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SUSITNA HYDROELECTRIC PROJECT

1984 ANNUAL REPORT

BIG GAME STUDIES

CARIBOU

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ALASKA DEPARTMENT OF FISH AND GAME

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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 April 1980, continue with the primary objectives of delineating seasonal range use and migratory routes of the main Nelchina herd and determining range use, movements and herd size of the upper Susitna-Nenana subherd. 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. The primary methodology for the study is the repetitive relocation of radio-collared caribou.

During the winter of 1983-84 Nelchina caribou wintered in three general areas with interchange of animals between the groups. The largest concentration (@15,000) was along the Wrangell Mountain foothills between Copper Lake and the Dadina River. A small group (@2,500) moved to the northeastern slopes of the Mentasta Mountains while the third group (@6,500) wintered on the Lake Louise Flat, primarily west of Lake Louise. During spring migration to the west many animals crossed the Richardson Highway between Gakona and Sourdough rather than the traditional route north of Sourdough. After crossing the Lake Louise Flat, caribou entered the Talkeetna Mountains in the lower Oshetna River area south of the proposed Watana impoundment. During the one survey flown during the calving period, females were found primarily in Kosina Creek and the Black River. During summer, the female-calf segment of the herd remained in the northern and eastern Talkeetna Mountains. Male caribou were found scattered throughout the high country of the basin. During autumn most animals remained on summer range although limited dispersal across the Lake Louise Flat and north of the Watana impoundment area occurred. During the rut most animals were found west of Lake Louise and in the Talkeetna Mountain foothills near the Little Nelchina River. Year around use of the Nelchina Range by radio-

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collared caribou during the study period encompassed an area of about 16,000 mi^2. The northern and eastern Talkeetna Mountains are the core of the Nelchina caribou range as they are consistently used as calving and summer range and on occasion as winter range. The northwest sector of the Nelchina range has received minimal use during this study while historically it was important summer and winter range.

Herd size was estimated at 24,095 caribou in October 1984 by ADF&G management staff which was slightly lower than the 1983 estimate. Sex and age composition sampling indicated 39.5 males ≥ 1 year per 100 females ≥ 1 year and 33.7 calves per 100 females ≥ 1 year; both lower than average figures obtained during recent years. Adult survival, based on radio-collared caribou, was estimated at 0.90 for females and 0.89 for males. Calf survival from May 1983 to April 1984 was estimated at 0.19; the lowest estimate obtained during this study. The reported sport and subsistence kill of caribou for regulatory year 1983-84 was 969 animals; 827 males, 137 females and 5 for which the sex was not specified. Considering these population parameters it appears herd size will stabilize or decline until increases in survivorship occur.

The upper Susitna-Nenana subherd was estimated at about 1,500 caribou. This group of resident animals was found in an area of about 2,050 mi^2 in the northwestern corner of the Nelchina range. Calving by females from this group was dispersed over three broad regions; eastern headwaters of the Susitna River, Butte Lake-Brushkana Creek area and the Chulitna Mountains. Summer range was similar to calving range except higher elevations were generally used. Primary wintering areas were in the Butte Lake-Brushkana Creek area, Monahan Flat and along and to the east of the Susitna River above the Denali Highway. During winters of low to moderate snowfall the Chulitna Mountains are used as winter range, particularly the northern area. It appears that about half of this subherd migrates from summer range in the Chulitna Mountains to winter range to the east.

The proposed Devil Canyon impoundment and transportation and powerline corridors to the west do not appear to be of serious concern to Nelchina caribou as neither currently nor historically have many caribou occurred in this region. The Watana impoundment area has historically been crossed by large segments of the Nelchina herd both during spring migration to the calving ground and during summer and fall movements to the Chulitna Mountain foothills to the north of the impoundment. Recent crossings have been light but it is not unreasonable to assume that large-scale crossings will again resume at some future time. Crossings of the Watana impoundment could be hazardous to caribou particularly during spring. Ice covered shores, ice sheets and steep ice ramps could present obstacles to movement. Stacked ice floes along the southern shore of an open water reservoir could make exiting the water difficult. Crossings during summer, autumn and winter are not expected to present serious hazards to caribou. Caribou could choose not to cross the impoundment which would either increase migration routes or reduce use of portions of their range, particularly the northwest sector. Skoog (1968) considered this region to be the most important for year-round use by Nelchina caribou.

The proposed Denali access road bisects summer and winter range for about half of the upper Susitna-Nenana subherd. Considerable disagreement exists about the effects of roads and other development on caribou movements and behavior. Large numbers of Nelchina caribou cross the Richardson Highway during many years without apparent problems. Therefore it is unclear how the Denali access road and associated traffic will impact migrating upper Susitna-Nenana caribou. Mortality from vehicle collisions is not anticipated to be a serious problem as caribou-vehicle collisions are infrequent at other highway crossing sites.

Disturbance from increased aircraft traffic resulting from project construction does not seem to be of serious concern and could be easily mitigated by area and elevation restrictions.

Increased access and development in remote areas of the Nelchina caribou range resulting from project construction must be considered, as potentially detrimental to the herd.

The Susitna hydroelectric project should be viewed as one of a number of probable developments which are occurring 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.

Pools of radio-collared caribou should be maintained and monitored in both the main Nelchina herd and the upper Susitna-Nenana subherd to monitor range use and migratory routes and to determine relationships between the groups.

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INTRODUCTION

The Nelchina caribou herd, found primarily in the large basin formed by the upper drainages of the Susitna and Copper Rivers, and surrounded by four mountain ranges, the Wrangell Mountains, the Talkeetna Mountains, the Alaska Range and the Chugach Mountains, has been an important wildlife resource because of its size and proximity to the majority of the states human population. During the past 30 years, in excess of 100,000 caribou were harvested from this herd. In 1984, 12,516 people applied for 1,900 permits to hunt for Nelchina caribou.

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 started 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. In April 1983 and April 1984 progress reports were distributed updating research results (Pitcher 1983, 1984). Following is a summary of background material, methodology, results, possible impacts and recommendations from the 1984 report.

> 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. Primary methodology

for the study is the repetitive relocation of radio-collared caribou. Population estimates are being 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 portions of the Gakona and Chistochina River drainages to Slana. During the winter of 1982-83 Nelchina caribou wintered from the Lake Louise Flat north and east from the Tok-Tetlin-Northway area to the western slopes of Mount Sanford in the Wrangell Mountains. Movements of Nelchina caribou northeast of the Mentasta Mountains have only occurred during about three of the past 30 years. Rapid, directed movement of caribou to the calving grounds commenced during the last week in April when the female segment of the herd was massed between Lake Louise and Crosswind Lake. Most females entered the Talkeetna Mountain foothills in the area of the lower Oshetna River. There was less use of the Watana impoundment area by caribou during the 1983 spring migration than during the previous two years.

Calving took place from Sanona Creek and the Little Oshetna River westward to the hills east of Stephan and Fog Lakes. Most calving activity occurred between the Black and Little Oshetna Rivers.

Summer range for the female-calf segment of the herd was the northeastern Talkeetna Mountains between Horn Mountains and the hills west of Tsisi Creek. Males were found in the highlands throughout the Nelchina Basin.

Most caribou remained on summer range until late in the autumn period (late September) when they rapidly moved to the east. By early October most were located between Hogan Hill and Boulder Creek on the lower slopes of Mount Sanford.

The Nelchina herd was estimated to contain 18,713 caribou in October 1980, 20,730 in 1981, 21,162 in 1982 and 24,825 in 1983. Herd composition in October 1983 was estimated at 53% females ≥1 year, 32% males ≥1 year and 14% calves.

In 1982-83 calf survival from birth to 10.5 months of age was estimated at 0.54. Average annual survival for radio-collared caribou throughout the study period was estimated at 0.87 for females and 0.85 for males. Reported hunter kill of Nelchina caribou for the 1982-83 regulatory year was 861 animals.

The population estimate for the upper Susitna-Nenana subherd was reduced from 2,500 to 1,500 because it was determined that animals from the main Nelchina herd were present during the subherd census. The subherd census should be repeated when the two groups are well separated. Calving by females of this subherd was not restricted to a limited geographic area but was dispersed over a wide region. It appears that about 50% of the subherd crosses the proposed Denali access route twice yearly during migration to and from summer range in the Chulitna Mountains.

Both the Watana impoundment and Denali access road appear to be potential barriers to the free movement of Nelchina caribou. Should the main Nelchina herd resume use of summer and winter

range north of the proposed impoundments the potential for adverse impacts will greatly increase. Increased direct mortalities may occur during hazardous impoundment crossings and from collisions with vehicles along the access road. Loss of habitat does not appear to be a serious consideration as only a small proportion of the total range is involved and it appears to mostly be of poor quality. Increased human access to the calving grounds and summer range in the Talkeetna Mountains facilitated by project construction could increase development and disturbance in this now remote area. Reduced condition resulting from extended and more difficult migratory routes could impact herd productivity, particularly during spring migration when pregnant females are in relatively poor condition.

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.

The remainder of this report deals, mainly, with findings obtained since preparation of the last progress report (November 1983 - October 1984) and a discussion of the significance of these findings to project construction.

In 1984 the scope of this project was substantially reduced per instructions of the Alaska Power Authority. Census and composition sampling activities were dropped leaving basically a seasonal range use and movements study of the main Nelchina herd and a range use, movements and herd size study of the upper Susitna-Nenana subherd.

METHODS

Data on timing and routes of migration, range use and subherd status were collected by the periodic relocations of radio-collared animals. It was assumed that in general the behavior of radio-collared caribou was representative of the herd. Details of capture and radio-tracking techniques were previously described (Pitcher 1982). At the end of the reporting period 50 radio-collared caribou were being monitored; 42 from the main Nelchina herd and eight from the upper Susitna-Nenana subherd.

Methodology for data storage, retrieval and analysis was included in the 1981 report for data management:biometrics (Miller and Anctil 1981).

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 ≥1 year 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).

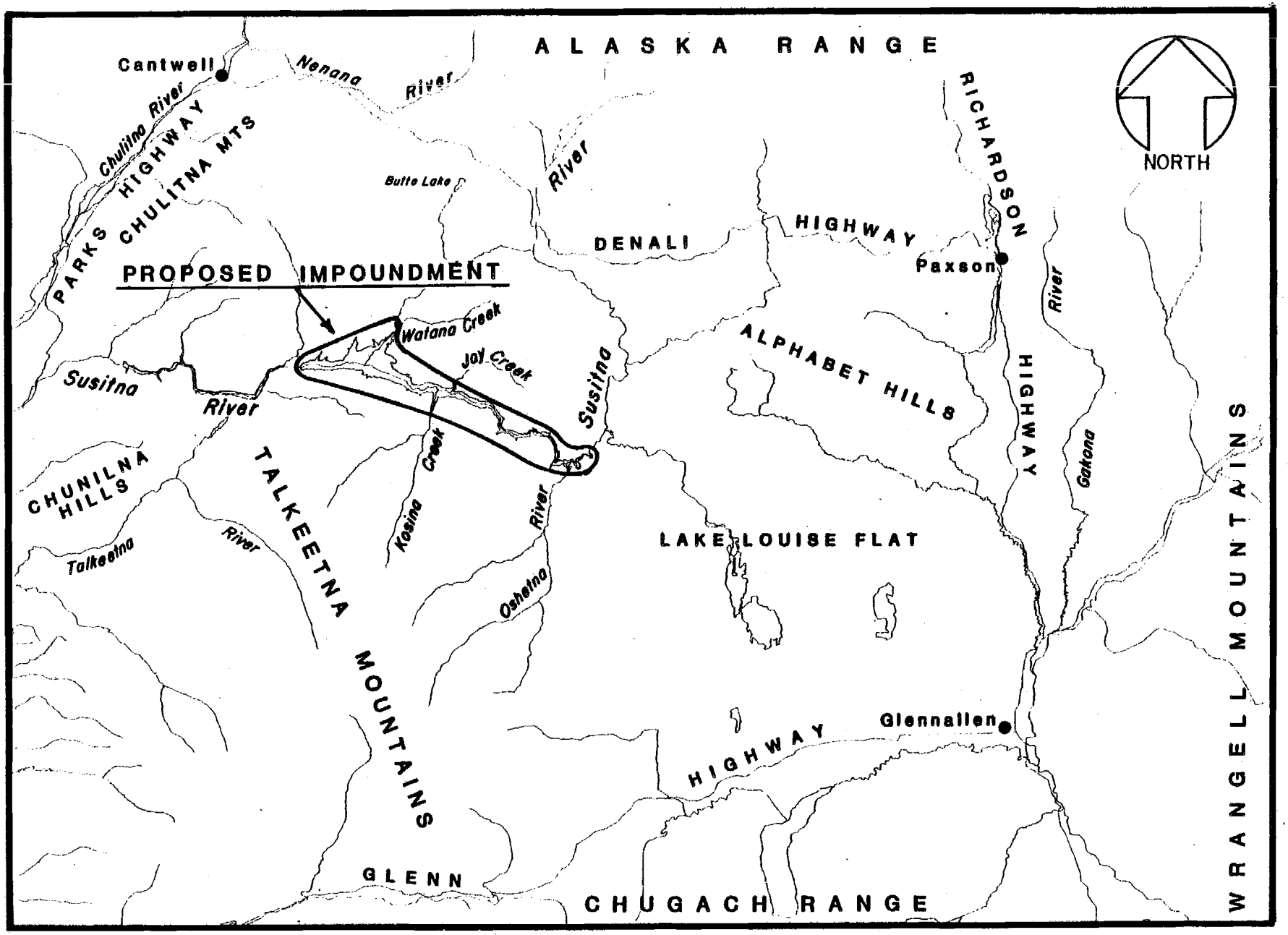

Figure 1. Nelchina caribou range with basic geographic features.

RESULTS AND DISCUSSION

DISTRIBUTION AND MOVEMENTS: MAIN NELCHINA HERD

Winter: by early October 1983 nearly the entire herd was east of the Richardson Highway with most animals concentrated along the lower reaches of Sinona, Indian and Boulder Creeks (Pitcher 1984). During the winter period the herd divided into three wintering concentrations (Fig. 2) with interchange between all groups. The largest concentration (about 15,000) was along the Wrangell Mountain foothills between the Dadina River and the headwaters of the Copper River. A small group of animals (perhaps 2,500 caribou) moved to the northeastern slopes of the Mentasta Mountains. The third group wintered on the Lake Louise Flat, primarily west of Lake Louise. This group probably numbered about 6,500 animals. The three groups remained separated into mid-March. By early April the Mentasta Mountains group had merged with the Wrangell Mountains group. The 1982-84 winter distribution was the most dispersed I have observed during the four winters of this study (Fig. 3). More use of the western Lake Louise Flat occurred than during previous years while less use of the eastern Lake Louise Flat and Gakona and Chistochina River drainages took place. Wintering Nelchina caribou were spread over an east-west range of about 150 miles.

During the winters of 1980-81 and 1981-82 the primary wintering areas were the eastern Lake Louise Flat and Chistochina and Gakona River drainages. In 1982-83 wintering caribou ranged from northeast of the Mentasta Mountains to the Wrangell Mountains foothills throughout the Gakona and Chistochina River drainages and onto the eastern Lake Louise Flat.

Spring migration: by early April most females were grouped in two areas; the Wrangell Mountains foothills and the western Lake Louise Flat. By 23 April many of the females had moved out of Wrangell Mountains foothills and were crossing the lower Gakona drainage. This movement occurred south of Sourdough (Fig. 4)

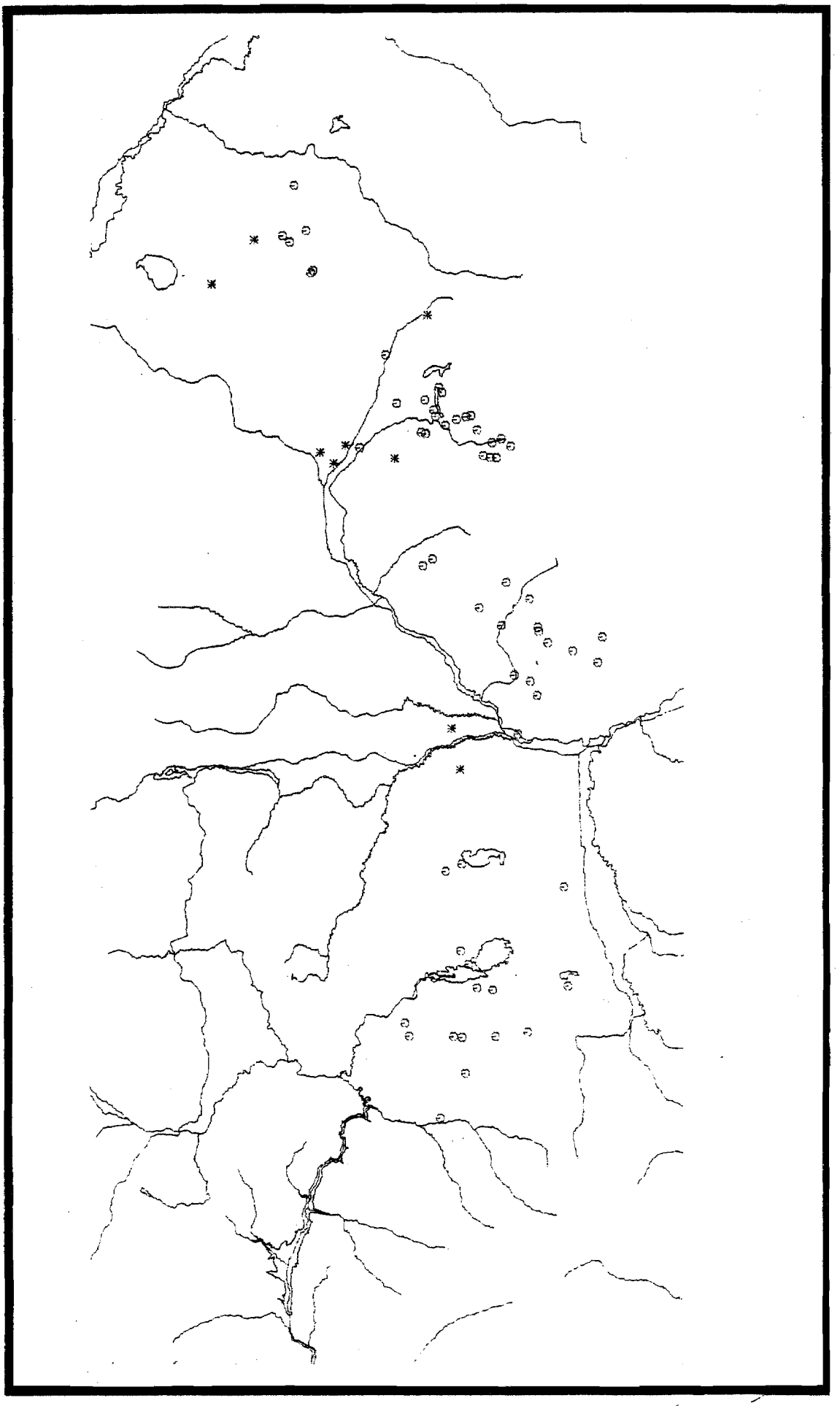

Figure 2. Distribution of Nelchina radio-collared caribou during winter, 1 December–31 March 1984. ⊙ = female, * = male.

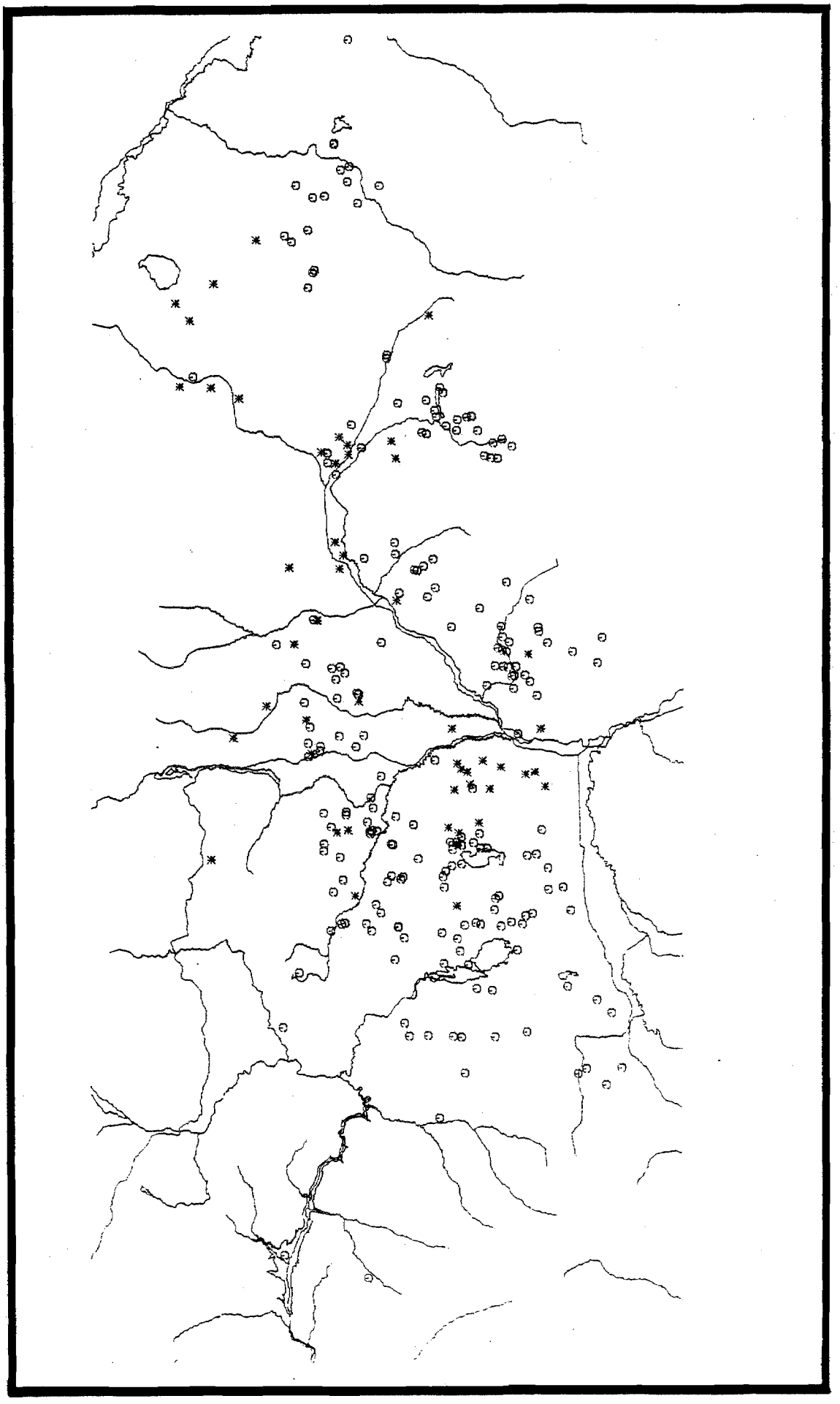

Figure 3. Distribution of Nelchina radio-collared caribou during winter, 1 December-31 March 1980-1984. o = females, * = males.

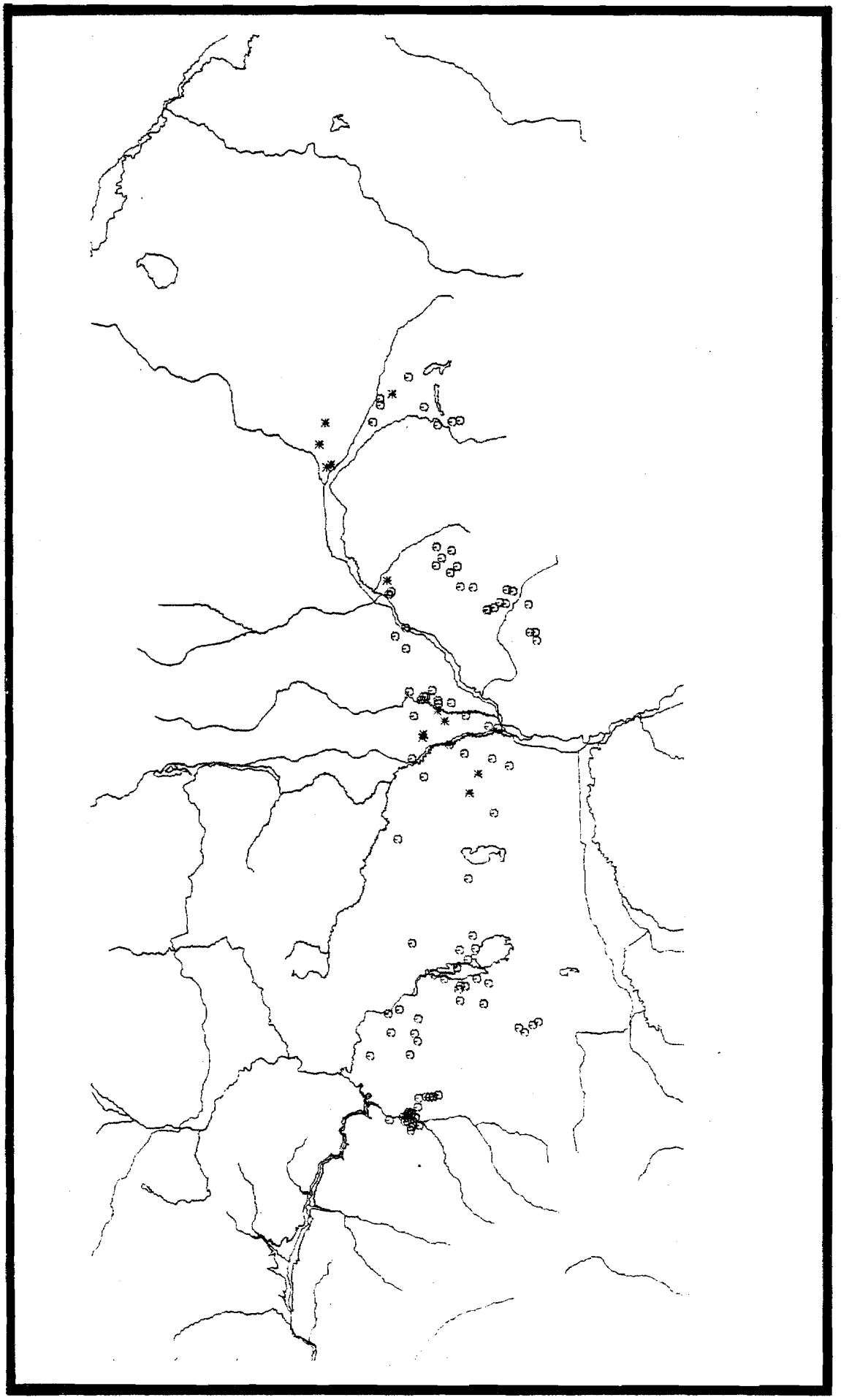

Figure 4. Distribution of Nelchina radio-collared caribou during spring migration, 1 April–14 May 1984. ● = females, ✱ = males.

rather than the traditional route in the Sourdough to Hogan Hill area. By 8 May females were scattered across the Lake Louise Flat from the Ewan-Fish Lakes area to the lower Oshetna River where they entered the Talkeetna Mountains calving area. The migratory route appeared to run south of the Watana impoundment area similar to 1983 (Pitcher 1984). This was in contrast to 1981 and 1982 (Fig. 5) when numerous animals either crossed the proposed impoundment or used the frozen Susitna River as a travel route (Pitcher 1982, 1983).

Calving Period: only one survey was flown during the calving season (4 June) so the full geographical extent of the area used for calving is unknown. During the survey (Fig. 6) females were found from the Oshetna River west into the hills west of Tsisi Creek. Primary concentrations were found in Kosina Creek and the Black River. Locations of radio-collared females during the calving period throughout the study (1980-84) are displayed in Figure 7. The core calving area included the Oshetna and Black Rivers and Kosina Creek.

These observations are consistent with those made of calving locations since 1949, the first year for which records are available. While the local areas utilized have varied, calving has taken place between Fog Lakes and the Little Nelchina River. The only deviations have been during years with extremely heavy snow accumulations when some calving took place during migration to the calving grounds (Lentfer 1965, Skoog 1968, Bos 1973).

Summer: summer distribution of Nelchina caribou has been similar throughout the five years of study (Fig. 8). The female-calf segment has utilized the northern and eastern Talkeetna Mountains. Particularly heavy use has occurred between the Little Nelchina and Black Rivers. Radio-collared male caribou were found scattered throughout the high country of the Nelchina Basin. It appeared that the largest concentration of summering bulls was located in the southeastern Talkeetna Mountains in the vicinity of Caribou Creek.

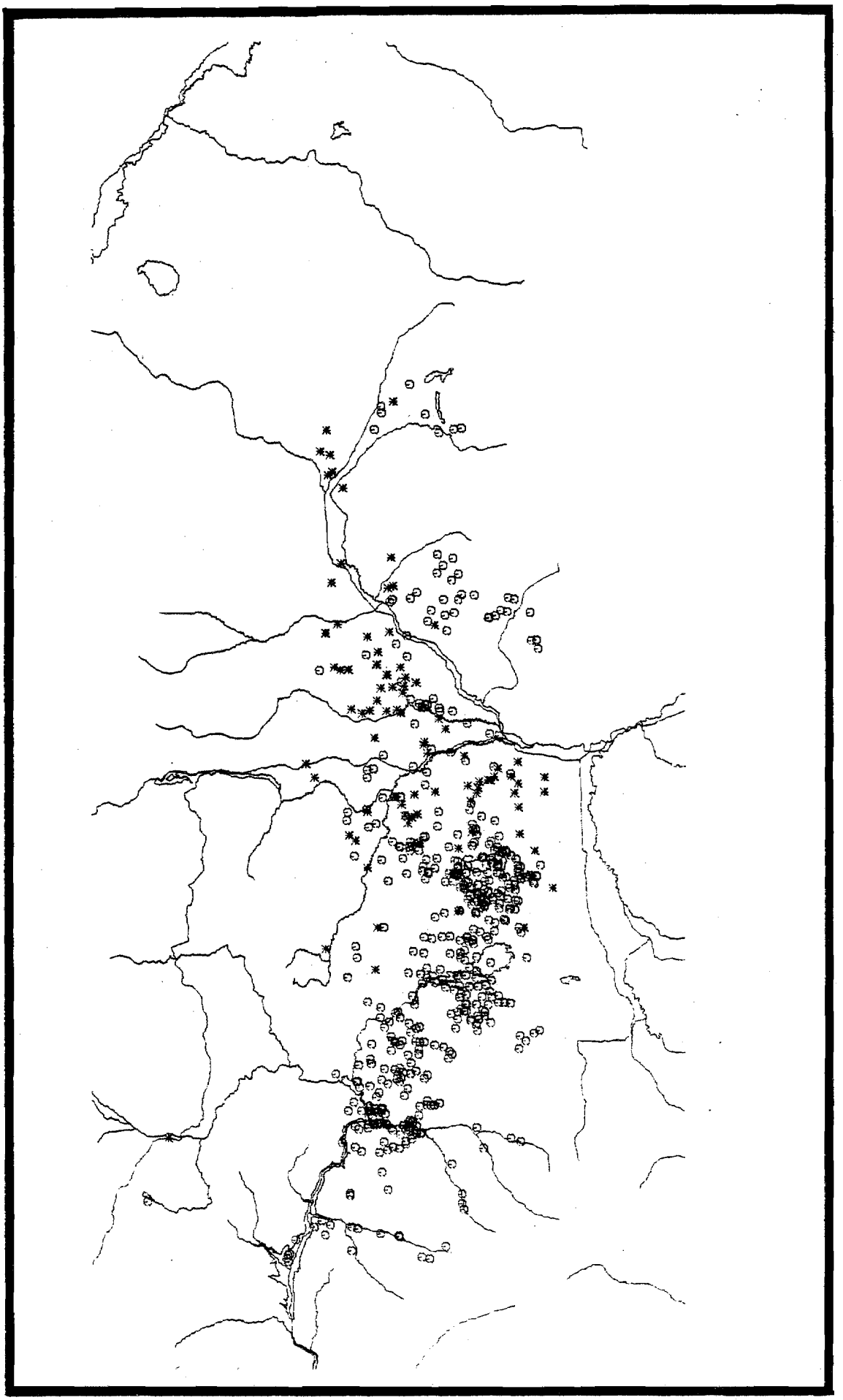

Figure 6. Distribution of Nelchina radio-collared caribou during spring migration, 1 April–14 May 1981–1984.
o = females, * = males.

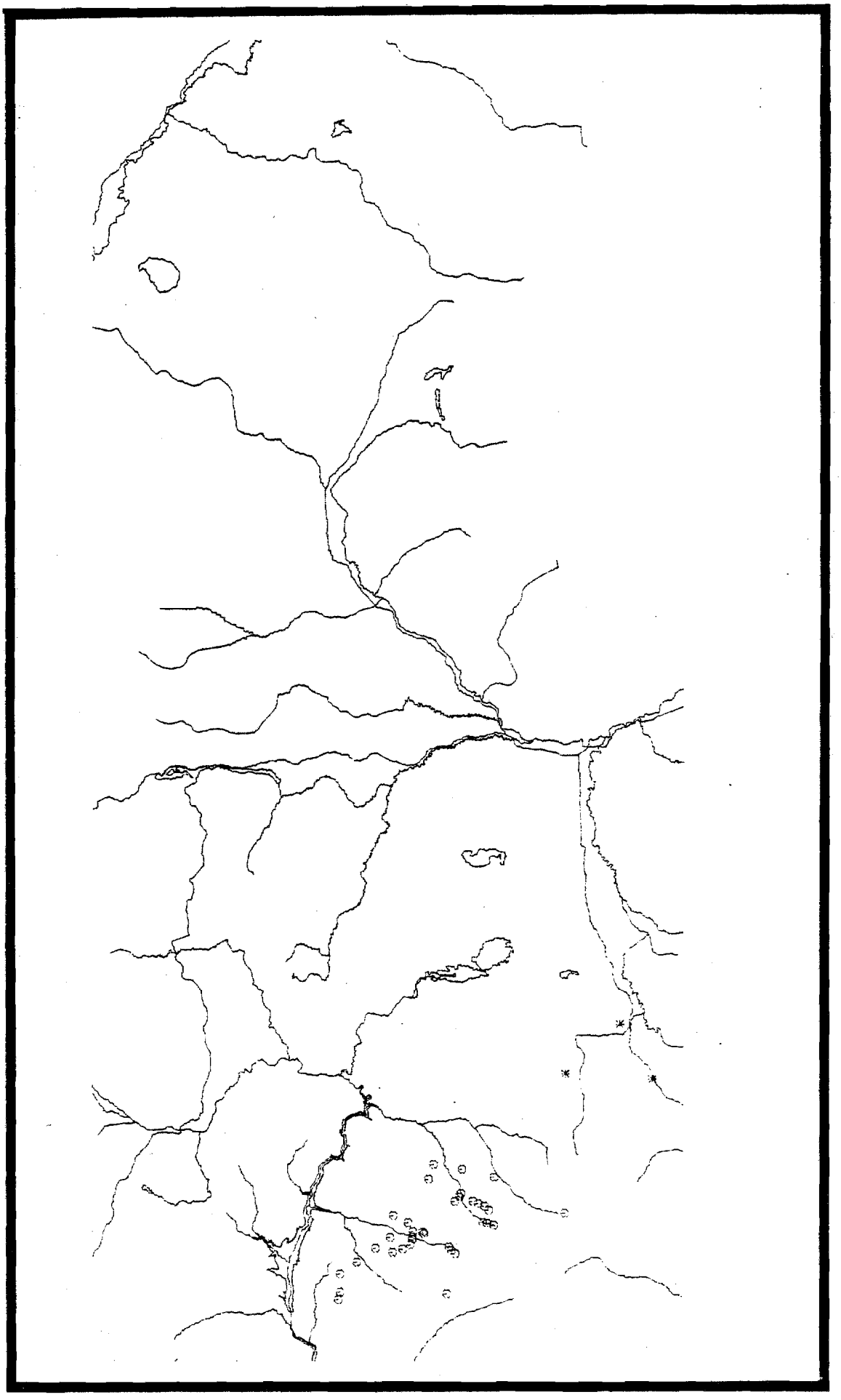

Figure 6. Distribution of Nelchina radio-collared caribou during calving, 15 May-10 June 1984.
o = females, * = males.

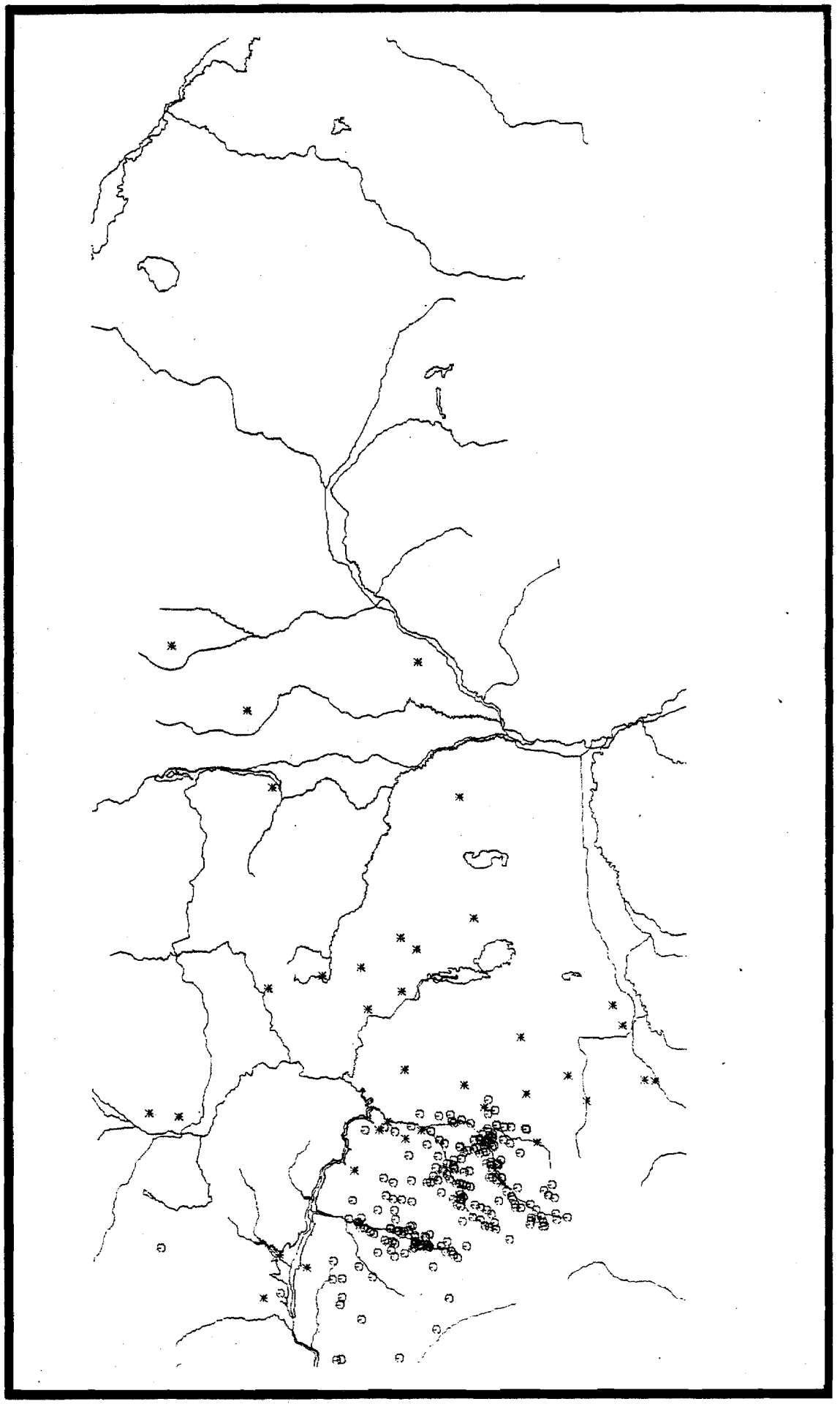

Figure 7. Distribution of Nelchina radio-collared caribou during calving, 15 May–10 June 1980–1984.
o = females, * = males.

Figure 8. Distribution of Nelchina radio-collared Caribou during summer, 11 June-31 July 1980-1984. ⊙=females, ✱=males.

Historically, the female-calf segment has summered nearly exclusively in two areas; the eastern Talkeetna Mountains (the area utilized during this study) and north of the Susitna River in the eastern benchlands of the Chulitna Mountains (Skoog 1968, Hemming 1971). To my knowledge main herd Nelchina caribou have not utilized the latter area as summer range to any significant degree since about 1976 although between about 1950 and 1973 it was utilized during most years (Pitcher 1982). Movements from the Talkeetna Mountains across the Susitna River ranged from mid-June through July. Crossings apparently occurred between Deadman Creek and V Canyon (Skoog 1968).

Autumn: most radio-collared caribou remained on summer range during the autumn period in 1984 (Fig. 9). Four radio-collared animals crossed the Lake Louise Flat to the Alphabet Hills but then three returned to the Talkeetna Mountains. Three other radio-collared caribou crossed the Susitna in the Watana Impoundment area and dispersed to the north. This was generally the same pattern as seen during previous years (Fig. 10) although most caribou remained in the Talkeetna Mountains longer and there was less dispersal to the Lake Louise Flat.

Rut: during a 8 October 1984 radio-tracking survey nearly all radio-collared caribou were found on the Flat west of Lake Louise or in the Talkeetna Mountain foothills near the Little Nelchina River (Fig. 11). Several radio-collared animals which had moved north of the impoundment area and one in the Alphabet Hills were still in those locations. This was the farthest west the herd has been during the rut period since the study began in 1980. During the entire study period rutting caribou have been found from the Talkeetna Mountains east to the Wrangell Mountains (Fig. 12). Historically Nelchina caribou have rutted in a wide variety of locations with the eastern Talkeetna Mountains and Lake Louise Flat being most extensively used. The Deadman-Butte Lakes area

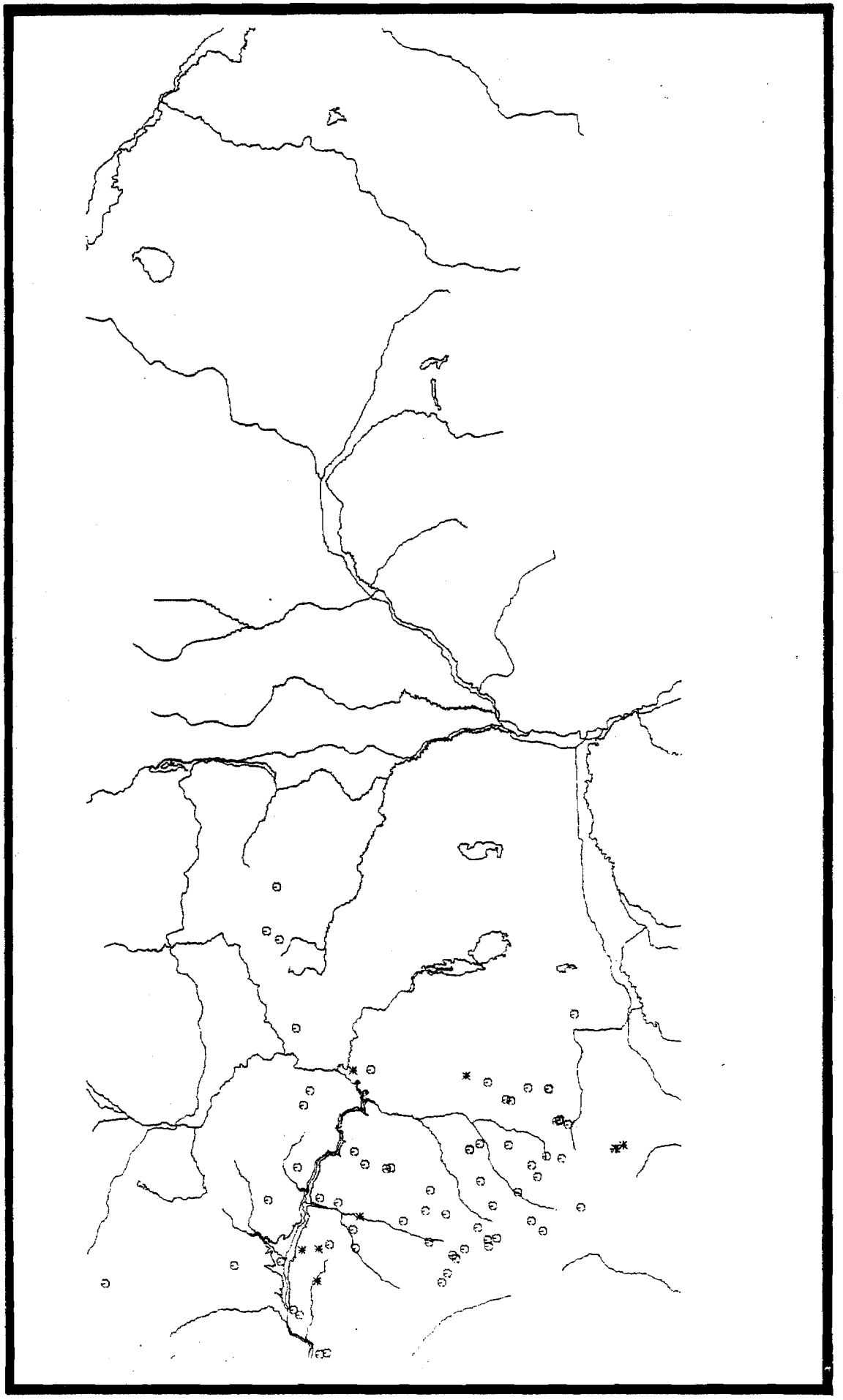

Figure 9. Distribution of Nelchina radio-collared caribou during autumn, 1 August-30 September 1984.
o = females * = males.

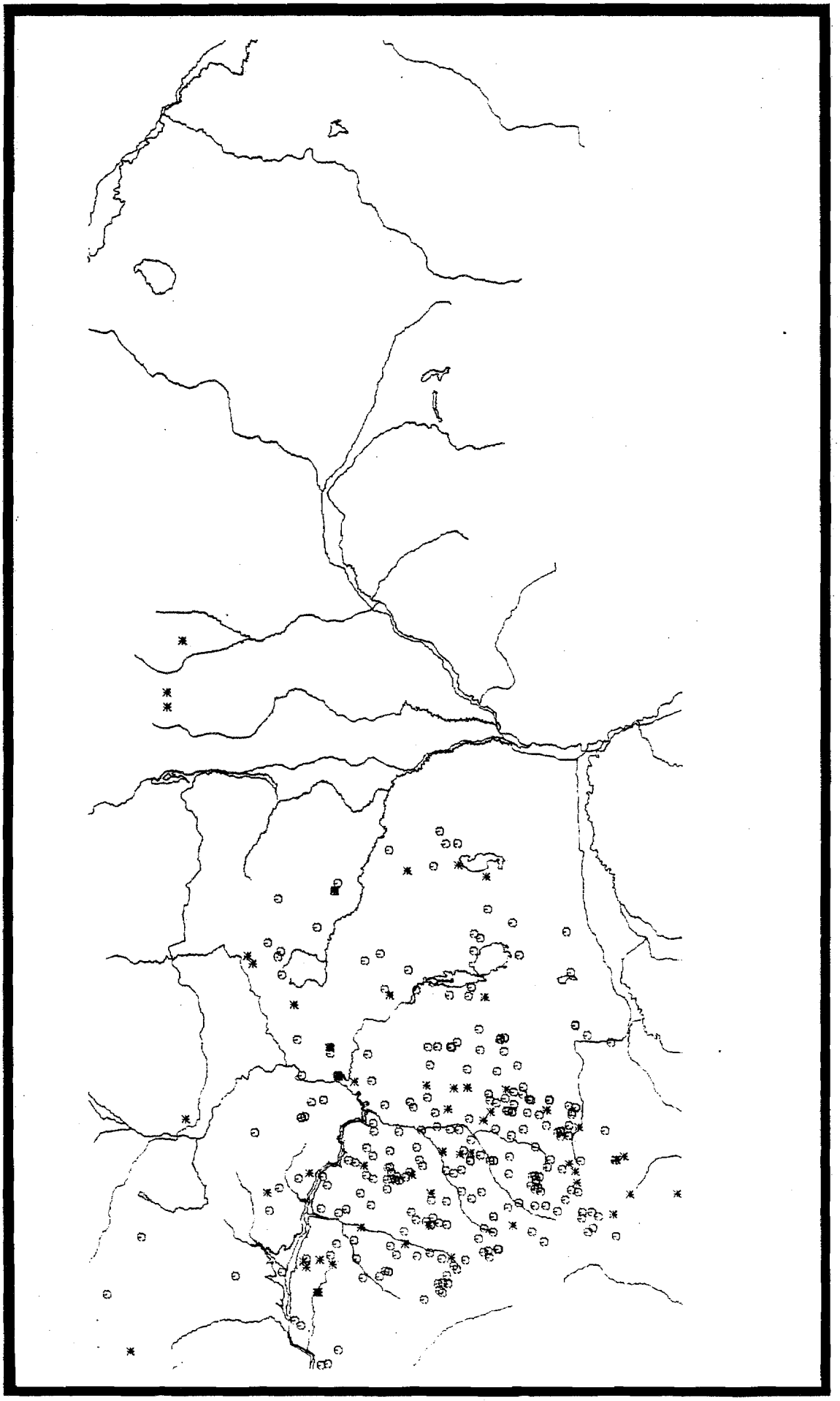

Figure 10. Distribution of Nelchina radio-collared caribou during autumn, 1 August-30 September 1980-1984. o = females, * = males.

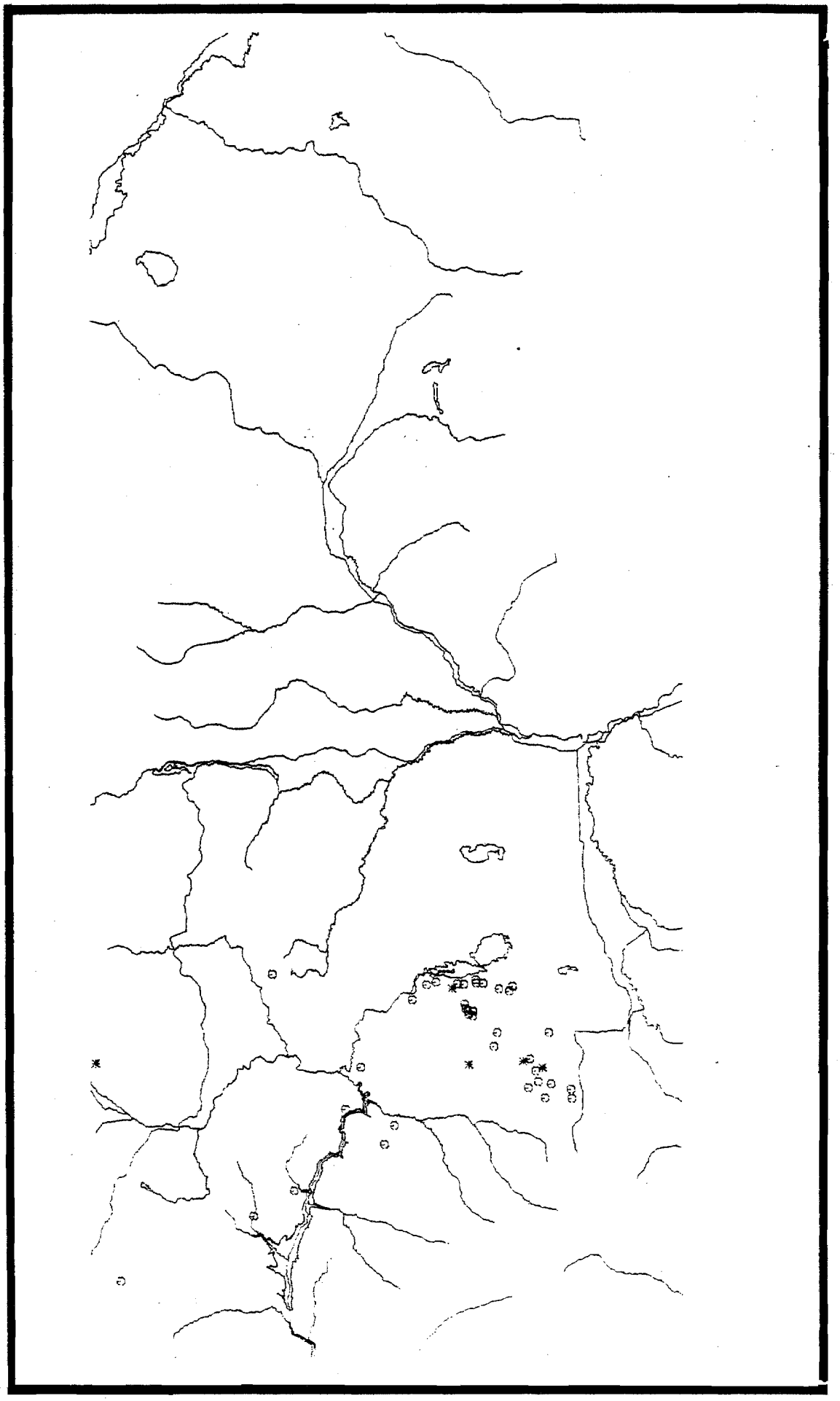

Figure 11. Distribution of Nelchina radio-collared caribou during the rut, October 1984.
o = females, * = males.

Figure 12. Distribution of Nelchina radio-collared caribou during the rut , October 1980-1984.
o = females, ✱ = males.

was also heavily used during years when major segments of the herd summered or wintered in the area. During the fall period Nelchina caribou are moving extensively and the rut may take place in a number of locations (Skoog 1968). It appears that habitat type is not a critical determinant of rutting locations but rather rutting occurs in virtually any area that caribou might be moving through during that period.

Current Distribution: year around use of the Nelchina Range by radio-collared caribou from the main herd during the entire study period is shown in Figure 13 and encompassed an area of about 16,100 mi^2. The northern and eastern Talkeetna Mountains can be considered the core of the Nelchina caribou range. The herd has shown near perfect fidelity to the calving grounds located in the Talkeetna Mountains. The Talkeetna Mountains are also the primary summer range and have been used on occasion as winter range (Skoog 1968). Winter ranges are the most variable (Skoog 1968) and during the four winters of this study have included the Lake Louise Flat, Chistochina and Gakona River drainages, Wrangell Mountains foothills and to a lesser extent the area to the northeast of the Mentasta Mountains. The northwestern portion of the Nelchina Range including drainages of the upper Chulitna, Nenana and Susitna Rivers received minimal use by main Nelchina herd animals during the study period while historically it was important summer and winter range.

POPULATION SIZE AND COMPOSITION: MAIN NELCHINA HERD

A herd census was conducted by the area management staff of ADF&G in late June 1984. The extrapolated October population estimate of 24,095 (ADF&G unpublished data) was slightly lower than the 1983 estimate (Table 1). the lower estimate resulted primarily from a low bull ratio (39.5 males ≥1 year per 100 females ≥1 year) obtained during the fall sex and age composition sampling. This ratio was considerably lower than those obtained during the previous four years ($\bar{x}$ = 59.7; range = 55.4 - 61.9) and resulted

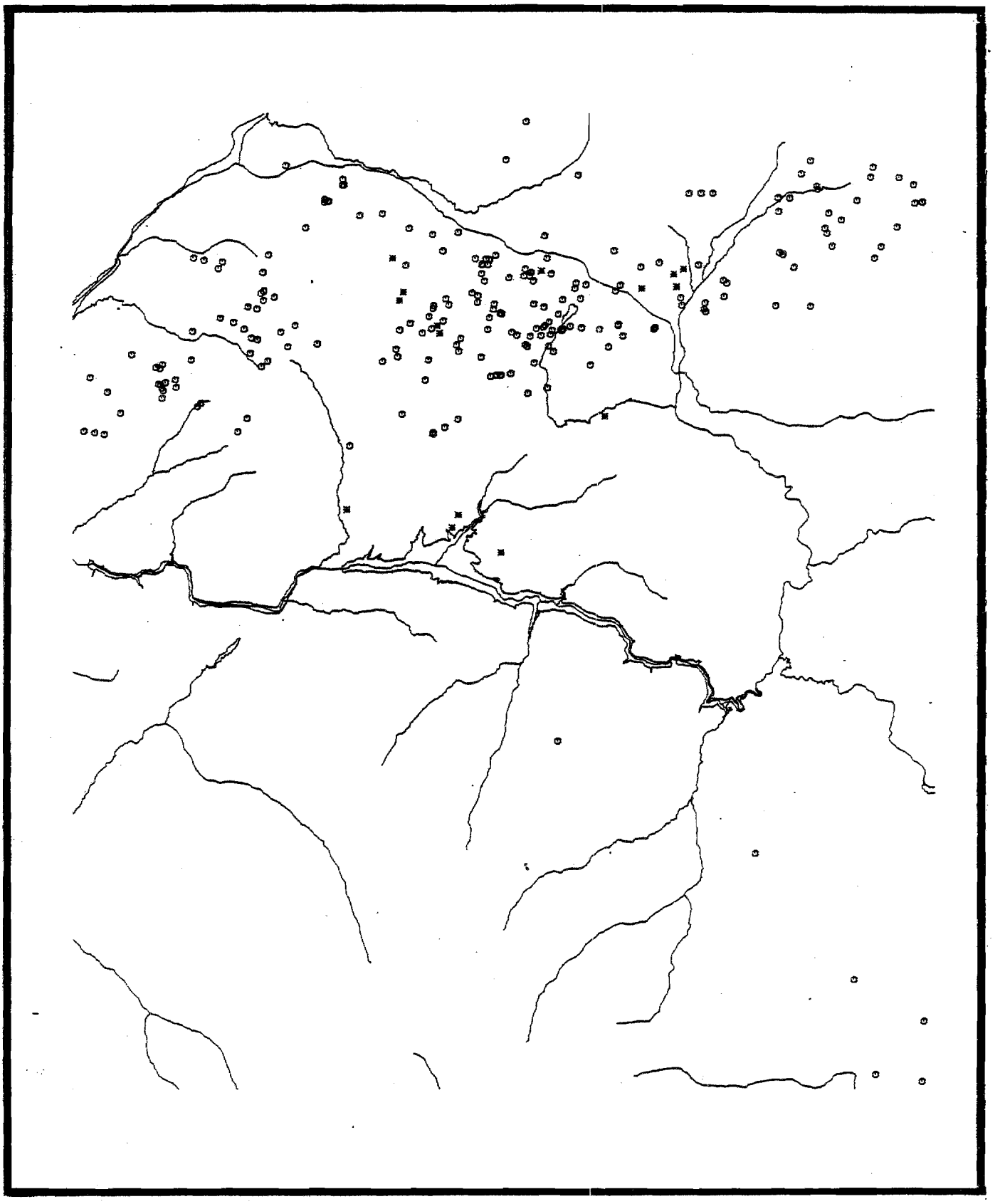

Figure 14. Distribution of upper Susitna–Nenana radio-collared caribou during entire study period, 9 May 1980–15 October 1984. o = females, * = males.

in an estimate about 3,000 animals lower than would have resulted from a ratio similar to those obtained during the previous four years. The ratio of calves per 100 females ≥1 year (33.7) was also lower than the average for the past 4 years (41.6) although slightly higher than the 1983 ratio of 27.1. This also contributed to the lower herd estimate.

It seems unlikely than the actual bull ratio declined from 61 to 40 in one year. Misclassification of sexes could be responsible for the differences. I conducted the sampling between 1980 and 1983 while the management staff conducted the 1984 effort. Overestimation of the bull ratio by me would have inflated earlier population estimates while underestimation of the bull ratio in 1984 would have resulted in an underestimate of herd size. It is also possible that the bull segment of the herd was not full represented in the area where composition sampling took place in 1984 which would account for the seemingly low bull ratio.

The ratio of calves per 100 females ≥1 year at 33.7 was also lower than the average for the past four years (x = 41.6, range = 27.1 - 54.0). Low values were obtained for both 1983 and 1984 probably indicating reduced or even negative herd growth.

MORTALITY

Natural mortality: only one radio-collared caribou, a female from the upper Susitna-Nenana subherd, died during the past year (1 October 1983-30 September 1984). Cause of death was not determined but it was assumed to have been from natural causes because of the remote location. The death occurred during the calving season. Skoog (1968) reported that complications of the birth process occasionally caused deaths of parturient females.

Estimates of x annual survival rates of radio-collared animals for the entire study period (1 July 1980-30 September 1984) were 0.90 (0.94-0.86, 80% confidence interval) for females, 0.89 (0.96-0.76, 80% confidence interval) for males and 0.90 (0.93-0.86, 80% confidence interval) for sexes combined.

Calf survival from birth to about 11 months of age (20 May 1983 to 24 April 1984) was estimated from a theoretical birth rate of 0.66 calves per 100 cows ≥1 year, an observed ratio of 14 calves per 100 cows ≤1 year in April and estimated survival of females of 0.90 between 20 May and 24 April. Estimated calf survival was $\frac{(0.14 \times 0.90)}{0.66} = 0.19$. This was the lowest estimate of calf survival obtained during this study; 1981=0.43, 1982=0.58, 1983=0.54.

Hunting mortality: the reported sport and subsistence hunter kill of caribou from the Nelchina herd in regulatory year 1983-84 was 969 animals; 827 males, 137 females and 5 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 1984-85 season indicate a slightly higher harvest.

Considering the population parameters of calf survival, adult survival and hunting mortality just described it seems unlikely that the herd could sustain the growth observed over the past few years. Indeed an actual decline in numbers will probably occur unless changes in survivorship take place.

Table 1. Nelchina caribou herd population estimates, in fall unless otherwise noted.

Year	Total Estimate	Female Estimate	Male Estimate	Calf Estimate
1955	40,000 1/	-	-	-
1962	71,000 2/	-	-	-
1967	61,000	-	-	-
1972	7,842	4,800	1,622	1,420
1973	7,693	4,646	1,268	1,779
1976	8,081	4,979	1,663	1,439
1977	13,936	7,509	2,868	3,559
1978	18,981	9,866	4,429	4,686
1980	18,713	9,164	5,673	3,876
1981	20,694	10,154	6,184	4,356
1982	21,356	10,199	5,650	5,507
1983	24,838	13,212	8,046	3,580
1984	24,095	13,912	5,495	4,688

1/ Watson and Scott (1956), February census.
2/ Siniff and Skoog (1964), February census, perhaps should be adjusted downward by as many as 2,000 caribou due to presence of Mentasta herd.

Herd size: an attempt at a total count of this resident group of caribou which occupy the northwestern portion of the Nelchina Range was made on 4 and 5 April 1984. Snowfall in the area was above normal during the 1983-84 winter and caribou were concentrated in several locations. We counted a total of 913 caribou in the area with major concentrations found in the following areas: hillside to the east of the middle portion of Brushkana Creek (352); foothills to the east of Butte Lake (198); Rusty Hill Ridge between Valdez Creek and the Susitna River (199); and Reindeer Hills (57).

The count was probably considerably low as counting conditions were poor in places and not all animals were within the area counted. Some knolls and ridges were windblown and caribou appeared to select these areas probably because vegetation was readily accessible. Animals in these windblown, bare areas were difficult to see and count. At the time of the census I had nine radio-collared caribou in this subherd. However, only seven were within the count area at the time of the census. None of 34 radio-collared animals from the main Nelchina herd were found within 50 miles of the count area and most were over 100 miles to the east; therefore it was unlikely that main herd animals were included in the count.

Because of the factors affecting the count; poor counting conditions (bare patches), subherd animals outside of count area (demonstrated by radio-collars) and low probability of main herd animals being included in the count - it is likely that the count was a substantial underestimate of subherd size. Previously I had estimated subherd size at about 2,500 animals based on a count of 2,077 caribou (Pitcher 1983). Subsequently, movements of caribou which were radio-collared at the time of the count revealed that significant numbers of main Nelchina herd animals were probably included in the count resulting in a substantial overestimate.

It seems reasonable that the two counts, one of which was an overestimate and the other which was an underestimate, are likely outer bounds of true population size. The upper Susitna-Nenana subherd likely ranges between 1,000 and 2,000 caribou with the mid-point 1,500 being a reasonable estimate.

Distribution: year around observations of radio-collared caribou from the upper Susitna-Nenana subherd during the entire study period are shown in Figure 14 and encompass an area of about 2,050 mi^2 (excluding relocations of female 152.410 who spent the winter and calved with the main Nelchina herd during one year). Distribution of the herd extended west from the Clearwater Mountains and headwaters of the Susitna River, across Monahan Flat and the Butte Lake-Brushkana Creek country into the Chulitna Mountains. Observations of females during the calving period (Fig. 15) have been dispersed over a wide area, primarily in three general regions; eastern headwaters of the Susitna River, the Butte Lake-Brushkana Creek-Deadman Creek area and the Chulitna Mountains. In 1984, one upper Susitna-Nenana radio-collared female (152.410) calved in the Talkeetna Mountains with the main Nelchina herd. By mid-August she had returned to summer range north of the Susitna River. The previous year she had calved in the upper Brushkana-Deadman Creeks region. This was the first instance in this study in which a radio-collared female has not shown complete fidelity to one calving area. The dispersed calving demonstration by this group is in contrast to the main Nelchina herd where females formed a relatively cohesive group and gave birth to their calves in a restricted geographic area. Summer range was similar to calving distribution (Fig. 16) although animals were often found at higher elevations. The primary wintering areas were in the Butte Lake-Brushkana Creek area, Monahan Flat and along and to the east of the Susitna River above the Denali Highway (Fig. 17). Some use of the Chulitna Mountains occurred, particularly the northern slopes, although during deep snow winters such as 1983-84 nearly all animals moved to the east. During deep snow conditions caribou concentrated in

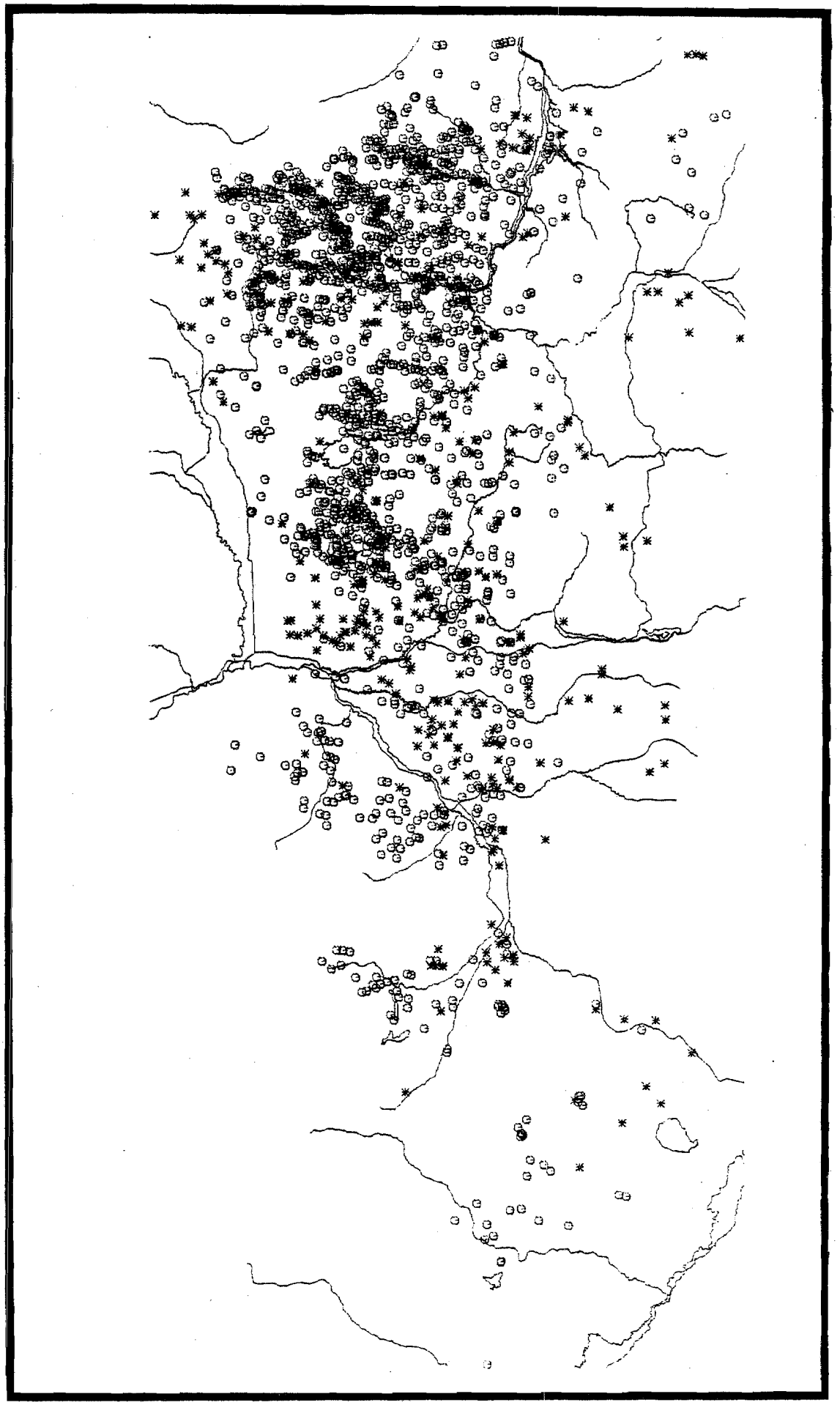

Figure 13. Distribution of Nelchina radio-collared caribou during entire study period, 14 April 1980-15 October 1984. o = females, * = males.

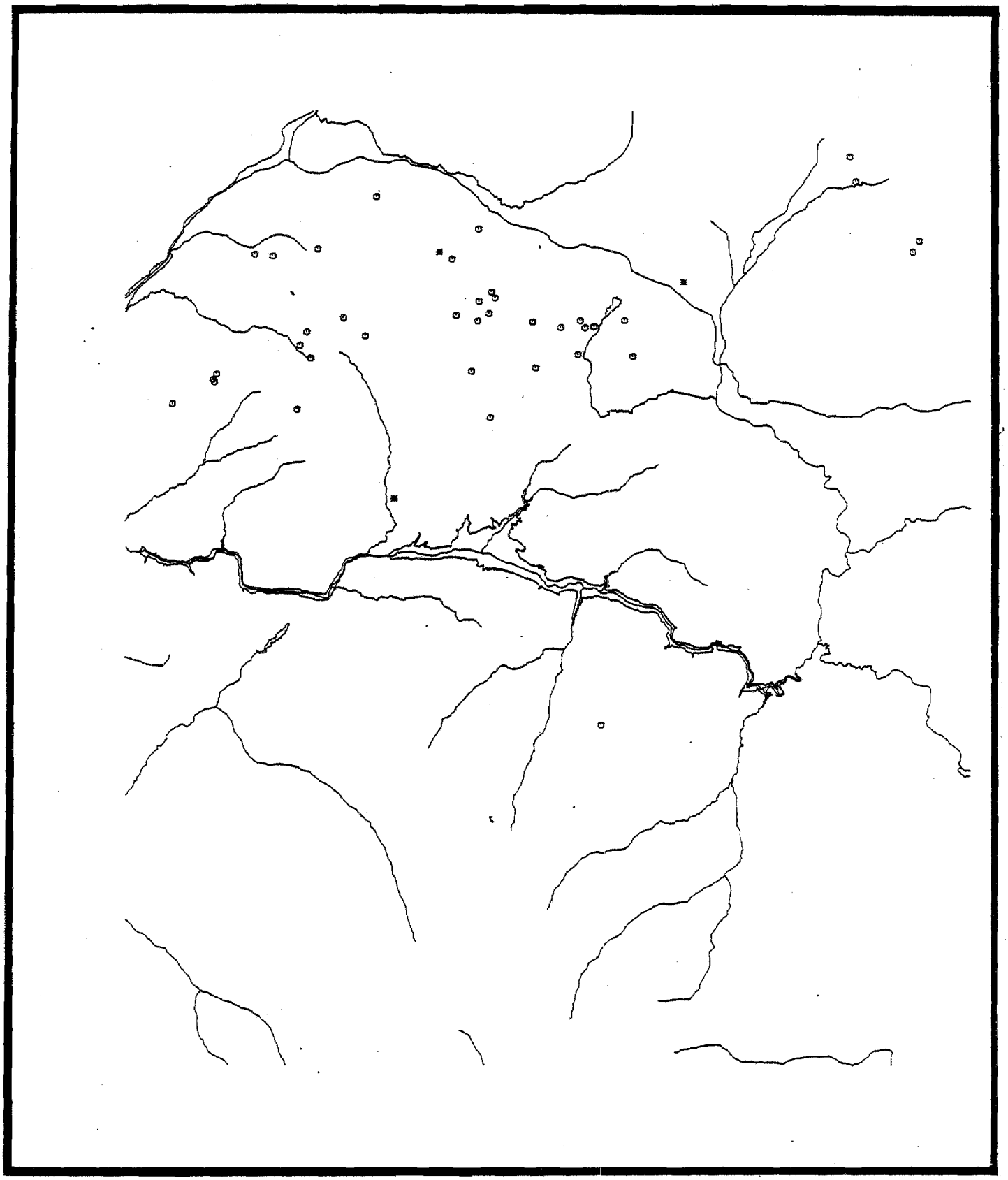

Figure 15. Distribution of upper Susitna-Nenana radio-collared caribou during calving, 15 May -10 June 1980-1984. o = females, * = males.

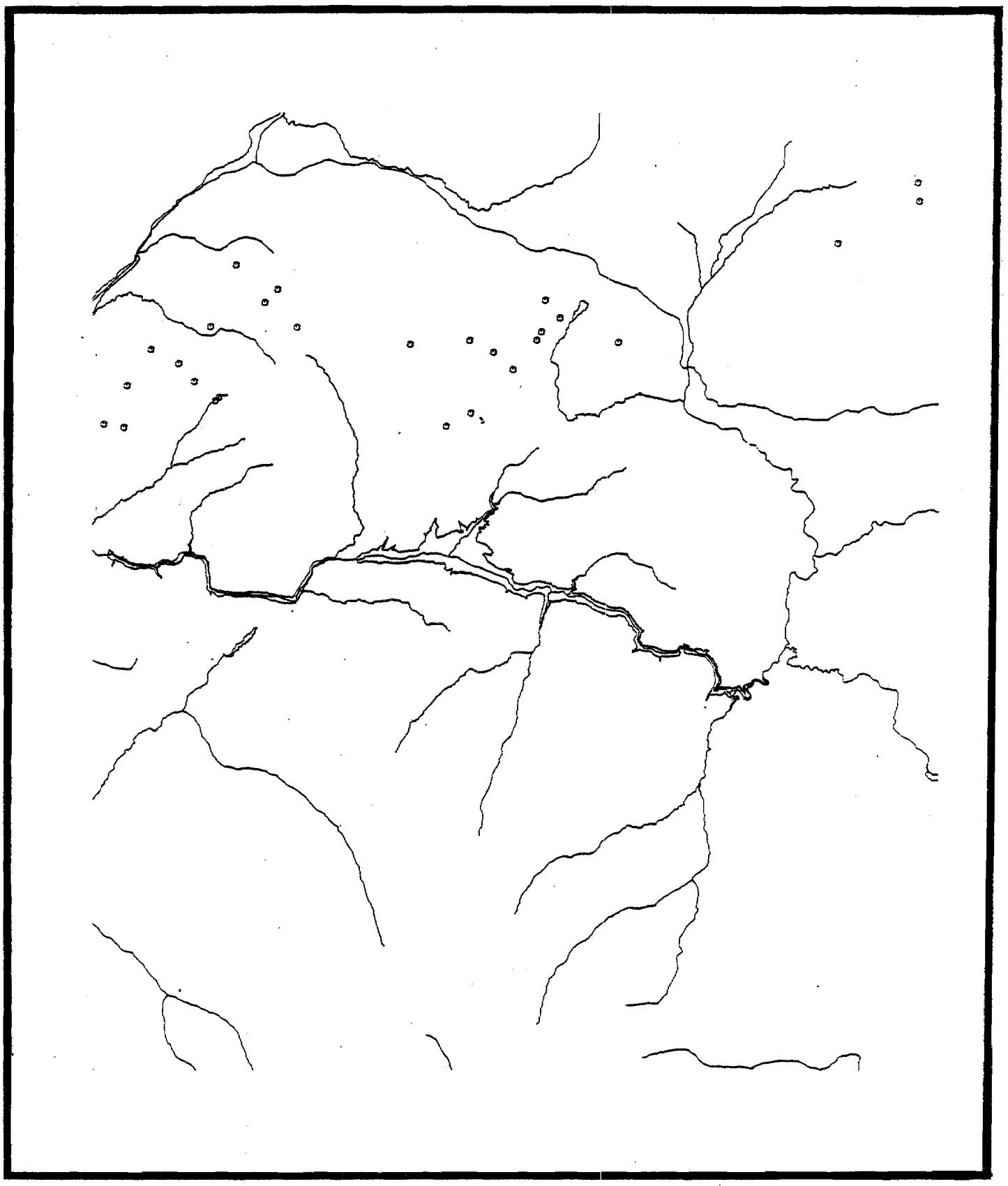

Figure 16. Distribution of upper Susitna - Nenana radio-collared caribou during summer, 11 June-31 July 1980 -1984. o=females.

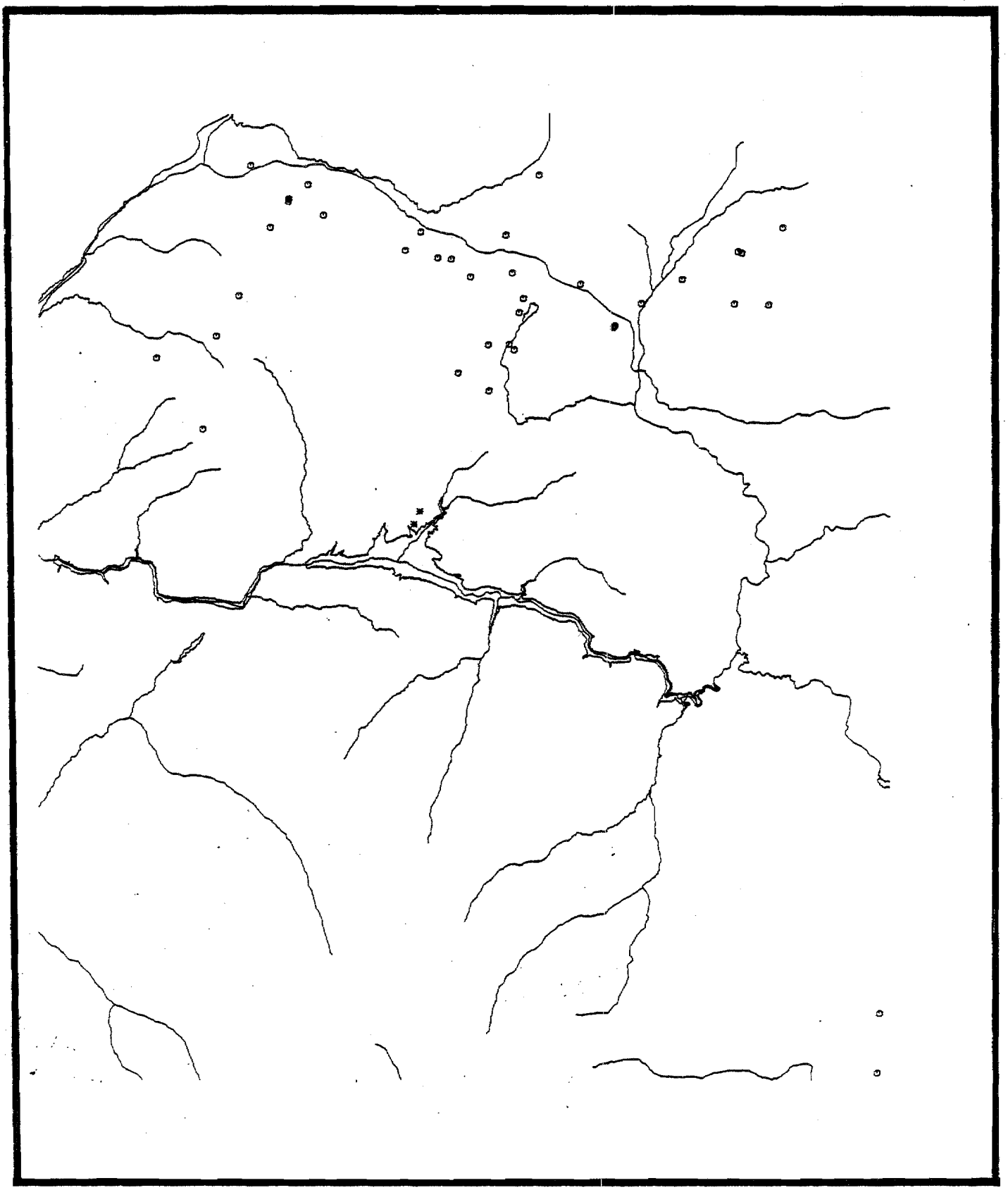

Figure 17. Distribution of upper Susitna-Nenana radio-collared caribou during winter, 1 December-31 March 1980-1984. ● = females, ✱ = males.

the hills surrounding Butte Lake and on Rusty Hill Ridge between the Susitna River and Valdez Creek. It appeared that wind blown areas in this higher terrain were being used by caribou. About half of the radio-collared caribou from the upper Susitna-Nenana subherd migrated from summer range in the Chulitna Mountains and winter range to the east (thereby crossing the proposed Denali access route). Therefore probably about 750 upper Susitna-Nenana caribou spend the summer in the Chulitna Mountains plus an unknown number of bulls from the main Nelchina herd.

POTENTIAL IMPACTS OF PROJECT CONSTRUCTION

The proposed Susitna Hydroelectric project is located in the western portion of the Nelchina caribou range. The Devil Canyon impoundment and transportation routes and powerlines to the west do not appear to be of serious concern as neither currently nor historically have many caribou occurred in this region. Recent use (1980-1984) of the Watana impoundment area by Nelchina caribou has been moderate. During spring migration from winter range to the east some use of the Watana impoundment area often occurs, particularly the upper end. During the spring of 1981 it appeared that many caribou used the frozen Susitna river between the confluences of the Oshetna River and Kosina Creek (within the proposed Watana impoundment) as a travel route (Pitcher 1982). In 1982 I estimated that perhaps in excess of 50% of the female segment was in the upper reaches of the Watana impoundment during spring migration to the Talkeetna Mountains calving grounds (Pitcher 1983). The following spring, 1983, less use of the impoundment area appeared to occur as most females entered the Talkeetna Mountains in the vicinity of the Oshetna River and Goose Creek (Pitcher 1984). In the spring of 1984 little use of the Watana impoundment area occurred, similar to 1983. It is apparent that considerable variation occurs in use of the impoundment area during spring migration from eastern winter

range. No apparent correlations were noted between migratory routes and snow conditions during different years. However, it may well be advantageous for caribou to migrate through the impoundment area under certain conditions, an option that would be lost or at least altered after project construction.

Historically Nelchina caribou wintered north of the impoundment area particularly between 1955 and 1964 (Skoog 1968, Hemming 1971). Spring migration for these caribou entailed a crossing of the Susitna River in the Watana impoundment area enroute to the Talkeetna Mountains calving area. Animals usually crossed the Susitna between the mouths of Deadman Creek and Jay creek. It is unclear how caribou would react to the sudden presence of a large reservoir. Refusal to cross would extend the distance traveled to the calving grounds by perhaps 60 miles and might result in isolation and reduced use of the northwestern corner of the Nelchina range. Crossing conditions during spring might be hazardous as ice covered shores, ice sheets, ice shelves and steep ice ramps formed by winter drawdown of the reservoir could present hazardous obstacles to movement (Hanscom and Osterkamp 1980). Skoog (1968) mentioned several instances of injuries and death resulting from falls on or through ice. Both Klein (1971) and Vilmo (1975) mention ice shelving as a mortality factor of reindeer on reservoirs in Scandinavia. If crossings were attempted during the period of reservoir breakup and ice floes were stacked along the southern shore by a northerly wind, mortalities might result from animals being unable to exit the water.

There are indications that migratory mammals will on occasion attempt to follow traditional routes even after changes have occurred which make them hazardous. Mule deer (*Odocoileus hemionus*) fell from a precipice created by highway construction across migratory trails (Reed et al. 1979). Possibly more than 10,000 caribou from the George River herd were killed while attempting to cross a river at flood stage during fall migration (Sullivan 1984, Goddard 1985).

During the course of this study the female-calf segment of the main Nelchina herd utilized summer range in the Talkeetna Mountains. However, during most years between 1951 and 1976 (Pitcher 1982) segments of the female-calf component of the herd crossed the Susitna in the Watana impoundment area to use summer range in the greater Deadman Lake area. This crossing occurred between mid-June and late July. It seems reasonable to assume that resumption of use of this summer range will take place at some time. If the Susitna project is constructed the caribou will be faced with crossing an open water reservoir with minimum widths in the traditional crossing areas of about 1.25 mi. Caribou are known to be strong swimmers. Skoog (1968) saw a band cross Lake Louise a distance of 5 mi. He also stated that caribou commonly crossed much larger bodies of water in Canada. Calves would be quite small during early summer crossings. However, Skoog (1968) observed that caribou take readily to the water at an early age. Crossings during this period would not appear to pose a great hazard except perhaps to young calves.

During autumn dispersal low to moderate rates of crossing in the Watana impoundment area have taken place during the past 5 years. Rather than large scale migrations, movements during this period appear to be of a wandering nature. Impoundment crossing during this period would probably be relatively nonhazardous. Light rates of crossing were noted during the rut and winter periods, neither of which appear to pose serious threats because of reservoir conditions and numbers of animals involved. The transitory phase of freeze-up might present increased hazards, but would probably be similar to conditions already occurring on large lakes.

The proposed Denali access road from the Denali Highway to the Watana dam site runs between summer and winter range for about half of the upper Susitna-Nenana subherd. Relocations of radio-collared caribou indicate that the Chulitna Mountains are important calving and summer range with most animals moving to

the east for the winter, particularly during deep snow years. Thus about half of this subherd would be crossing the road twice annually. Some calving occurs in the vicinity of the proposed access road. However, because females from this subherd do not congregate on a discrete calving ground but rather calve while dispersed over a large area it is probably impossible to route the Denali access road to completely avoid calving females. Conversely only a small amount of calving would occur wherever the road is constructed.

Based on the composition of caribou sampled along the Trans-Alaska pipeline haul road and compared to region wide surveys (Cameron et al. 1979) and based on the relocation of collared caribou (Whitten and Cameron 1983) it was concluded that the cow-calf segment of the Central Arctic herd tended to avoid the pipeline corridor and associated activity. Carruthers et al. (1984) maintained that these conclusions were erroneous because the differences in composition were the result of differential habitat selectivity rather than avoidance of the corridor. Horejsi (1981) reported that caribou showed signs of anxiety and fear in the presence of a fast-moving vehicle and react strenuously to escape. Johnson and Todd (1977) concluded that a group of mountain caribou became habituated to a highway and traffic and continued to use a traditional movement route despite harassment and mortality. Klein (1971) reported that well traveled highways and railroads have obstructed the movements of wild reindeer in Norway. Bergerud et al. (1984) failed to find strong correlations with construction of roads through caribou ranges and population declines except when the roads were uses as access routes for hunters resulting in overharvests. Despite these contradictory findings on the impacts of highways on the free movement and behavior of caribou it does appear that high levels of activity along highways may influence behavior in certain situations (Klein 1971, Horejsi 1981, Smith and Cameron 1983). It is not clear how the Denali access road and associated traffic will impact caribou migrating from the Chulitna Mountains to and

from winter range to the east. Nelchina caribou continue to cross the Richardson Highway often in large numbers, and have done so during many years since about 1960 (Hemming 1971). The area where the Richardson crossings take place is timbered in contrast to the open tundra and shrublands of the proposed Denali access route. Nelchina caribou also cross the Glenn Highway (primarily the Tok-Cutoff), Denali Highway, Lake Louise Road and Nebesna Road on occasion. The Glenn Highway and Nebesna Road are crossed twice yearly during those years (perhaps half of recent years) when the Nelchina herd winters in the Wrangell Mountains-Mentasta Mountains area. Small numbers of caribou, primarily bulls, cross the Glenn Highway west of Glennallen during winter and spring each year. Most years small numbers of caribou cross the Lake Louise Road during the autumn dispersal period.

Some mortality of caribou from collisions with vehicles along the Denali access road may occur although it is not expected to be a serious problem. Caribou-vehicle collisions along the Richardson Highway where major crossings occur probably do not result in over about 50 deaths per year (Tobey, pers. commun.). Vehicle-caribou accidents are reportedly uncommon along the Dalton Highway (Cameron, pers. commun.).

Increased aircraft traffic in the western Nelchina range would be expected in conjunction with project construction. Several studies (Miller and Gunn 1979, Calef et al. 1976) have recorded responses of caribou to aircraft disturbance and made recommendations to mitigate possible adverse impacts. Davis and Valkenburg (1984) reported that the Delta caribou herd has been exposed to more disturbance than any other Alaskan caribou herd including considerable civilian and military aircraft traffic and yet has grown at a rapid rate and is now larger than ever recorded. Bergerud et al (1984) concluded that caribou can tolerate periodic severe disturbance without adverse effects on productively and survival. Based on these reports I would not

expect aircraft disturbance to be a serious problem impacting caribou if the Susitna project is constructed. Restricting aircraft access in the Talkeetna Mountains calving grounds and summer range and the area north of the Watana impoundment combined with minimum elevation requirements should provide adequate safeguards.

Project construction would likely increase human access to the northeastern Talkeetna Mountains which include calving grounds and summer range for the Nelchina herd. The Denali access road would also increase access to important caribou habitat which is currently used primarily by the upper Susitna-Nenana subherd. The area has in the past and probably will again be important summer and winter range for the Nelchina herd. The calving grounds are currently in one of the most remote and inaccessible regions within the Nelchina range. Smith and Cameron (1983) reported decreased use of the Prudhoe Bay oilfield complex by calving caribou during recent years. While it seems unlikely to me that development in the northern Talkeetna Mountains could reach this level in the near future, the possibility must be considered.

Perhaps 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, severe impacts. The proposed hydroelectric project is only one (although the major one) of a number of developments which may occur on 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 and human activity, disturbance, and barriers to free movement will all probably contribute to this.

Some biologists (Bergerud et al. 1984) feel that caribou are adaptable and can tolerate considerable human activity and development if protected from overharvest. They maintain however, that caribou require space to successfully deal with a changing environment and that some concern must be directed towards ensuring their mobility. They state "we must not permit the dissection of caribou populations into small discrete units...".

RECOMMENDATIONS FOR CONTINUING STUDY

Range use and migration routes of the main Nelchina herd should be documented by maintaining and monitoring a pool (25+) of radio-collared caribou. Particular emphasis should be given to determining herd use of range to the north of the proposed Watana impoundment. Up to 10 radio-collared caribou from the upper Susitna-Nenana subherd should also be monitored to document range use and seasonal movements and to determine relationships with the main Nelchina herd. This would be particularly relevant if large numbers of main herd animals began sharing summer or winter range with this subherd.

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PERSONAL COMMUNICATIONS

Raymond Cameron, Alaska Department of Fish and Game, Research Biologist, 26 November 1984.

Robert Tobey, Alaska Department of Fish and Game, Area Management Biologist, 21 November 1984.