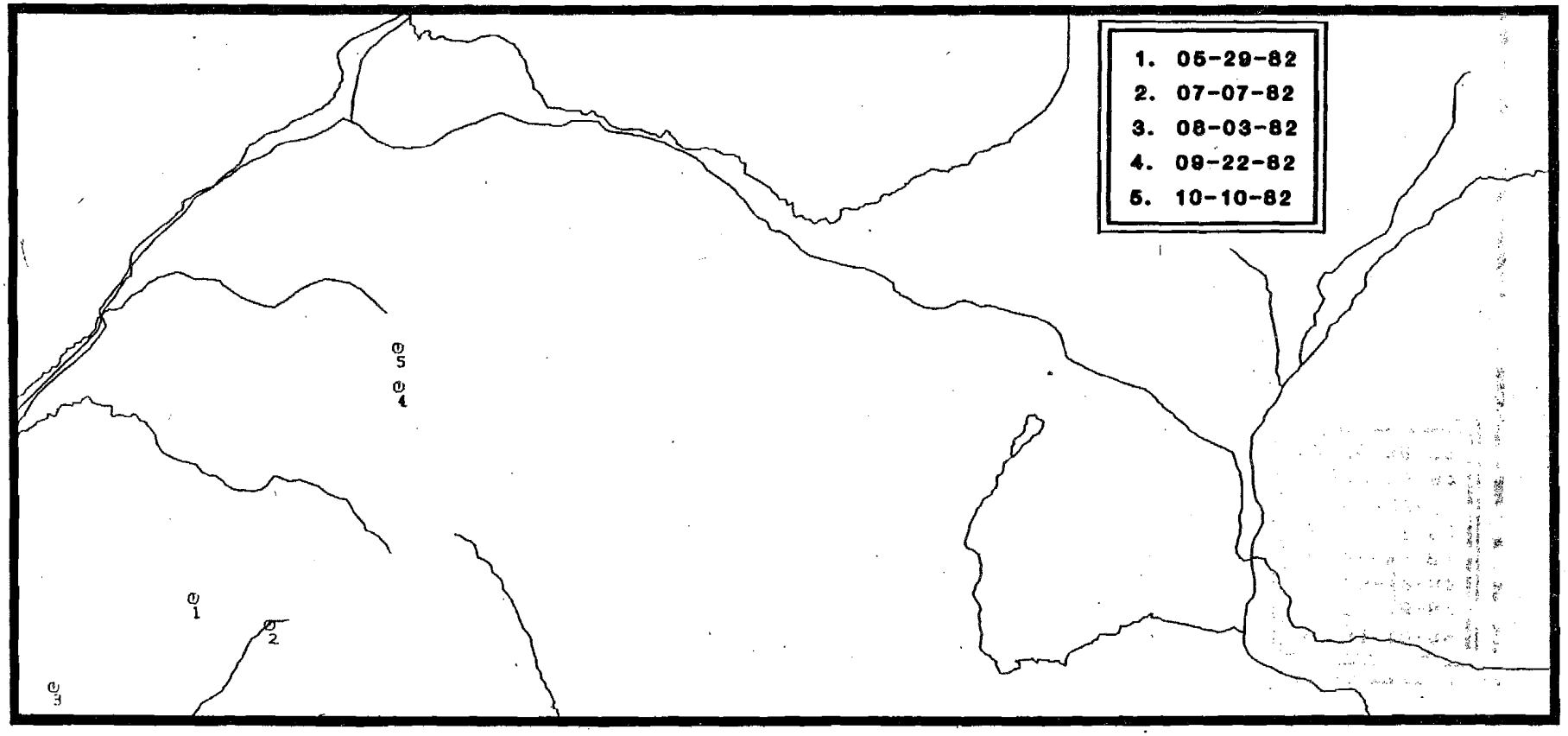

Figure 15. Sequential sightings of radio-collared caribou 145 (female).

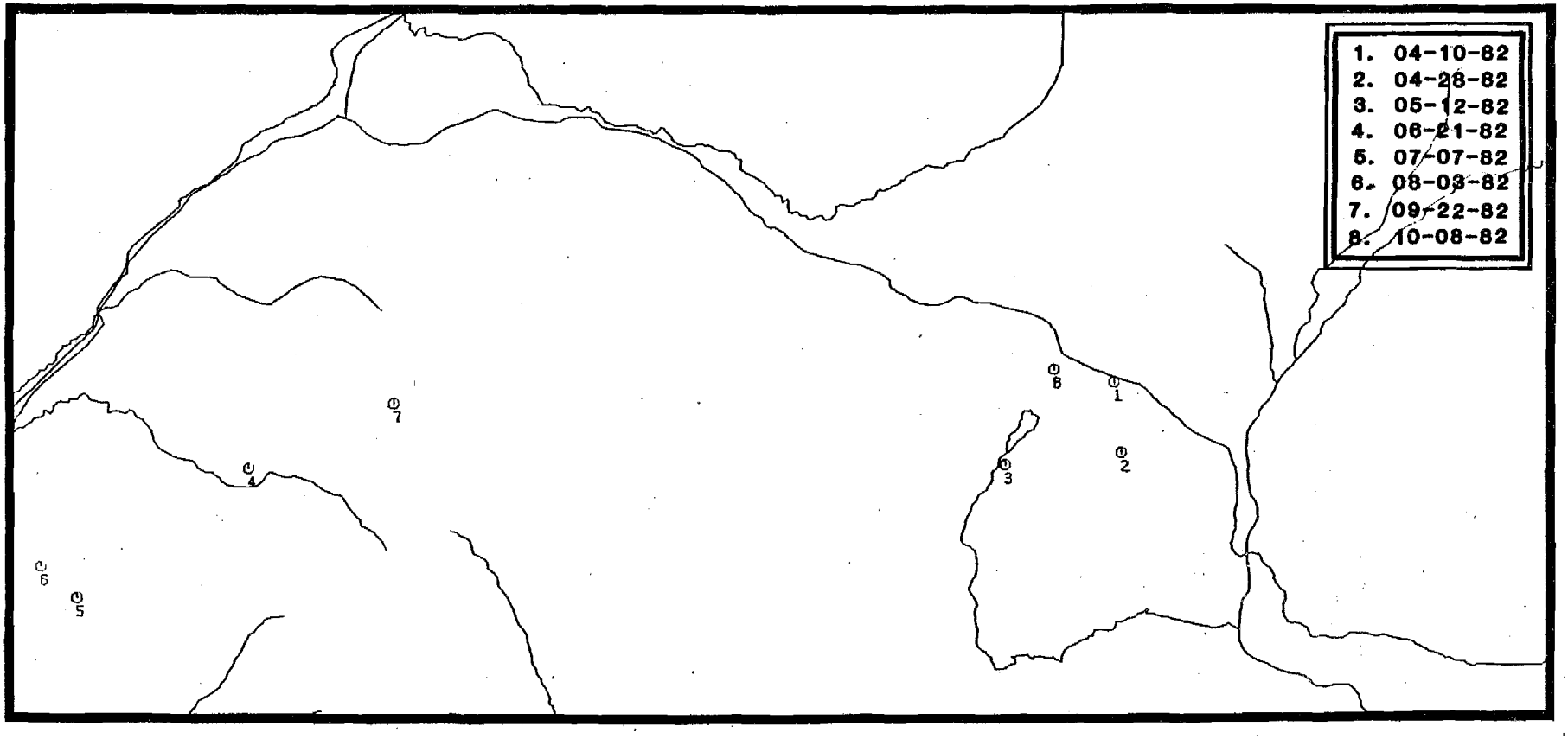

Figure 16. Sequential sightings of radio-collared caribou 160 (female).

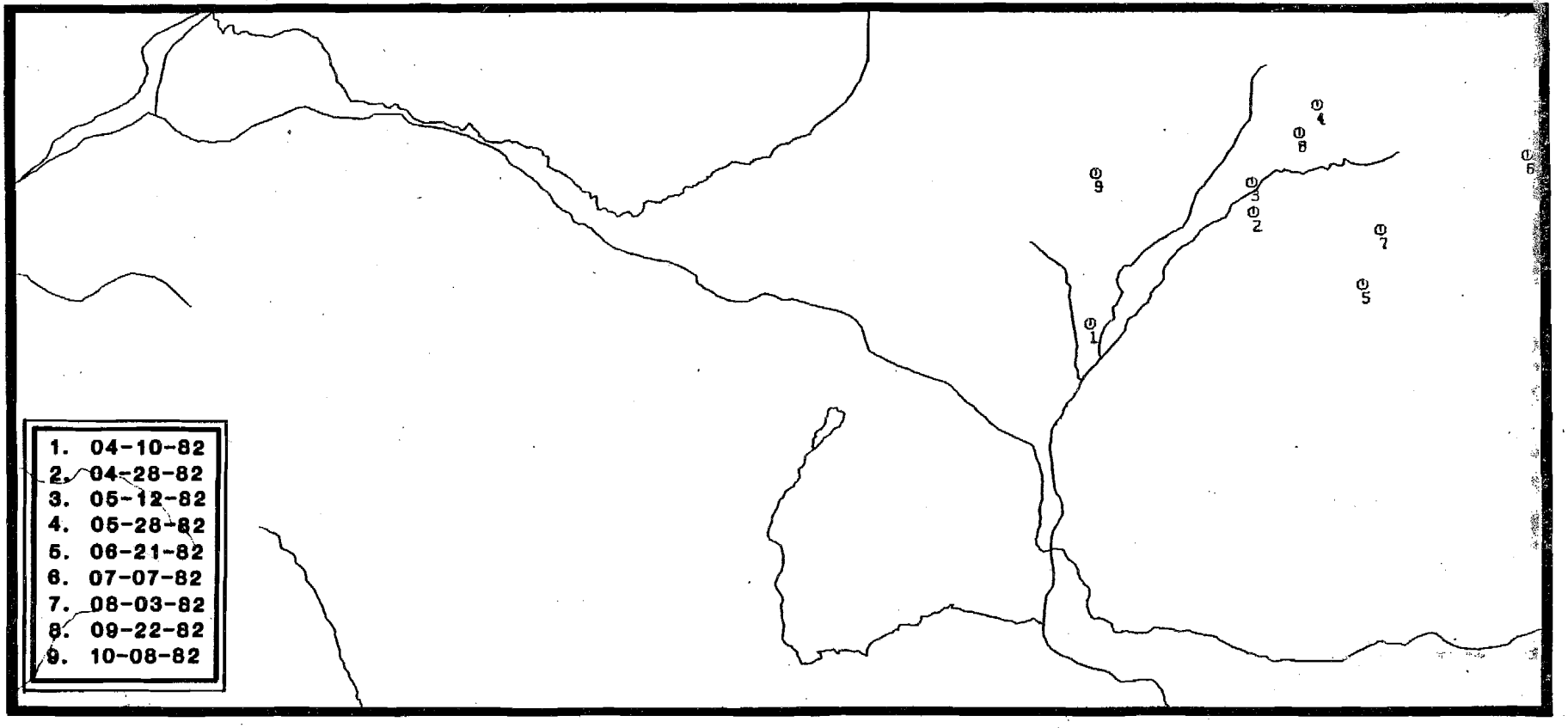

Figure 17. Sequential sightings of radio-collared caribou 230 (female).

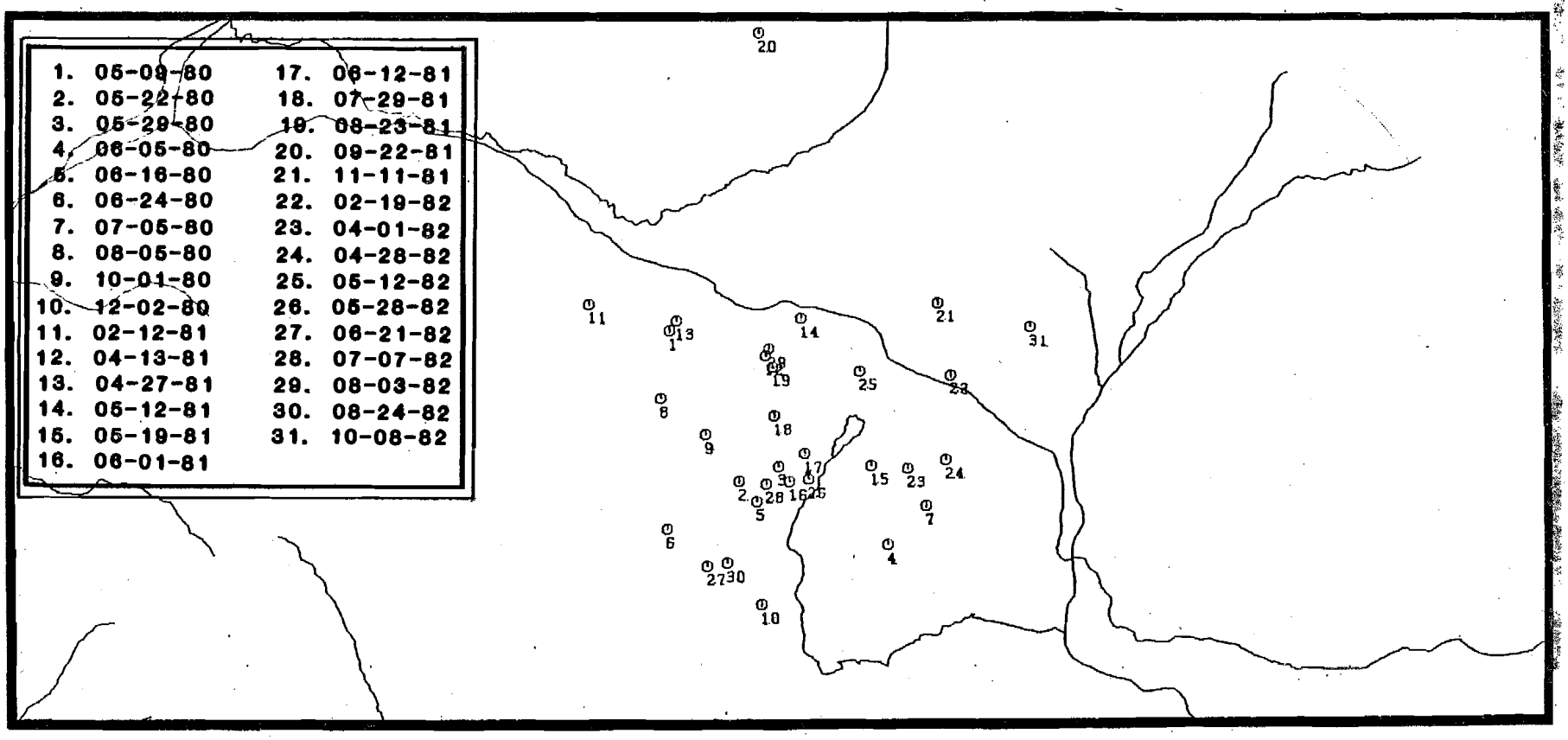

Figure 18. Sequential sightings of radio-collared caribou 453 (female).

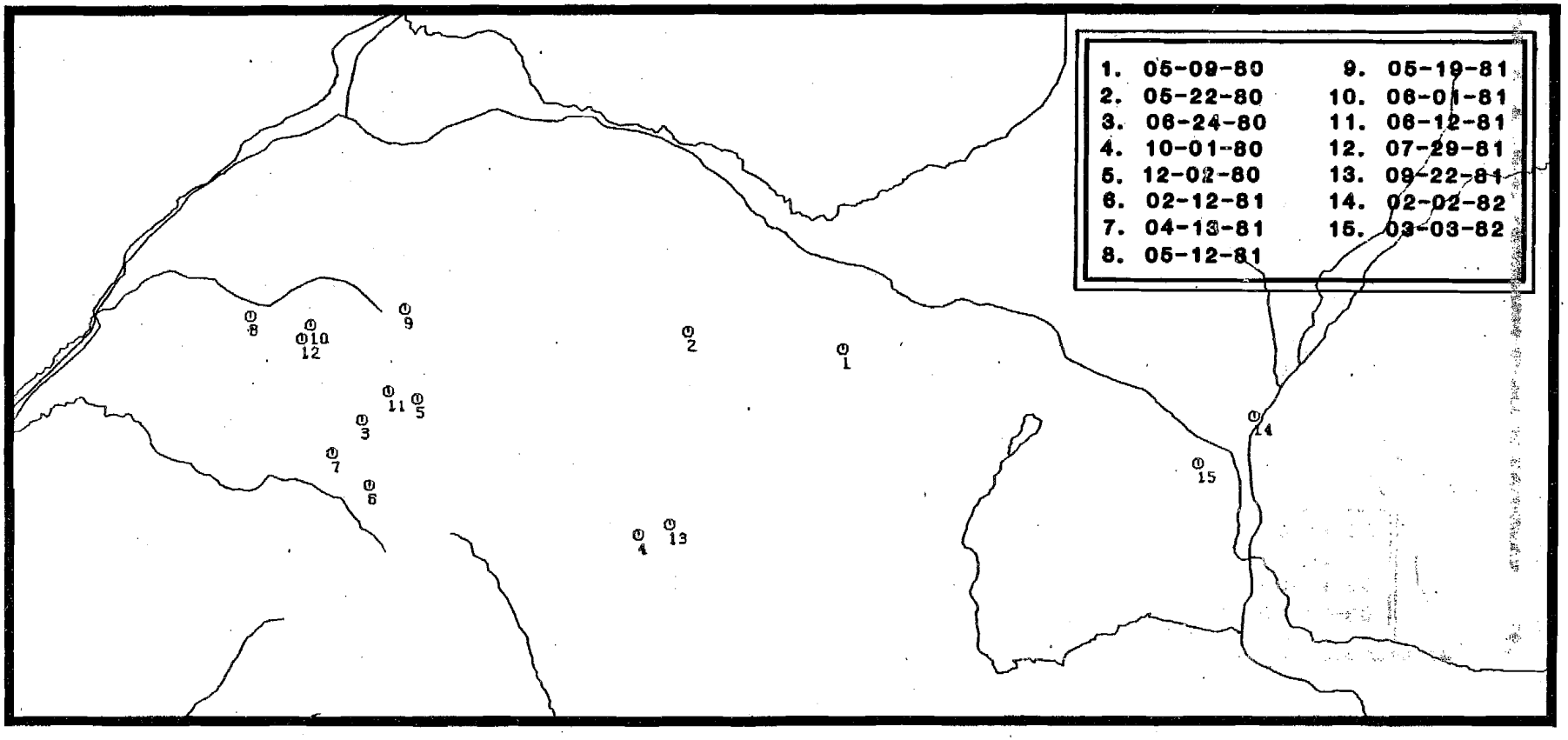

Figure 19. Sequential sightings of radio-collared caribou 456 (female).

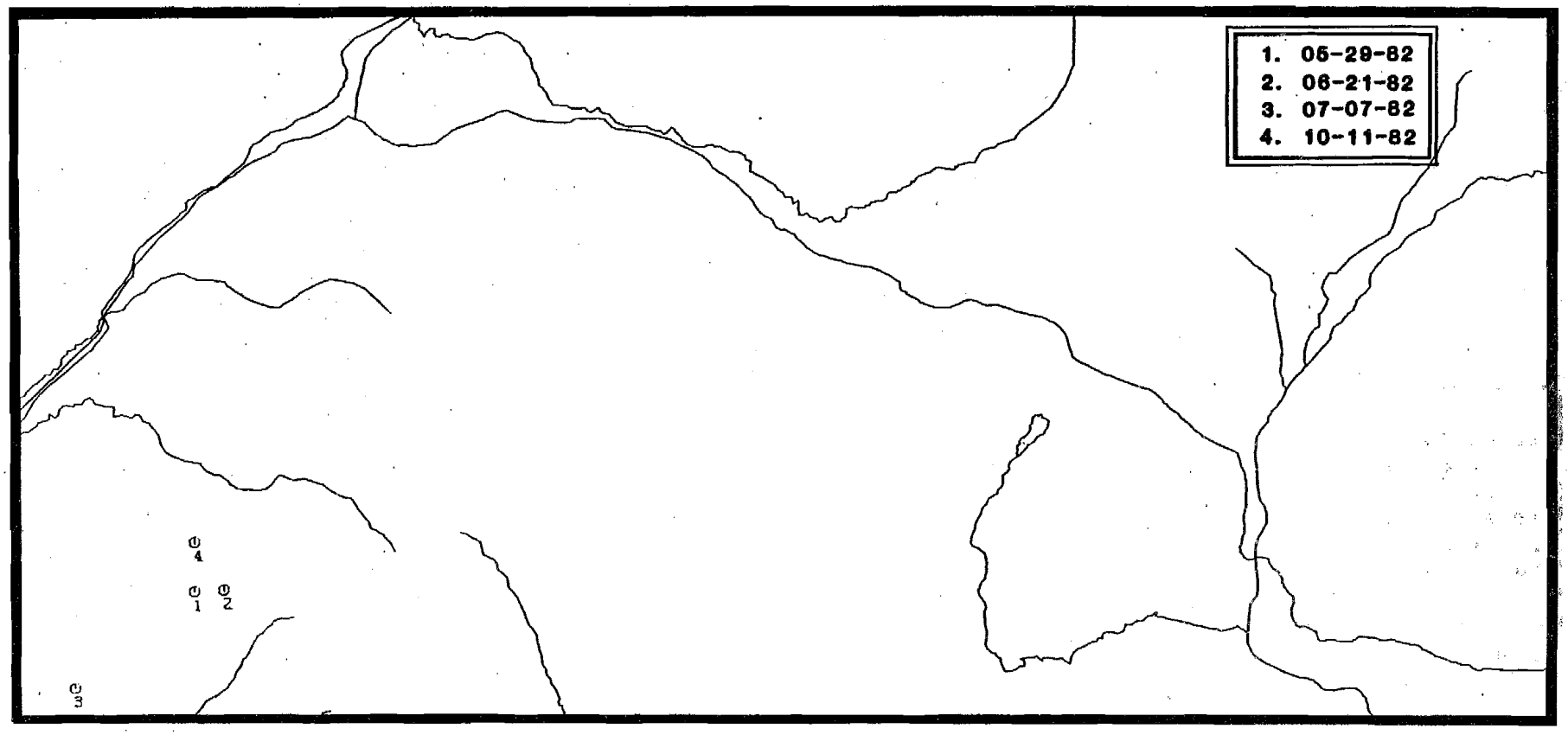

Figure 20. Sequential sightings of radio-collared caribou 490 (female).

most animals were found in groups (5-75 animals) again improving sightability. We counted 2,077 caribou in the study area. I now conservatively estimate a total of 2,100 caribou in this subherd. A more realistic estimate based on my subjective impressions of sightability and area coverage is 2,500. It seems unlikely that the total actually approaches 3,000 caribou. This is a considerable increase over my previous estimate of 1,000 animals but is not surprising considering the paucity of data previously available.

Several factors may have affected the accuracy of the census. Periods of bad weather resulted in the count being spread over a five day period when it could have been completed in two days thereby increasing the likelihood of movements which could have resulted in either double-counting, undercounting or a combination of both. The potentially most serious complication was the migration of perhaps 10% of the main Nelchina herd through the southeastern corner of the study area during the counts. The migratory route of these animals as they left the Talkeetna Mountains, crossed the Susitna River and moved through the study area was relatively distinct because of trailing in the snow. Animals encountered along this route were not included in the counts. Therefore resident animals which may have been in this area were not included in the census which would have resulted in an underestimate. Conversely, animals from the main herd which may have dispersed from the migration route would have been counted thereby inflating the subherd estimate. None of 31 radio-collared animals from the main herd were in the areas where caribou were counted (most were 40 miles to the east) indicating that it was unlikely that large numbers of main herd animals were counted. However even if only a small proportion of the main herd was in the area it could significantly inflate the estimate for the much smaller subherd. Because of these factors I recommend repeating the census under hopefully more favorable conditions.

Group behavior of the upper Susitna-Nenana subherd was distinctly different than most recognized herds. They remained apart from the main Nelchina herd during the calving period and therefore must be given distinct recognition according to the definitions of Skoog (1968). However the female segment of this subherd did not congregate on a localized calving area but rather calved while dispersed over the three general regions previously mentioned (Butte Lake, Deadman Lake, Brushkana Creek area; Chulitna Mountains; Susitna River headwaters). The large post calving aggregations of the female:calf segment did not appear to form as they do in many herds.

It is probable that considerable genetic interchange takes place between the main Nelchina herd and this subherd as segments of the main herd have been within the range of the upper Susitna-Nenana subherd during the rut in at least 10 of the past 30 years (including 1982). Historically the main herd has periodically used this area for both winter and summer range. Currently some bulls from the main herd spend the summer in the area (Fig. 6).

I can find no historical reference to this subherd. Skoog (1968) did not mention it in his exhaustive work on the Nelchina caribou herd. It is conceivable, that the subherd was present at that time, but was not recognized because its presence was confounded by large numbers of main herd animals which frequently migrated through the area; often spending summers or winters. It was not until the mid to late 1970's that biologists suspected that this subherd existed (Eide 1980) and its presence was not confirmed until this study.

Potential Impacts of Project Construction

Significant numbers of Nelchina caribou migrated through the proposed Watana impoundment during three periods in 1982. During spring migration (approximately 7 May - 20 May) perhaps 50% of the female segment moved through the upper reaches of the Watana

impoundment area enroute to the calving grounds. In mid-August about 15% of the female segment crossed the upper Watana impoundment area and moved onto the Jay Creek - Coal Creek plateau. During the second week of October about 10% of the herd crossed the Susitna River in the area between Fog Lakes and Kosina Creek and migrated across the Jay Creek - Coal Creek plateau. It was apparent, that even though the massive north-south migrations across the Susitna which occurred with regularity in the past did not occur, that large numbers of Nelchina caribou do currently cross or move along the Susitna River in the area of the proposed Watana impoundment. While it is not possible to predict the impacts of the Watana impoundment on migrating caribou it does appear that the greatest potential for deleterious impacts occurs during the spring migration to the calving grounds. This would be during a period of transition from an ice-covered reservoir at maximum drawdown with ice shelving and ice covered shores to an open reservoir rapidly filling from spring runoff. Particularly hazardous conditions could occur if windrows of broken ice accumulated along the southern shore leaving the northern shore ice free. Caribou enroute to the calving grounds would at first encounter open water but might have difficulty leaving the reservoir with the mass of jumbled, broken ice. Pregnant females are often in the poorest condition of the year at this time and might be particularly vulnerable to migratory barriers.

The presence of the impoundment would reduce optional migratory routes available to the caribou which may be of particular importance during years with high snow accumulation in the Talkeetna Mountains.

Crossings during summer and fall when the reservoir would be ice free appear to pose less hazard. Caribou are excellent swimmers and are known to cross much larger bodies of water than the proposed impoundment. Young calves might have problems if the migrations occurred shortly after calving. Rafts of floating debris could cause problems for the first few years after filling

the impoundment. Mortalities of moose who could not reach shore because of floating debris have been reported in impoundments in Canada (Ballard, pers. comm).

It seems inevitable that Nelchina caribou will again use the area north and west of the Susitna as summer and winter range as they have done in the past. When that occurs the entire female segment of the herd will cross or migrate around the impoundment area twice or more each year.

The proposed access road from the Denali Highway to the Watana damsite which parallels the eastern border of the Chulitna Mountains will probably immediately impact the upper Susitna-Nenana subherd and will impact the main Nelchina herd when it again uses the area north and west of the upper Susitna in large numbers. Probable impacts include increased mortality from vehicle collisions, impeded east-west movements, increased hunter access and possibly increased predation. Movements of radio-collared caribou (Figs. 14-20) along with general observations indicated that perhaps 35-50% of this subherd migrated westward into the Chulitna Mountains each summer returning to the east in the fall. Thus perhaps up to half of this subherd could be exposed to the problems associated with a road crossing in a treeless area twice a year. The Chulitna Mountains are excellent summer range and should the main herd again spend summers in the area they would also encounter the access road.

Reports on reactions of caribou to roads and vehicular traffic are somewhat contradictory. Cameron et al. (1979), in the most thorough study to date, documented avoidance of the Trans-Alaskan Pipeline corridor by females and calves during summer (the Denali access route passes through summer range which historically has been important for the female-calf segment of the main Nelchina herd). They also suggested avoidance by large groups, group fragmentation and/or decreased group coalescence near the pipeline corridor. Horejsi (1981) reported that caribou exhibited

signs of anxiety and fear when encountering a fast-moving vehicle and speculated that they might avoid well-traveled highways. Klein (1971) reported that well-traveled highways have obstructed the movement of wild reindeer in Norway. It has also been suggested the roads might increases susceptibility of caribou to predators (Robey 1978).

In another study it was concluded that mountain caribou became habituated to the presence of a highway and traffic and continued to use a traditional movement route despite harassment and mortality (Johnson and Todd 1977). Nelchina caribou continue to cross the Richardson Highway, often in large numbers, and have done so during many years since about 1960 (Hemming 1971).

Calving by members of the upper Susitna-Nenana subherd is dispersed over three large regions: Chulitna Mountains; Deadman Creek, Brushkana Creek and Butte Lake drainages; and the headwaters of the Susitna River (Fig. 11). Because of this it appears impossible to route the access road so that calving females will be completely avoided. However because of the dispersed calving only a small proportion of calving females would be impacted wherever the road is placed.

From 1979 through 1981 about 20% of the annual harvest ($\bar{x}$ of 120/year) for the Nelchina herd came from the range of the upper Susitna-Nenana subherd. This harvest while comprised mostly of subherd animals undoubtedly contained some bulls from the main herd (which summered in the area) and possibly a few females which had dispersed from the Talkeetna Mountains. This level of harvest is within the limits of a herd this size. Concern has been expressed that increased hunter access via the Watana access road could result in overharvest. Alaska Department of Fish and Game regulatory procedures should be adequate to prevent this from happening.

Habitat loss from flooding and from borrow areas does not appear

to be a serious problem. Both developments are proposed for small areas of low quality caribou habitat. Human activity associated with construction and operation could possibly cause avoidance of very local areas. Increased aircraft traffic should not be a serious problem provided suitable elevation is maintained and traffic is restricted in the calving grounds of the main Nelchina herd.

Perhaps in the long run the major impact of the Susitna hydroelectric development on the Nelchina caribou herd will be a contribution towards gradual, long term cumulative habitat degradation rather than immediate catastrophic results. The proposed hydroelectric project is only one (although the major one) of a number of developments which will probably occur in the Nelchina range. Considerable mining activity already is taking place in the southeastern Talkeetna Mountains, traditional summer range. A state oil and gas lease sale is planned for the Lake Louise Flat, a major wintering area. The Bureau of Land Management is planning to open much of the Nelchina Basin to oil exploration. Considerable land is passing from public to private ownership through the Alaska Native Claims Settlement Act and through state land disposal programs. While no single action may have a catastrophic impact it seems likely that long-term cumulative impacts will result in a lessened ability for the Nelchina range to support large numbers of caribou. Habitat destruction, increased access, disturbance, and partial barriers to movement will all probably contribute to this.

Recommendations for Continuing Studies

Herd population status should be monitored with annual censuses and sex and age composition sampling. Range use and migration routes, particularly in the general area of the proposed developments, should be documented by maintaining and monitoring a pool of radio-collared caribou from the main Nelchina herd. Up to 10 radio-collared caribou should be monitored in the upper Susitna-

Nenana subherd to document range use, particularly in the area of the proposed access road and proposed impoundments and associated developments. Another census of the upper Susitna-Nenana subherd should be attempted in order to generate a more reliable estimate of population size.

Acknowledgements

Warren Ballard, Jim Dau, Jim Lieb, Patsy Martin, Dennis McAllister, Mike McDonald, Bob Tobey and Jack Whitman all participated in field activities. Ken Bunch, Don Deering, Craig Lofstedt, Vern Lofstedt, Chuck McMahon and Harley McMahon piloted aircraft for the project. Danny Anctil and SuzAnne Miller provided support in data management and analysis. Karl Schneider supervised the project. I appreciate the contributions made by each of these individuals.

REFERENCES

Cameron, R. D., K. R. Whitten, W. T. Smith, and D. D. Robey. 1979. Caribou distribution and group composition associated with construction of the Trans-Alaska Pipeline. Canadian Field Naturalist 93:155-162.

Davis, J. L., P. Valkenburg, and S. J. Harbo, Jr. 1979. Refinement of the aerial photo-direct count-extrapolation caribou census technique. Alaska Department of Fish and Game, Fed. Aid in Wildl. Rest., Proj. W-17-11. Juneau, AK. 23pp.

Doerr, J. 1979. Population dynamics and modeling of the Western Arctic Caribou Herd with comparisons to other Alaskan *Rangifer* populations. Unpubl. M.S. Thesis, Univ. of Alaska, Fairbanks. 341pp.

Eide, S. H. 1980. Caribou Survey-Inventory Progress Report. Pages 31-34 In R. A. Hinman, ed. Annual Report of Survey-Inventory Activities. Alaska Fed. Aid in Wildl. Rest. Proj. W-17-11.

Fuller, T. K. and L. B. Keith. 1981. Woodland caribou population dynamics in northeastern Alberta. J. Wildl. Manage. 45:197-213.

Hemming, J. E. 1971. The distribution and movement patterns of caribou in Alaska. Alaska Dept. Fish and Game, Wildl. Tech. Bull. No. 1. 60pp.

Hemming, J. E. and L. P. Glenn. 1969. Caribou report. Alaska Dept. Fish and Game, Fed Aid in Wildl. Rest., Proj. W-15-R-2. Juneau, AK 41pp.

Horejsi, B. L. 1981. Behavioral response of barren ground caribou to a moving vehicles. Arctic 34:180-185.

Johnson, D. R. and M. C. Todd. 1977. Summer use of a highway crossing by mountain caribou. Canadian Field Naturalist 91:312-314.

Klein, D. R. 1971. Reaction of reindeer to obstructions and disturbances. Science 173:343-398.

Pitcher, K. W. 1982. Caribou (Volume IV) In Big Game Studies. Susitna Hydroelectric Project. Phase I Final Report. Alaska Department of Fish and Game, Anchorage. 101pp.

Robey, D. D. 1978. Behavioral patterns of barren-ground caribou of the Central Arctic herd adjacent to the Trans-Alaska Oil pipeline. M.Sc. Thesis, Univ. Alaska. 199pp.

Skoog, R. O. 1968. Ecology of the caribou (*Rangifer tarandus granti*) in Alaska. Ph.D. Dissertation, Univ. of California, Berkeley, CA. 699pp.

Trent, T. T., and O. J. Rongstad. 1974. Home range and survival of cottontail rabbits in southwestern Wisconsin. J. Wildl. Manage. 38:459-471.