ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

ENVIRONMENTAL STUDIES
ANNUAL PROGRESS REPORT

SUBTASK 7.11

BIG GAME

Submitted by

Alaska Department of Fish and Game

March 1, 1981

SUMMARY

Phase I big game studies were initiated to determine the probable nature and approximate magnitude of impacts of the proposed Susitna Hydroelectric project on moose (*Alces alces*), black bear (*Ursus americanus*), brown bear (*Ursus arctos*), wolf (*Canis lupus*), wolverine (*Gulo gulo*), caribou (*Rangifer tarandus*) and Dall sheep (*Ovis dalli*).

Radio telemetry and aerial surveys were primary techniques used to delineate subpopulations and to determine population size, seasonal distribution, movement patterns and habitat use. Data on food habits, physiologic condition, and behavior were collected by a variety of methods to aid in assessment of the degree of dependence of each species on specific habitats or habitat types. Information collected during the first year of study was limited by a relatively short period of data collection (in most cases less than 9 months) and unusually mild snow conditions. Data analysis procedures were under development and were not operational in time for preparation of this report. A number of analyses are presented and potential impact mechanisms were identified but these should be considered extremely tentative until supported by additional data and more rigorous analysis.

Procedures for analysis and display of data using the Alaska Department of Natural Resources' geoprocesser were developed and tested. These procedures will allow automated analysis of animal locations, associated descriptive data and other map based data. Problems with habitat selectivity and species interaction analyses were examined and approaches to solving these problems were identified.

Moose - downstream - Only 10 moose were radio-collared because only resident moose may have been captured on the late date of the collaring operation--17 April 1980. A map and explanation of each moose's movement patterns is given.

A wide variety of migratory patterns was documented. Some moose spent the entire year in the vicinity of the river. Others moved half way between the river and the Talkeetna Mountains and remained there. Two moose summered west of the Susitna but spent the rut in the Talkeetna Mountain foothills. One bull went immediately to the mountains and remained there from early spring to mid-winter. Another bull north of Talkeetna moved up and down the river drainage getting as far up river as the proposed dam site. The longest movement between relocations was 40 miles.

The use of the river's islands for moose calving was documented but not quantified. Summer use of the river by moose may be low especially as flooding progresses. Hunter kills of moose along the Susitna indicated fall use on or near the river by moose.

The timing of relocation flights during the midday period may have biased observations of habitat use. Moose were seen in dense or medium climax mixed birch/spruce 46 percent of the time, but they may have used it more for cover and not foraging.

On browse availability/utilization transects on the overall study area (OSA) dense-climax cottonwood/spruce and sparse-low cottonwood/willow/alder were the most frequently encountered habitats. In the Sheep Creek Study Site (SCSS) dense-medium and dense-tall cottonwood/willow/alder were the most abundant habitat types.

A mean of 1.4 browse plants/m^2 was recorded for all habitat types in the OSA, and many habitats had browse densities close to that value. Browse species were most utilized in equisetum/willow and medium-tall cottonwood/willow/alder habitats and least utilized in medium-dense climax cottonwood/spruce and sparse-climax birch/spruce.

Willow and cottonwood occurred most frequently in habitats that were early successional stages of cottonwood/willow/alder. Percent utilization of these two species, however, was greatest in habitats in which they less frequently occurred. Birch was seldom found on floodplain habitats, but where it occurred near the river, it was well utilized (26.9%). Highbush cranberry and rose were found most in tall or climax habitats. Mean densities for highbush cranberry and rose were higher than those of willow and cottonwood. The mean utilization of highbush cranberry was similar to that of cottonwood but both highbush cranberry and rose had lower utilization than willow.

On the SCSS as in the OSA, about 20 percent of available browse plants were utilized. Dense-medium cottonwood/willow/alder contained the greatest density of browse plants but medium-tall cottonwood/willow/alder had the highest utilization of it's available browse.

Approximately one-third of available willow on the study site was utilized by moose. Willow was most dense (2.4 plants/mon dense-medium cottonwood/alder/willow but utilized most (70.3%) on medium-climax cottonwood/willow/alder. Cottonwood was less dense than willow and utilized much less (only 8.5%). No birch was found on the SCSS. As in the OSA, highbush cranberry and rose were most abundant in climax type habitats. There were mean densities of 1.5 and 1.0 plants/m2 for the two species, respectively. Highbush cranberry was utilized twice as much as rose (16.3% vs 8.3%).

General observations indicated that alder was seldom browsed by moose but in some localities a small alder clump could be heavily browsed. Some islands with good moose browse were not used by moose every winter. Moose sign indicated heavy use in the past but no use at the time of observation.

Preliminary statistical tests were conducted on the data concerning percent utilization of browse species. Significant differences in utilization of browse was shown between several pairs of habitat types. More statistical analysis is warranted and planned.

Moose - upstream

During April 1980, 40 adult moose were captured by darting from helicopter and each was radio-collared and biological specimens were collected to evaluate the physical condition of each moose. Average age of captured adult cow moose was 9.4 years, which was significantly older than moose captured in 1977. Sixty-two percent of the moose were 10 years old or older. The average age of these moose was older than other Alaskan moose populations sampled. At least 73 percent of the cow moose examined were pregnant. This pregnancy rate was lower than that obtained in other moose studies and may have been due to a number of factors such as inexperienced palpators, low bull:cow ratios, or nutritional stress.

Blood parameters from captured moose were compared with those collected from earlier Susitna studies and other Alaskan moose populations. The physical condition of Susitna moose appears to have deteriorated since 1977. This, in conjunction with the possibility of a lower pregnancy rate and an older age structure suggests that this population is declining or is about to decline.

Forty-three radio-collared moose (three were from earlier studies) were radio located on 563 occasions. Of that total, 9.2 percent occurred at elevations scheduled to be inundated. Most moose exhibited relatively short movement patterns, spending late winter and early spring at lower elevations and occupying upland areas in summer and fall. Only one moose was observed calving in the proposed areas to be inundated.

Migratory moose were located in areas east of Jay Creek except for one moose located at Watana Creek. Several migratory routes were identified. Moose river crossings on the Susitna for radio-collared animals were concentrated at the mouth of Fog Creek, between Watana and Jay Creek and above Goose Creek. The proposed impoundments did not appear to harbor any significant rutting groups of moose.

Moose parturition occurred from 22 May to 10 June. Nineteen cows produced 30 calves with 58 percent producing twins. Rates of calf production were comparable with those observed in 1977 and 1978. Mortality of newborn moose calves was high and comparable to that observed in 1977 and 1978 when brown bears were identified as the largest cause of mortality. Six percent of the moose observed during a winter distribution survey conducted in March 1980 were located in areas to be inundated. Tracks suggested that considerably more moose had been in these areas earlier in the winter. Track concentrations in areas which would be inundated were observed at Watana Lake, Watana Creek, Jay Creek and the Oshetna River.

Sex and age composition surveys and a random stratified census were conducted in the study area during November 1980. It was estimated that 2,046 ± 382 moose occupied the areas north and south of the proposed Watana impoundment. A crude population estimate of 1,151 moose was made for the project area lying west of Kosina and Watana Creek.

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

Caribou

The Nelchina caribou herd which occupies 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.

Late winter distribution of caribou in 1980 was in the Chistochina-Gakona River drainages, the western foothills of the Alphabet Hills and the Lake Louise Flat. The two main routes to the traditional calving grounds in the northern foothills of the Talkeetna Mountains were across the Lake Louise Flat into the calving area via the lower Oshetna River and across the Susitna River in the area from Deadman Creek to the big bend of the Susitna. Calving occurred between the Oshetna River and Kosina Creek from 3,000 to 4,500 feet elevation. The main summering concentration of Nelchina caribou occurred in the northern and eastern slopes of the Talkeetna Mountains between Tsisi Creek and Crooked Creek, primarily between 4,000 and 6,000 feet. Most caribou were located on the Lake Louise Flat during the rut. During early winter the herd was split in two groups; one in the Slide Mountain-Little Nelchina River area and the other was spread from the Chistochina River west to the Gakona River through the Alphabet Hills to the McLaren River.

It appeared (based on only 8 months data) that at least two small subherds with separate calving areas existed, one in the upper Talkeetna River and one in upper Nenana-Susitna drainages. Insufficient data were available to evaluate the status of the Chunilna Hills group.

The Nelchina caribou herd was estimated to contain 18,558 animals in October 1980. Herd composition was estimated at 49.0 percent cows, 30.3 percent bulls and 20.7 percent calves.

It was apparent from historical records (and to a lesser degree from movements of radio-collared animals) that the proposed Watana impoundment would intersect a major migratory route. It seems possible that the impoundment could be a barrier to movement and potential source of mortality particularly during spring migration when females are in relatively poor condition and various combinations of ice shelving, ice sheets, overflow, ice floes and wind-blown glare ice could occur. The impoundment could tend to isolate the northwestern corner of the Nelchina range an area which has been heavily used in the past. Access routes; roads, railroads and air fields, could affect caribou movements depending on locations and amount of use. The proximity of the calving grounds to the Watana impoundment is of concern because of its importance to the herd and the possibility that increased human access and activity could result in reduced use.

The Devil Canyon dam site and impoundment, if built alone, appears to have virtually no potential to impact Nelchina caribou. Conversely the Watana site would almost certainly have negative impacts although the extent cannot be predicted.

Wolf

During 1980, 23 wolves from five separate wolf packs were radio-collared in an effort to partially identify packs which could be impacted by Susitna hydroelectric development. An additional four or five wolf packs were suspected of occupying parts of the project area, but no wolves from these packs were captured because of both late arrival of telemetry equipment and poor snow conditions. Five hundred and fifty-six radio locations were obtained on the 23 radio-collared wolves during 1980.

History of the five radio-collared wolf packs prior to and during this study were provided in the body of the report. One territorial dispute between the Tyone Creek and Susitna wolf pack was described.

Territory sizes for the five studied wolf packs averaged 452 mi^2 and ranged from 212 mi^2 to 821 mi^2. Known and suspected wolf territories were mapped. Based upon track counts, public sightings and radio telemetry studies, it was determined that at least four and perhaps five wolf packs would be directly affected by the proposed impoundments. An additional five wolf packs could be indirectly affected by the proposed project if it results in lower moose densities or disrupts movement patterns of migratory moose. Two wolf packs located away from the study area were formed as a result of wolf dispersal from the Susitna area to adjacent vacant habitat. Known wolf territories were essentially nonoverlapping during any particular year.

A minimum of 40 wolves were known to inhabit the study area in spring 1980. By fall the packs had increased by 93 percent to an estimated 77 wolves.

Radio-collared wolves were observed on 48 kills during 1980. Moose of all age classes comprised 52 percent of the kills. Calves were the most common moose age class. Caribou of all age classes comprised 38 percent of the observed kills. The occurrence of caribou kills during 1980 was slightly larger than that observed in previous years. This was partially the result of increased availability of caribou during winter.

During 1980 two packs were intensively monitored to determine rates of predation on moose. Predation rates varied from 1 kill/4.0 days for a pack of four wolves to 1 kill/4.9 days for a pack of eight wolves. Moose counts were conducted in each pack territory and the observed numbers were compared with predation rates. It was concluded that these two wolf packs were a significant cause of calf (short yearling) mortality. Age, sex and physical condition of kills examined in situ were listed and have been analyzed in an earlier report (Appendix 1). Wolf scats were collected at den sites for food habits studies but the results were not available for this report.

The general locations of 17 wolf den and rendezvous sites which have been observed in the project area since 1975 were given. Thus far two wolf packs have been discovered which either have den or rendezvous sites in areas which would be directly impacted by the project.

During May and June 1980 activity patterns of the Susitna wolf pack were intensively studied. Two hundred twenty-seven hours of ground observation were made at the den site. Various associations of adult wolves present at the den site were described.

Continuous monitoring of radio signals from mid-May through early June revealed that the pack excluding the adult female was away from the den site during evening and early morning hours. It was recommended that project personnel avoid wolf den sites during May and June but if absolutely necessary, they should conduct activities near the den during hours when most adult wolves are away from the den. Conceivably this could reduce disruptions to pack members. Movement of pups to the first rendezvous site occurred in early June, probably in response to the presence of the observer at the den site. Subsequent observations revealed that no pup mortality had occurred. It is recommended that if work needs to be conducted near a den site, that personnel delay work until after 6 June. Since the Watana wolf pack would definitely be impacted by project activities, it is recommended that an activities study be conducted on those wolves.

The most important potential impact of the Susitna hydroelectric project on wolves would occur indirectly due to reductions in prey density, particularly moose. Disruption of movements or reductions in migratory moose densities may reduce wolf densities for considerable distances away from the areas actually inundated. Temporary increases in wolf density may occur in the project area due to the displacement of moose and caribou from the impoundment areas. Direct inundation of wolf habitat, particularly den and rendezvous sites, may also lower wolf densities. Additional wolf mortality will probably occur due to increased hunting and trapping activities resulting from publicity concerning the area's wildlife and as access becomes developed.

Some additional data needs for evaluating the impacts of the proposed project on wolves were identified.

Wolverine

During April and May 1980, five adult wolverine were captured and four (3 males, 1 female) were radio-collared. Eighty-six radio locations were obtained during 1980.

Yearly home range sizes for male wolverines 040 and 043 were 154 mi^2 (399 km^2) and 105 mi^2 (272 km^2), respectively. The summer home range for lactating female 042 was 33 mi^2 (86 km^2). Summer movement patterns of the three male wolverine seemed to be influenced by the Susitna River. Only three occurrences of river crossings were documented during the study period. Within their home ranges, all radio-collared wolverine showed a fidelity toward upland shrub (willow-birch) habitats and toward southerly and westerly slopes.

All three male wolverine displayed a gradual change in their home range usage. Seasonal preferred areas are suspected to be related to the breeding period and timing of ground squirrel emergence and caribou calving.

Ground tracking during May and December, 1980 indicated wolverine dependence on small mammals.

Potential impacts on wolverine by the Susitna hydroelectric project include the following: loss of habitat due to inundation, and road and transmission line construction; a probable reduction in prey densities; increased competition with other scavengers and predators; and a readjustment of home range size and seasonal movements.

There is evidence that wolverine are intolerant of human disturbance. Impacts from disturbance might be influenced by timing and placement of construction activities. For example activities on southerly and westerly slopes are more likely to affect wolverines than are those on northerly or easterly slopes.

Bear

Both black bear (*Ursus americanus*) and brown bear (*U. arctos*) populations in the vicinity of proposed Susitna hydroelecrric dams appear to be healthy and productive. Brown bears are ubiquitous throughout the study area while black bears appear largely confined to a finger of forested habitat along the Susitna River. This finger becomes progressively narrower proceeding upstream. In 1980, 27 brown bears and 27 black bears were captured and marked utilizing helicopter darting techniques. Adults were radio-collared and periodically relocated. A total of 143 point locations were obtained for brown bears in 1980, 120 of these from 15 radio-collared individuals. A total of 229 point locations were obtained for black bears in 1980, 181 of these from 23 radio-collared individuals. Only preliminary and general comments are offered from these data, more detailed analyses await completion of computer digitization procedures, collection of more point-location records, and integrated analyses with vegetation data.

Brown bear use of areas directly impacted by proposed impoundments appeared greatest in the early spring following emergence from dens. We speculate that brown bears may have been attracted to these areas in the spring by the early availability of both vegetable and animal foods. Important vegetable foods may include berries from the previous year, tubers, fresh grasses and sedges which may be available earlier in these areas because of earlier snow melt. Animal foods utilized in these areas may be winter-killed or weakened moose and, somewhat later, moose calves. It is suggested that the proposed impoundments may reduce the extent and utility of these habitats occupied by many brown bears in the study area.

Denning sites of nine radio-collared brown bears in the winter of 1980-81 suggest that the proposed impoundments will have little impact on availability of adequate brown bear den sites.

The most interior run of salmon in the study area occurs at Prairie Creek, a feeder stream running from Stephan Lake to the Talkeetna River. Four of 11 radio-collared brown bears moved to Prairie Creek during the salmon run in July and August, we estimate no fewer than 30 brown bears fished here in 1980. Brown bear movements to or from Prairie Creek may be inhibited by impoundments or impoundment access routes, thereby reducing the availability of this salmon resource to some study area bears.

Studies in the headwaters of the Susitna River conducted in 1979 (Miller and Ballard 1980) estimated a brown bear density of 1 bear/41-62 km^2. We suspect that brown bear density in the impoundment area is roughly comparable to that in the area of the 1979 study. If so, the impoundment study area of 3,500 mi^2 contains approximately 70 brown bears.

Capture and relocation records for black bears suggested that black bear distribution in 1980 was largely confined to or near the spruce forests found in the vicinity of the Susitna River and its major tributaries. These are the habitats which will be maximally impacted by the proposed impoundments; the restricted nature of black bear distribution in the study area suggests that these populations may be highly vulnerable to habitat losses by inundataion as well as by disturbances associated with construction and improved access.

Within the spruce habitats inhabited by black bears, utilization appears most prevalent in the early spring. In late summer 1980 many black bears moved to the more open shrublands adjacent to the spruce forests. This movement appeared motivated by the greater prevalence of berries (*Vaccinium*) in these areas relative to the spruce forests.

Black bears crossed the Susitna River more frequently than brown bears. This result probably reflects the relative proximity of black bear home ranges to the river. The motivation or importance of these river crossings for black bears is not known, neither is it known whether the proposed impoundments would represent a significant barrier to such crossings.

All five of the radio-collared black bears with 1980 dens in the vicinity of the Watana impoundment denned below 2,200 feet elevation, the proposed high water mark of the Watana impoundment. Two of nine black bears denning in the vicinity of the Devil Canyon impoundment denned below the proposed high water mark (1,450 feet); the average elevation of nine of these dens was 1,935 feet (1,300-2,750 feet). Nine of 14 black bear den sites were in spruce habitats and five were in shrubland habitats adjacent to spruce habitats. Based on these data it appeared clear that many current den sites utilized by black bear in 1980 would be inundated by the proposed impoundments. The impact of this den inundation on black bear populations is unclear, clarification will be obtained in 1981 when these den sites will be visited and their characteristics described.

Black bear density appeared variable throughout the study area. A very rough estimate of 1 bear/4.1 km^2 was offered for one area of relatively high density.

Dall Sheep

An aerial survey of known or suspected Dall sheep habitat in the vicinity of the proposed Susitna Hydroelectric Project was conducted in July 1980 to delineate sheep distribution. Three discrete areas of habitat were identified. Sheep in all three areas may be subject to disturbance from construction activities, helicopter traffic or access routes although disturbance may be reduced or eliminated through routing or scheduling of human activities.

Sheep occupying the Watana Creek hills were observed in habitat that might be inundated by the proposed Watana impoundment. Little is known about the importance of this habitat to the population but it is possible that some attractant such as a mineral lick occurs there. If so, assessment of the impact of the Susitna Project on this sheep population will be more complex than anticipated and an expansion of the scope of the study will be necessary.

CONTENTS

SUSITNA HYDROELECTRIC PROJECT
ANNUAL PROGRESS REPORT

BIG GAME STUDIES

PART I BIOMETRICS AND DATA PROCESSING

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SUMMARY

The data processing and analysis requirements of the big game studies are identified and discussed. Technical and conceptual problems associated with those requirements are outlined and proposed solutions presented. Computer resource requirements are identified and the progress to date in acquiring those resources and developing a production system is reported. Sample products are included.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

The objective of the biometrics and data processing project is to provide technical assistance in the quantitative and information-management aspects of the big game studies. The time constraints, volumes of data, and reporting requirements associated with the Susitna Hydroelectric Project Impact Assessment studies mandate the development of efficient and accurate means of recording, analyzing, displaying and reporting the data collected. This can only be done by means of electronic data management systems.

Four major aspects of the big game studies have been identified as requiring support from the biometrics and data processing project:

1. Animal Distribution Analyses - Radio telemetry techniques are being used by all the principal investigators. The large numbers of animals fitted with radio collars and the numbers of observations per animal dictate that automated means be used for data analysis and display. The cartographic nature of radio telemetry data creates special problems in data processing which require use of specialized computer resources.

2. Habitat Selectivity Analyses - An important component in evaluation of the potential impacts of dam construction is understanding how the various species utilize the landscape available to them. The radio telemetry data is used to identify where animals are located and, in some cases, the activities in which the animals are engaged at that spot. However, in order to identify those elements of the landscape which influence animal distributions and movements, it is necessary to relate those observations to

the total landscape available to each animal. Several conceptual and technical problems are associated with such analyses.

3. <u>Species Interaction Analyses</u> - The direct impacts of the proposed hydroelectric project will undoubtedly vary among the big game species. However, close ecological relationships between species (e.g. predator-prey interactions) can result in indirect impacts which may not be immediately apparent with single-species analyses. The complexities of such analyses require the use of systems analysis techniques and specialized computer resources.

4. <u>Basic Data Processing and Analysis</u> - Direct assistance to principal investigators in data processing and analysis is provided in the form of sampling designs, data collection and analysis techniques, statistical analyses and computer software.

RESULTS AND DISCUSSION

In the first year of Phase I studies the biometrics and data processing efforts have concentrated on development of techniques and procedures designed to meet the objectives outlined above. Delays in obtaining personnel and access to needed computer resources have resulted in little actual analysis being accomplished in the first year, but substantial progress has been made in development and many kinds of analyses appear ready to begin early in the second year of Phase I studies. The following is a brief discussion of these techniques and procedures.

Data Entry of Radio Telemetry Observations

Each time a marked animal is relocated the observer pinpoints the location on a map and records pertinent descriptive information (identity, behavior, associations, habitat, environmental factors, etc.) on a field form.

The types of descriptive information recorded varies between species. In order to facilitate analysis, the cartographic information about the location of the animal must be associated with the descriptive information. This process requires handling the two types of information separately for data entry and conversion, and subsequently merging them for data analysis.

Descriptive data are transcribed onto standardized forms by the principal investigators. These data are subsequently key-punched and entered on the IBM computer at the Department of Administration, Division of Data Processing, Anchorage. A magnetic tape of these data is created and the information transferred to the Department of Natural Resource's geoprocessing center for analysis.

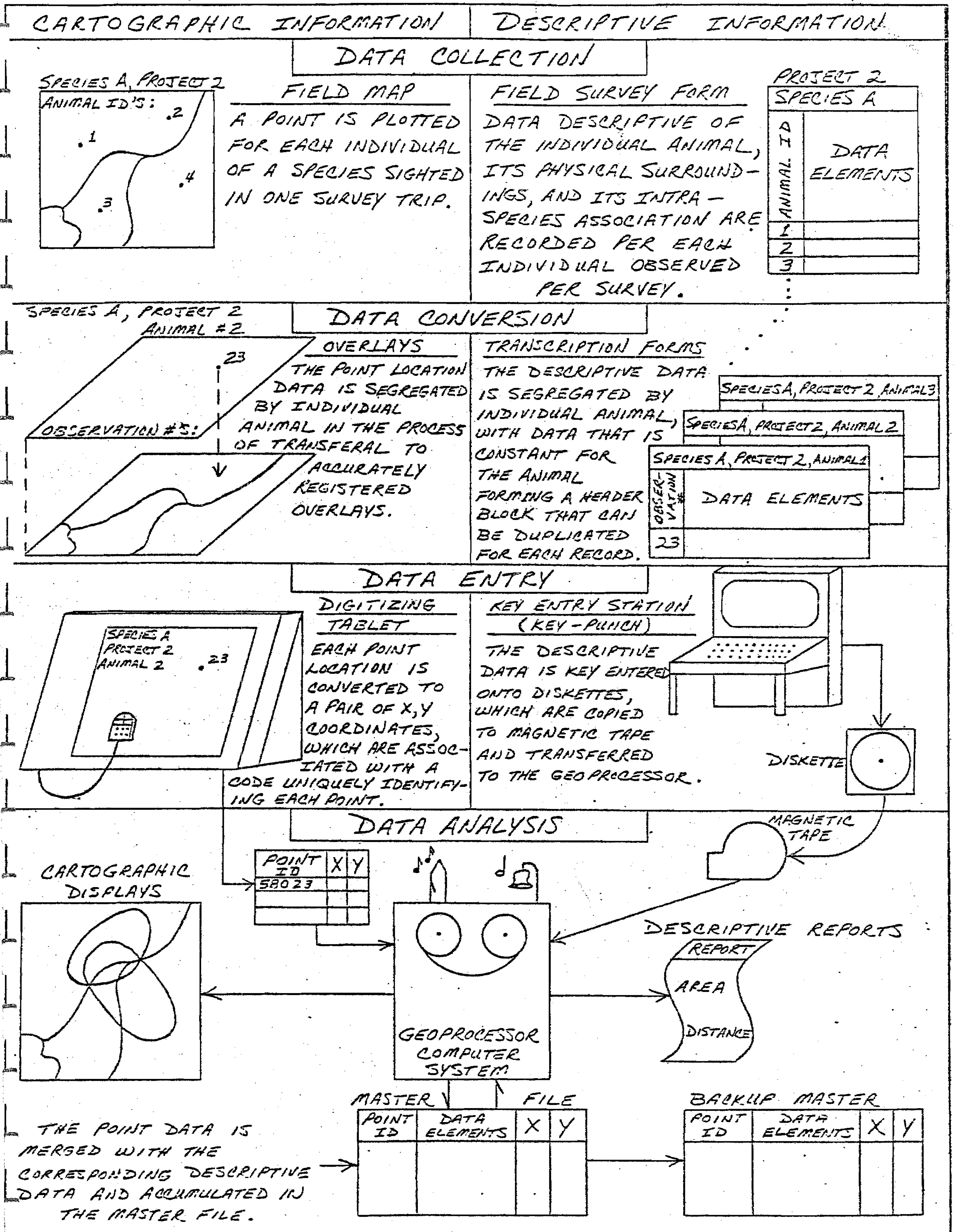
Cartographic information is converted to digital, x-y coordinates through the process of digitization. This involves placing a map on a digitizing table which, with the use of an electronic tracing tool known as a cursor, records the two-dimensional coordinates of a given location relative to known reference points. Defining the reference points requires registration of each map each time it is placed on the digitizing table. To avoid having to register the same map for every individual animal with sightings on that map, points of sightings are transferred from maps used in the field to mylar overlays, one for each individual animal for every base map on which it has been sighted. Digitization is done from these mylar overlays at the Department of Natural Resource's geoprocessing center, with registration of each base map required only once for each corresponding set of overlays.

The cartographic information from digitization is then combined with the descriptive information in a master file. This master file is continually updated as new information is gathered. A backup copy of the master file is created after each update. A flow diagram for the data entry process is given in Figure 1.

Data Analysis of Location Information

The Department of Natural Resource's geoprocessor was especially designed for automated analysis and display of geographic-based information. The geoprocessor is a mini computer with an array of associated peripheral devices such as a tape drive, disk unit, digitizer, lineprinter, computer terminals and an x-y drum plotter for drawing high quality color graphic displays on paper or mylar. The system includes a versatile set of computer programs (software) for performing functions on map-based information. These functions include calculating polygon-line interactions, polygon-polygon intersections, unions and relative differences, scale conversions, directions and distances between points and areas.

Figure 1. Data Entry of Radio Telemetry Observations



Additional programs are available to perform functions on descriptive data such as sorting, selecting subsets, report writing, and mathematical calculations. User-specific software can also be written and integrated into the system.

Before committing the Big Game studies to utilization of the geoprocessor for data analysis, a pilot project was undertaken. This was intended to provide project personnel with the opportunity to gain a better understanding of its capabilities and limitations, and to iron out potential technical difficulties prior to actual use on real information. The pilot project consisted of creating a "dummy" set of animal sightings and going through the process of data entry and analysis. Three individual animals, two moose and one wolf were created with 25 sightings each. Descriptive data forms for each animal were created and observation points mapped on two USGS 1:63,360 scale maps. In developing the pilot project, several new computer programs had to be developed to perform the task of merging the cartographic and descriptive files. These programs have been tested and the system is now ready for the data entry process as previously outlined.

Several major problems have yet to be solved, for example, means of lumping observations in a meaningful fashion in order to define home ranges or areas of use. In the pilot project, home range ploygons were defined by connecting the outermost points with straight lines. Computer-generated plots of each of the three pilot animals are shown in Figure 2. The area of each polygon and the areas of overlap, determined by the geoprocessor, are given in Figure 3. Other methods of describing areas of use may ultimately prove to be more meaningful, for example, ellipses encompassing a certain percentage of point locations.

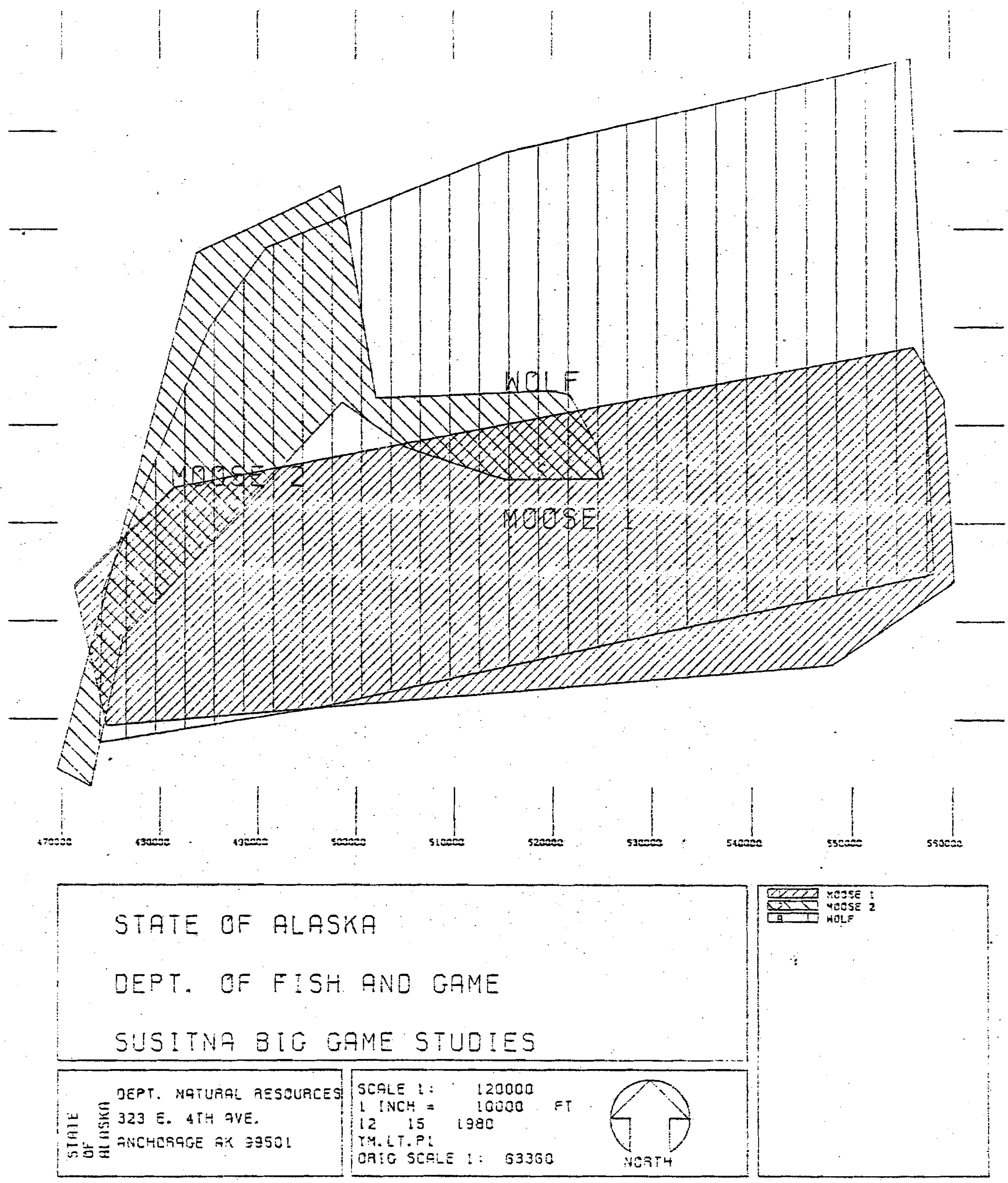


Figure 2. Sample of Computer Generated Plots of Home Ranges

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*          P O L Y G O N   L A B E L   R E P O R T          PAGE  1  *
*                                                                     *
*          ALASKA DEPARTMENT OF NATURAL RESOURCES         12 15 1980 *
***********************************************************************
* SUBPROJECT#=    0       FILE NAME = YM.P1          XMIN   = 469559 *
* ITEM NO.    =    1      DATA TYPE     = MOOSE+     XMAX   = 560259 *
* GEOCODE     =    0      # OF LABELS  =       0     YMIN   =2833161 *
* TOPIC CODE =  .00       # OF POLYGONS=       3     YMAX   =2907367 *
* FILE TYPE   =   35      TOTAL AREA =    163557     SCALE =   63360 *
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*  NUM        NAME       AREA       POLYS        AREA      POLYS      *
*                                                                     *
*    1  MOOSE1          52880.79       1          32.33    33.33      *
*    2  MOOSE2          18842.15       1          11.52    33.33      *
*    9  WOLF            91834.81       1          56.15    33.33      *
*                                                                     *
*          3 POLYGONS ON MAP TOTALING      163557.70 ACRES            *
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Figure 3. Sample of Computer Generated Analysis of Home Ranges

Habitat Selectivity Analyses

The radio telemetry observations provide information on where selected animals are at specific times. In order to utilize this information to analyze habitat selectivity by the various species several assumptions about these observations must be made, and information about areas where animals are not located is required.

The necessary assumptions are:

1. The individuals which have been radio-collared represent a random sample from the population. This assumption may be violated if, during the capture process, certain individuals or groups of individuals have different probabilities of being captured. Females with young, for example, may be more secretive and less prone to capture in some species.

2. The observations of an individual radio-collared animal represent a random sample from the distribution of that individual. All radio telemetry observations are made with the use of aircraft. The locations of individuals during times when the use of aircraft is not possible (e.g. inclement weather, hours of darkness) may differ substantially.

With these assumptions it is possible to compare areas which are utilized with those areas which are not utilized. However, several difficulties still remain. These include:

1. Determining the total area available to an individual. This is an obvious requirement for the basis of the comparison. It makes little sense to compare areas which are utilized with areas which are not available to be selected.

2. Accurately describing the landscape features. The particular components of the habitat which motivate selection may not be obvious nor easily quantifiable. They may also vary with temporal conditions.

Two techniques for analyzing habitat selectivity are being considered. The first involves expanding the use of the geoprocessor to include landscape features. This would require that the landscape attributes be spatially defined and entered into the system via digitization. The level of resolution required and the complexity of the attributes would determine the level of effort necessary to accomplish this task. For example, topographic features could be digitized from standard U.S.G.S. maps. However, capturing all the detail present in these maps would require an excessive effort and create data processing problems because of volume. Also, not all landscape features lend themselves to precise spatial definitions. Vegetation, for example, often occurs along continuums. Aerial photos are being used by the Agricultural Experimental Station to create vegetation maps, but these are limited primarily to overstory vegetation.

While the geoprocessor is an effective tool to overlay animal locations on landscape features, the degree of accuracy required to provide meaningful results is often beyond the level of the original maps. Extensive editing and integration of various maps may be required. For example, when vegetation maps made from aerial photos are electronically overlayed onto topographic maps, boundaries around water bodies and other dominant features rarely match up initially. Similarly, the ability of the observer tracking radio-collared animals to accurately pinpoint the location on a map can greatly influence the results. Likewise, the description of the habitat recorded by the observer at the time of sighting may not coincide with that entered from vegetation maps made from aerial photos.

Considering the problems associated with this technique for habitat selectivity analysis, it was decided that this technique would be applied on a trial basis only. Once the vegetation maps are made available by the Agricultural Experimental Station, landscape features for the area of impoundment will be digitized. This technique will then be evaluated before expanding into areas outside the impoundments.

The second technique for habitat selectivity analyses arose from consideration of the difficulties associated with the first technique. The basic premise of the second technique is that the most accurate information on the landscape features utilized by the various species is obtained from the observer recording the sighting. The process of transferring this information to maps introduces additional error. The second technique avoids this error by comparing landscape features at randomly selected points with those where animals were observed.

The experimental design for the second technique is as follows. The study area will be divided into sampling units based on ecological factors. Sample units will vary in size and shape and will be constructed such that it is reasonable to assume that the entire sample unit is available to any individual animal located in it. Once an animal observation has been made in a sample unit, random points will be selected within the sample unit. Observers will drop a marker from the aircraft at each random location and record the same landscape information as is recorded for animal sightings. The number of random locations selected will depend on the homogeneity of the sample unit and required accuracy. Standard statistical techniques will be used to compare the random locations with the animal observations.

Species Interaction Analyses

Computer simulation modelling is an effective technique for analyzing species interactions. The most cumbersome aspect of simulation modelling is the computer program development. Specialized computer software for simulation modelling is commercially available. These software packages provide the user with program flexibility, enhanced output capability in the form of graphics, and streamlined input procedures which greatly reduce the effort required for program development. However, the majority of the commercial packages are aimed at economic and business applications. It is, therefore, necessary to develop our own simulation software package. Specifications for the software are presently being developed. Several months of program developement and testing will be required to produce an operational system. Once this system is in place, simulation modelling of species interactions can proceed rapidly and efficiently.

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SUSITNA HYDROELECTRIC PROJECT
ANNUAL PROGRESS REPORT

BIG GAME STUDIES

PART II MOOSE - DOWNSTREAM

Paul D. Arneson

ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the
Alaska Power Authority

March 1, 1981

SUMMARY

Moose populations in the Susitna Valley were relatively small in the early 1900's. Extensive man-altered habitats greatly increased the size of the moose herd. Although the absolute identity of this population is unknown, it does not appear that the lower Susitna River population mixes with the Matanuska Valley and Peters-Dutch Hills populations.

Deep snow in winter has been documented as a cause of migration from rut and post rut areas in the Talkeetna Mountain foothills to the Susitna River and vicinity. No studies have determined the relative use by moose of the Susitna River floodplain versus upland habitats near the river.

This study will attempt to determine the identity of moose populations using the lower Susitna, the seasonal distribution and movement patterns of moose, the relative magnitude of moose use of the Susitna floodplain and the relative use of habitats by moose on the lower Susitna. Additionally, the food habits, relative condition and productivity of the moose herd will be studied.

In April 1980, 10 moose were immobilized by helicopter and equipped with radio/visual collars. Various biological specimens were taken from the moose at the capture site. Periodic relocation flights were conducted to determine each moose's location, the date, time, activity, association with other moose, habitat type in which it was found, elevation, slope, aspect and other environmental parameters. These data were re-recorded in the office and will be stored on a geoprocessor and other computer equipment.

For browse availability/utilization transects on the overall study area, an area 1 m X 10 m was searched for browsed and unbrowsed plants and an area 2 m X 10 m for pellet groups along

the entire length of the transect. On the Sheep Creek Study Site, 10 transects were selected and 2 X 2 m plots every 20 m determine browse availability and utilization while circular plots 2 m in radius were used to determine the number of pellet groups.

Five browse species were recorded: Willow (*Salix* sp.), cottonwood (*Populus balsamifera*), paper birch (*Betula papyrifera*), highbush cranberry (*Viburnum edule*) and rose (*Rosa acicularis*). Four densities, four heights and species makeup determined the habitat type.

<u>Moose movements</u> - Only 10 moose were radio-collared because only resident moose may have been captured on the late date of the collaring operation--17 April 1980. A map and explanation of each moose's movement patterns is given.

A wide variety of migratory patterns was documented. Some moose spent the entire year in the vicinity of the river. Others moved half way between the river and the Talkeetna Mountains and remained there. Two moose summered west of the Susitna but spent the rut in the Talkeetna Mountain foothills. One bull went immediately to the mountains and remained there from early spring to mid-winter. Another bull north of Talkeetna moved up and down the river drainage getting as far up river as the proposed dam site. The longest movement between relocations was 40 miles.

The use of the river's islands for moose calving was documented but not quantified. Summer use of the river by moose may be low especially as flooding progresses. Hunter kills of moose along the Susitna indicated fall use on or near the river by moose.

The timing of relocation flights during the midday period may have biased observations of habitat use. Moose were seen in dense or medium climax mixed birch/spruce 46 percent of the time, but they may have used it more for cover and not foraging.

Browse availability/utilization - On the overall study area (OSA) dense-climax cottonwood/spruce and sparse-low cottonwood/willow/alder were the most frequently encountered habitats. In the Sheep Creek Study Site (SCSS) dense-medium and dense-tall cottonwood/willow/alder were the most abundant habitat types.

A mean of 1.4 browse plants/m^2 was recorded for all habitat types in the OSA, and many habitats had browse densities close to that value. Browse species were most utilized in equisetum/willow and medium-tall cottonwood/willow/alder habitats and least utilized in medium-dense climax cottonwood/spruce and sparse-climax birch/spruce.

Willow and cottonwood occurred most frequently in habitats that were early successional stages of cottonwood/willow/alder. Percent utilization of these two species, however, was greatest in habitats in which they less frequently occurred. Birch was seldom found on floodplain habitats, but where it occurred near the river, it was well utilized (26.9%). Highbush cranberry and rose were found most in tall or climax habitats. Mean densities for highbush cranberry and rose were higher than those of willow and cottonwood. The mean utilization of highbush cranberry was similar to that of cottonwood but both highbush cranberry and rose had lower utilization than willow.

On the SCSS as in the OSA, about 20 percent of available browse plants were utilized. Dense-medium cottonwood/willow/alder contained the greatest density of browse plants but medium-tall cottonwood/willow/alder had the highest utilization of it's available browse.

Approximately one-third of available willow on the study site was utilized by moose. Willow was most dense (2.4 plants/mon dense-medium cottonwood/alder/willow but utilized most (70.3%) on medium-climax cottonwood/willow/alder. Cottonwood was less dense than willow and utilized much less (only 8.5%). No birch was found on the SCSS. As in the OSA, highbush cranberry and rose were most abundant in climax type habitats. There were mean densities of 1.5 and 1.0 plants/m^2 for the two species, respectively. Highbush cranberry was utilized twice as much as rose (16.3% vs 8.3%).

General observations indicated that alder was seldom browsed by moose but in some localities a small alder clump could be heavily browsed. Some islands with good moose browse were not used by moose every winter. Moose sign indicated heavy use in the past but no use at the time of observation.

Preliminary statistical tests were conducted on the data concerning percent utilization of browse species. Significant differences in utilization of browse was shown between several pairs of habitat types. More statistical analysis is warranted and planned.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

In the early 1950's, the Susitna Valley was termed "probably the most productive moose habitat in the [Alaska] Territory" (Chatelain 1951). It wasn't until man-caused fires and clearing of land during and after railroad construction created prime moose habitat that the moose population rapidly increased. Prior to 1930 few moose were found in the Valley (Spencer and Chatelain 1953). At that time moose likely utilized riparian habitats and what few browse species were available in the mature spruce-hardwood forest. With the creation of new habitat, the moose population expanded and presently remains at relatively high levels.

The identities of moose populations that may use the Susitna River during some stage of their life cycle have not been determined. Moose in peripheral areas have been studied and do not appear to mix with populations that are found in the Susitna Valley from the Deskha River on the south to Portage Creek on the north. An extensive collaring project in the Matanuska Valley in the late 1960's revealed that most moose remained in the Valley. Only three were known to emigrate out of the tagging area; one to Mt. Yenlo and two to Mt. Susitna (Rausch 1971). However, only visual collars were used, and observations normally occurred only on the wintering grounds. A radio and visual collaring project was conducted in 1975-1977 in the Peters-Dutch Hills area northwest of the Susitna River (Didrickson and Taylor 1978). No marked moose were known to have moved eastward to the Susitna River.

Therefore, the moose herd north of Willow to the proposed Devil Canyon is likely a discrete population although various subpopulations likely exist within the overall population. The greatest number of animals spend the rutting period on the western foothills of the Talkeetna Mountains. Many remain in that vicinity until deep snow covers their forage, and they must migrate to lower elevations where riparian and disrupted habitats provide suitable winter forage.

Because no surveys have been conducted in the past to determine winter moose use of riparian habitats of the Susitna River, the only data we can use as an indicator of moose presence on or near the river are records of railroad and highway killed moose and documentation of dead moose on the river's islands during a severe winter in 1970-71. When deep snows persist in the Willow to Talkeetna areas, the incidence of railroad and highway killed moose increases substantially. The most recent example of this is in the winter of 1978-79 when at least 171 railroad-killed moose were documented after a moderately heavy snow year. The following winter 1979-80 when much less snow fell, only 5? moose were recorded as railroad mortalities. During surveys in April 1971 following the severe winter of 1970-71, 155 winter-killed moose were tallied on the Susitna River and its tributaries. As stated by LeResche et al. (1974), "During harsh winters, river 'bottoms' become yarding areas for high densities of moose. When deep snow persists, overbrowsing may occur, and these areas have been the scenes of the most spectacular moose die-offs recorded in Alaska...riparian communities are the habitat of last resort for wintering moose." Winter range is widely considered a limiting factor in the welfare of moose and other ungulate populations.

Because moose are dependent upon secondary successional stages of vegetation for their winter forage, their winter range must be periodically disrupted by fire, land clearing, beaver activity or flooding in order to create the necessary transitory stage of vegetation (Chatelain 1951).

No research has been conducted to determine moose use of the important riparian winter range along the Susitna River, and only a few studies and quantitative records are available for that moose population in general. Chatelain (1951 and 1952) and Spencer and Chatelain (1953) reported on the early history and habitat use of moose in the Susitna Valley. Rausch's (1959) research dealt with various parameters of population dynamics of the moose herd in the Matanuska and Susitna Valleys. Bratlie (1968) further summarizes the status of the lower Susitna and Matanuska moose herds through 1967. LeResche (1974) briefly summarized the status of the Susitna moose. Since that time, the only information gathered concerning the welfare of the lower Susitna moose population has been the sex and age composition counts conducted most every fall, harvest data and some age data from railroad-killed moose.

When planning began for downstream moose studies on the proposed Susitna Hydroelectric Project, it was known that a paucity of quantitative data was available for the area of greatest impact and importance on the lower river. Therefore, basic research had to be initiated to meet the most obvious objectives. As the project continued, these objectives were periodically changed to meet changing conditions such as weather, logistics and other factors. The primary objectives of the study are:

1. To determine the identity of moose subpopulations using the lower Susitna.

2. To determine seasonal distribution and movement patterns of these moose subpopulations.

3. To determine the relative magnitude of moose use of the lower Susitna.

4. To determine the relative use by moose of various habitats along the lower Susitna and nearby areas.

5. To summarize historic data as it pertains to the above objectives.

Secondary objectives are:

1. To determine food habits of moose using the lower Susitna versus those using nearby areas.

2. To determine the relative condition and productivity of the moose herd of the lower Susitna and vicinity.

During the first year of study, 4 of 5 primary objectives have been partially fulfilled. Objective No. 3 will be accomplished in late winter if conditions permit.

STUDY AREA

In the broadest sense, the study area was defined as the floodplain of the Susitna River below the proposed Devil Canyon dam, and those areas included in the home range of moose radio-collared on the Susitna River. In a practical sense, the study area was reduced to that portion of the Susitna River from approximately Portage Creek south to the Delta Islands. This portion of river was further subdivided into three physiographic sections: 1. From Portage Creek to the confluence of the Susitna and Chulitna Rivers near Talkeetna, 2. From Talkeetna to the mouth of Montana Creek, and 3. From the mouth of Montana Creek to the southern end of Delta Islands (Fig. 1).

In addition, a specific study site consisting of several islands was selected near the mouth of Goose Creek and the north end of Sheep Creek Slough.

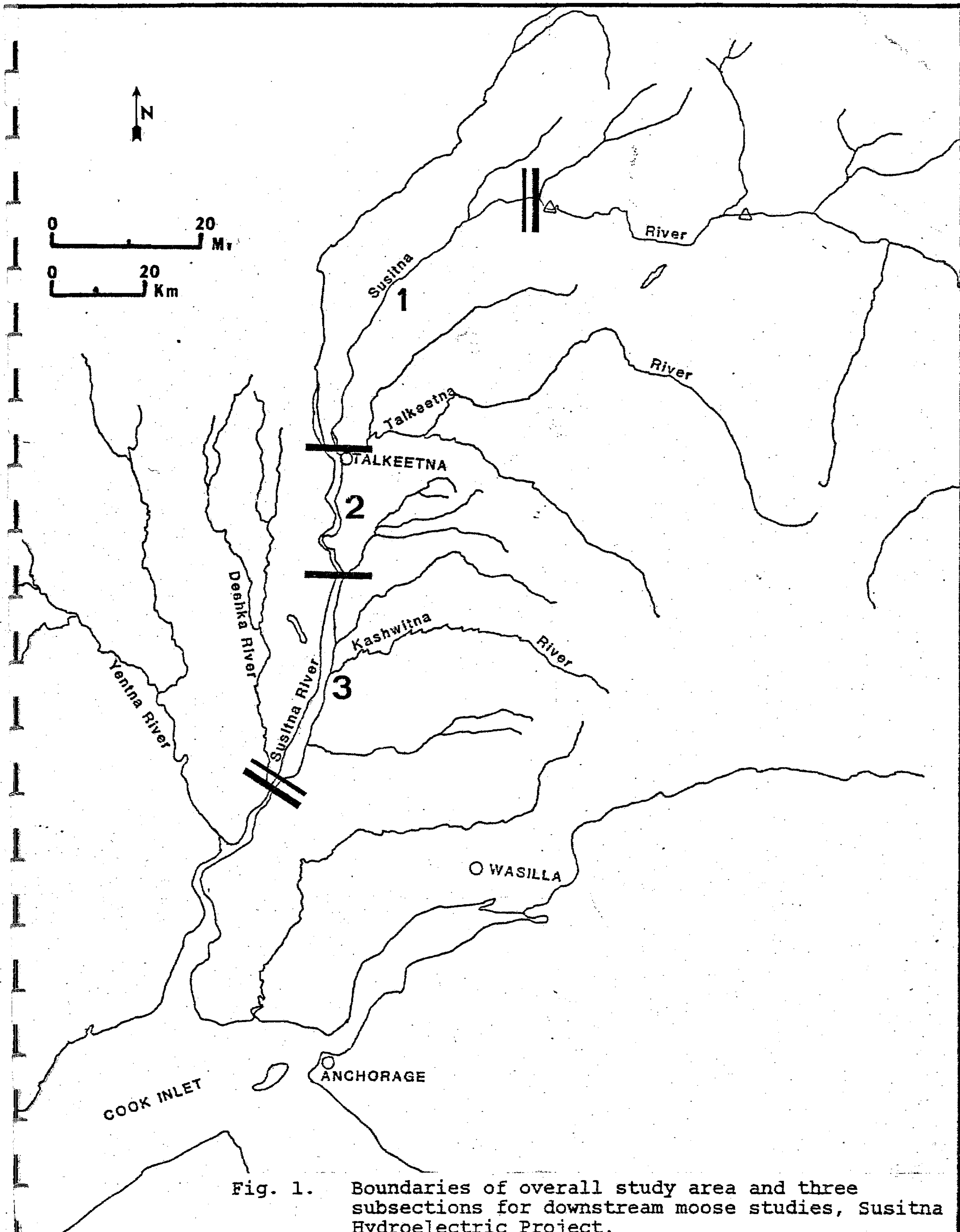

Fig. 1. Boundaries of overall study area and three subsections for downstream moose studies, Susitna Hydroelectric Project.

METHODS

Moose Movements

The study began in April 1980 when 10 moose were captured: three in the upper section (1 bull, 2 cows) north of Curry, three in the middle section (2 bulls, 1 cow) plus one cow was collared at the middle-lower section boundary, and three in the lower section (1 bull, 2 cows) near the mouth of Sheep Creek. All were darted from a helicopter using 9cc M-99 and 1cc Rompun. Besides placing a radio/visual collar on each moose, orange ear-flagging and a metal tag was placed in both ears. Blood, hair, a tooth and feces were collected from each moose, various morphometric measurements were made and each cow was palpated to determine pregnancy status. When given the antagonist M50-50 each moose recovered in a normal amount of time, and no mortalities occurred in the tagging operation.

Relocation flights of the radio-collared moose began 29 April 1980. Aircraft for these flights were: Cessna 172 and 180 and PA 18-150. Flights were conducted at approximately 10 day intervals during summer and fall and at 15 or more day intervals in winter when moose were not making long movements between relocations.

At each radio-relocation of a collared moose the following parameters were recorded: Date, time, location, visual relocation, antlers present, activity, number of young, association with other moose with a sex and age breakdown, habitat type, elevation, slope, aspect, weather conditions including snow cover and whether a photograph was taken.

After each flight the animal locations were plotted on 1:63,360 USGS Quad maps, and the data were organized on keypunch forms. Later, location data will be digitized on a geoprocessor to facilitate analysis. Other data from each observation of radio-collared moose will be computerized at a later date.

Browse Availability/Utilization and Pellet Counts

Techniques to be used in spring pellet group counts and browse utilization/density studies were researched and several experts in that field were contacted. Several designs were discussed, but it was decided that each project is unique, and methods of this type need to be "tailormade" for the project. Therefore, several methods were tried during spring 1980 to determine which was best suited for the habitats involved and which were best suited for the degree of moose use in the area. Areas determined to have the greatest variance this year will be sampled with greater intensity next spring 1981.

In the initial survey of the river, transect lines were randomly selected in the upper, mid and lower portions of each of the three sections (Figs. 2 and 3). Transects followed existing section lines. On these transects the number of browse plants available to moose and the number actually browsed by moose (or hare and beaver) were recorded on a strip 1 meter wide along the entire transect, but the transect was divided into 10 meter sections. Pellet groups were counted in a 2 meter width in each of the 10 meter sections. The habitat type in each 10 meter section was also recorded. Only the first 100 meters of upland habitat on opposite banks of the river were surveyed at each transect.

For the second portion of the study, one study site was selected near the mouth of Sheep Creek. Ten transects were randomly selected on the study area (Fig. 4). Along each transect a 2 X 2 meter plot was used every 20 meters to record the browse availability/utilization. At the same location a 2 meter radius circle was used for pellet groups. The smaller plot size was chosen to better fit within given habitat types.

Five browse species were considered: willow (*Salix* sp.), cottonwood (*Populus balsamifera*), paper birch (*Betula*

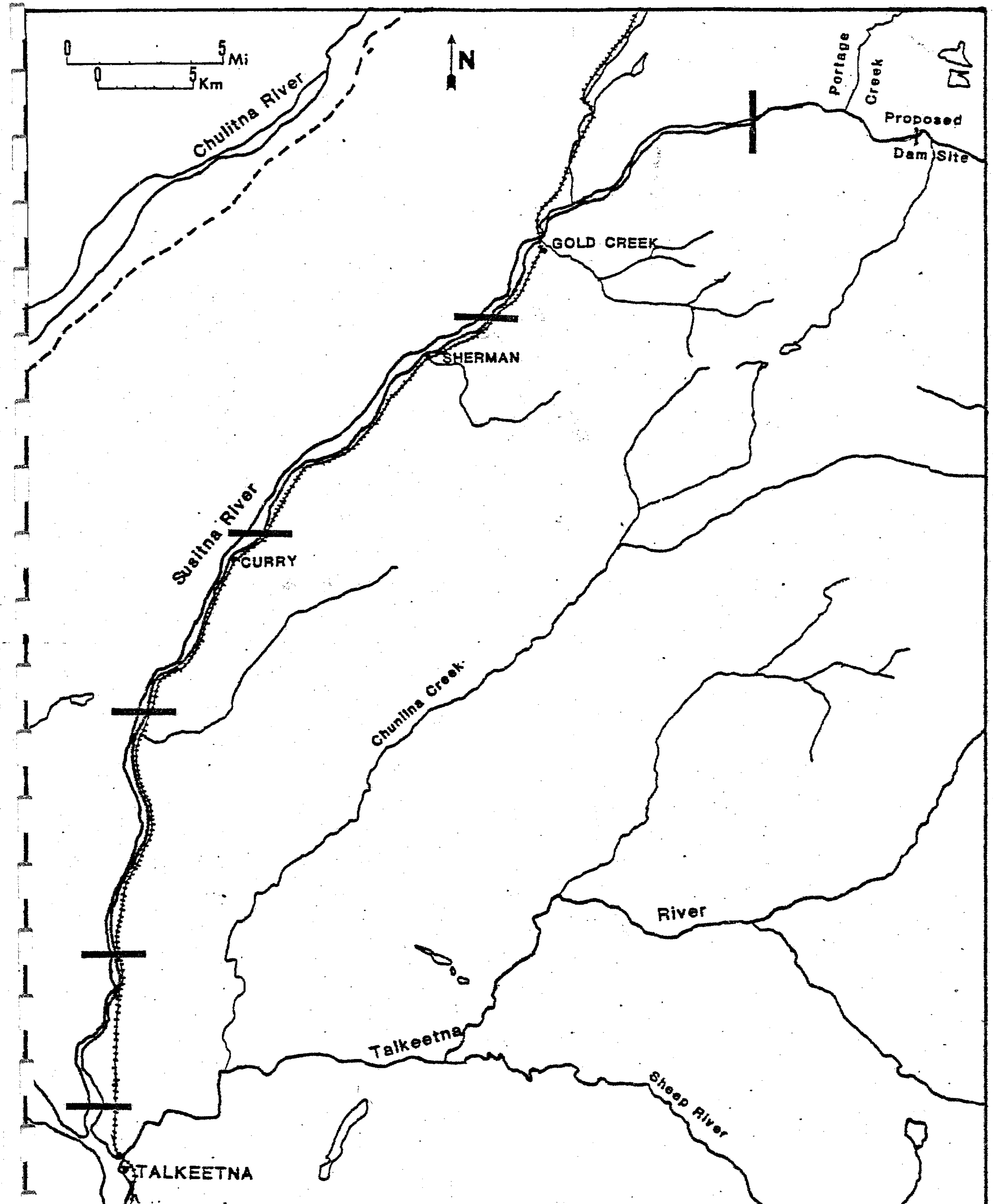

Fig. 2. Locations of browse availability/utilization and pellet group transects north of Talkeetna.

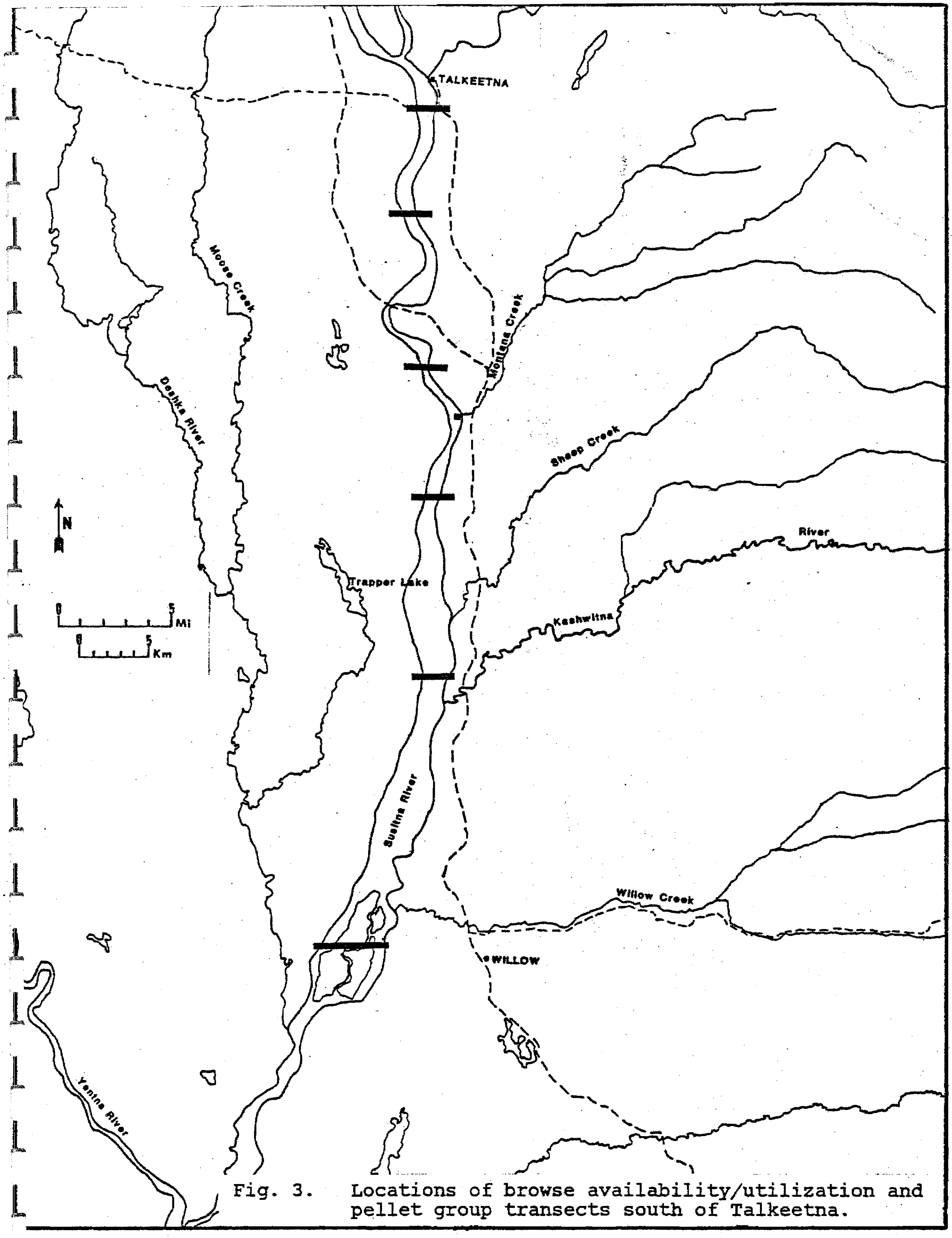

Fig. 3. Locations of browse availability/utilization and pellet group transects south of Talkeetna.

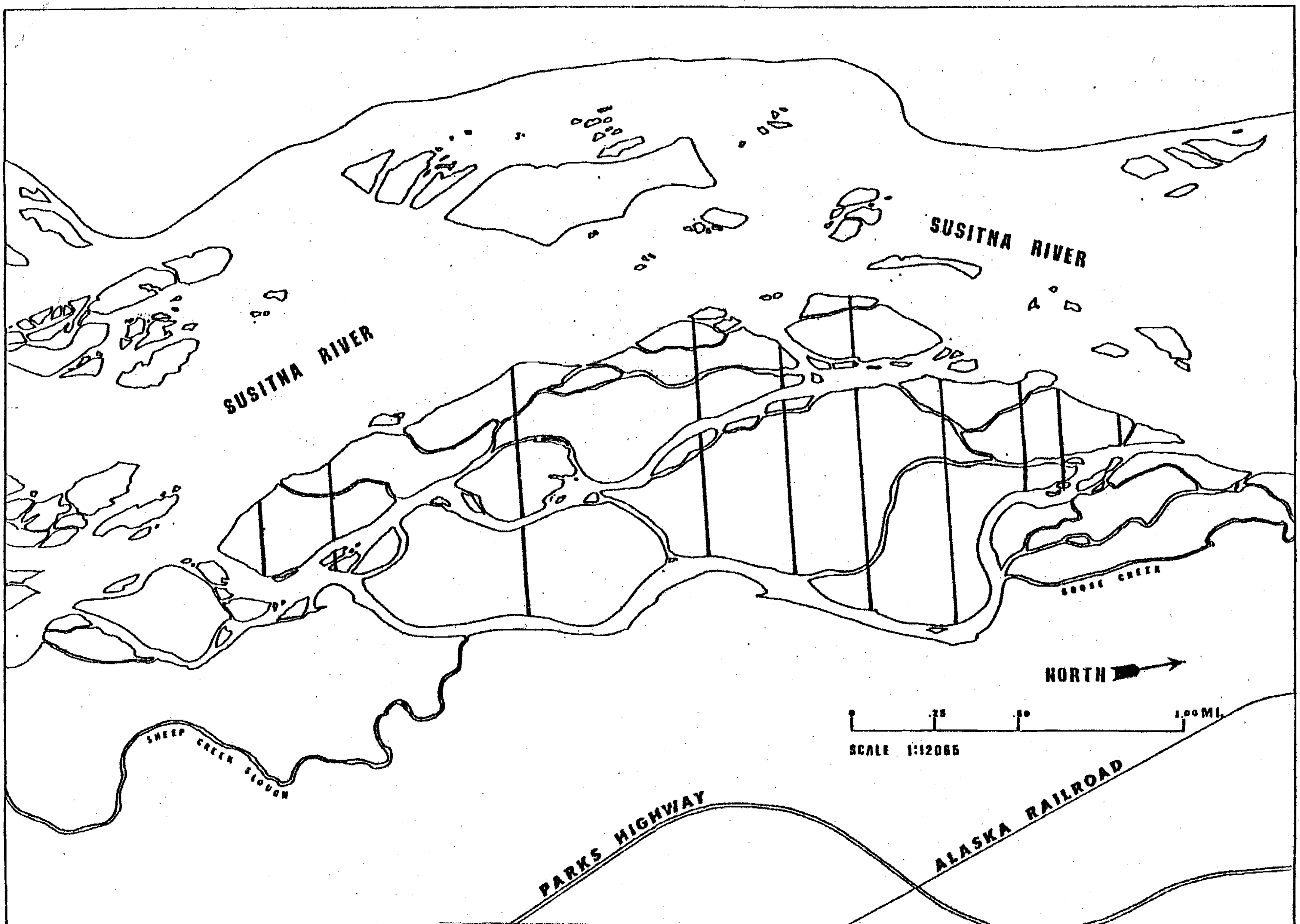

Fig. 4. Locations of browse availability/utilization and pellet group transects on the Sheep Creek Study Site.

papyrifera), highbush cranberry (*Viburnum edule*) and rose (*Rosa acicularis*). They were considered "browsable" if they were over 40 cm tall (i.e. available above or near the snowline in winter) and if their circumference at breast height was 13 cm or less (this circumference has been determined to be the maximum that can be broken over by moose while foraging). To be counted as a separate stem from a cluster of stems, the plant must have been surrounded by soil or if it was a "sucker" on a cut-off stump or mature tree it must have been at an angle of 45 degrees or less from the main stem of the plant. If it was between 45 degrees and perpendicular (90 degrees) to the trunk, it was classified as a branch and not a browse stem.

Only pellet groups containing 12 or more moose droppings and with their approximate geometric center within the transect were counted.

The habitat classification followed Viereck and Dyrness (1980) as closely as possible. Additionally, the density and height of plants were recorded. Four density categories were used: 1. Open (10% or less crown canopy cover), 2. Sparse (10-25%), 3. Medium (25-60% and 4. Closed (60-100%). Four heights categories were also used: 1. Low (1.5 m or less), 2. Medium (1.5-6.0 m [considered prime moose browse]), 3. Tall (6.0-9.0 m 5.0-13 cm dbh) and 4. Climax (9.0 m or more high, 13 cm or more dbh).

RESULTS AND DISCUSSION

On April 17, 1980 during collaring operations only 10 moose of the scheduled 20 were radio-collared. At that late date and after a reconnaissance flight revealed few moose on the Susitna River's floodplain, it was assumed that only "resident" moose remained.

LeResche (1974) described three types of moose movement patterns. Type A were those moose that only moved short distances between seasonal ranges with little change in elevation. Another name for this type is "resident." Type B moose move medium distances between two seasonal ranges with significant differences in elevation between low winter and high summer-fall ranges. Moose of the Type C pattern move medium to long distances between three distinct seasonal ranges and significantly change altitude between low winter and high summer-fall ranges.

Much of the snow had melted by the April tagging operation, thereby exposing moose forage at all elevations. Moose activity along the river had substantially decreased, and I thought that the Type B and C moose had left the river for higher elevations. I did not want to place all 20 radio-collars on Type A moose because Type B and C moose are more abundant and an important part of the population.

As it turned out, moose exhibiting all three types of migratory behavior were collared. However, sample sizes were too small to fully assess population identities along the lower Susitna River. Future collaring efforts must have broader distribution on the wintering areas of the river to ensure that all subpopulations of moose are sampled.

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Of the ten moose originally radio-collared, three females have shed their collars and one bull was killed during the September hunting season. The collars were put loosely on some moose because of their young age (mean age of the 10 collared moose was 3.5 years), small size and anticipated growth. When they shed their winter pelage, the collars were loose enough to slip over their heads. In the future, the collars will be fastened tighter and the design modified to make them less slippery.

Individual Moose Relocation Summaries

A description of the movement patterns of the 10 radio-collared moose follows:

Moose #20 (Fig. 5): Female, age 3. She was sighted only twice (in late April and early June) after collaring. She had remained in the collaring area. On 29 April she was with collared bull #92. The third sighting was of the shed collar which had come off between 6-19 June. The collar was retrieved on 19 July for reuse.

Moose #22 (Fig. 6): Female, age 6. After being collared at the mouth of Montana Creek, she moved to the Trapper Lake area to calve and summer. On 19 June she was seen with twin calves. Observations 1 through 5 were on 6 June through 17 July. She was then temporarily lost because of her long movement to the southwest. From 19 August through 25 September she remained in a small area east of Lockwood Lake. At no time when she was in this location or at subsequent observations were her twin calves observed. I presume that she lost her calves (cause unknown but likely predation) near Trapper Lake and then made the long movement southwest. After observation 10 on 25 September, she was again temporarily lost until I found her in the foothills of the Talkeetna Mountains along the south fork of Montana Creek. She has remained in that drainage for the past six observations through 5 January. The air distance between points 10 and 11 is approximately 40 miles and represented a change in elevation from 275 to 2,350 feet. On

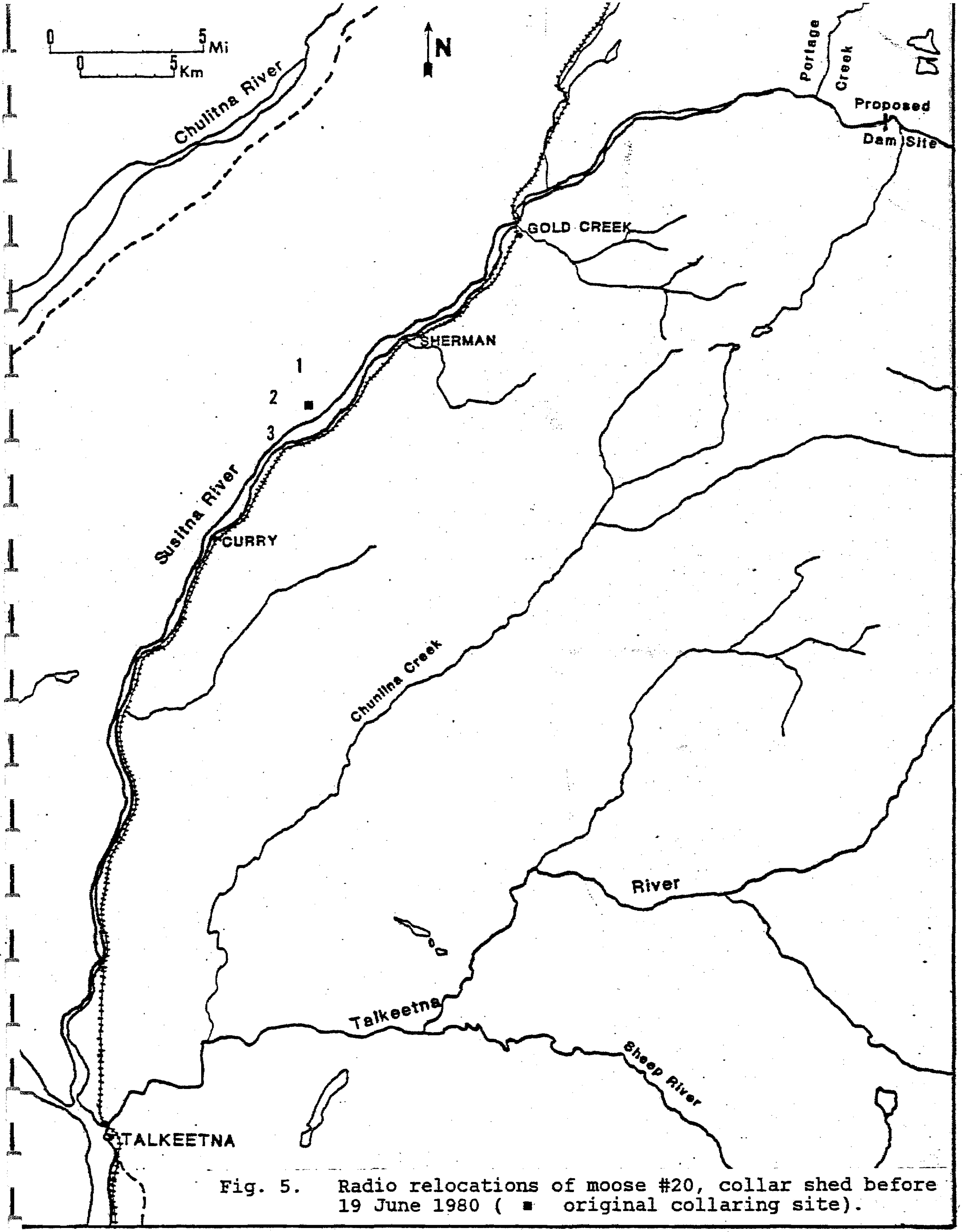

Fig. 5. Radio relocations of moose #20, collar shed before 19 June 1980 (■ original collaring site).

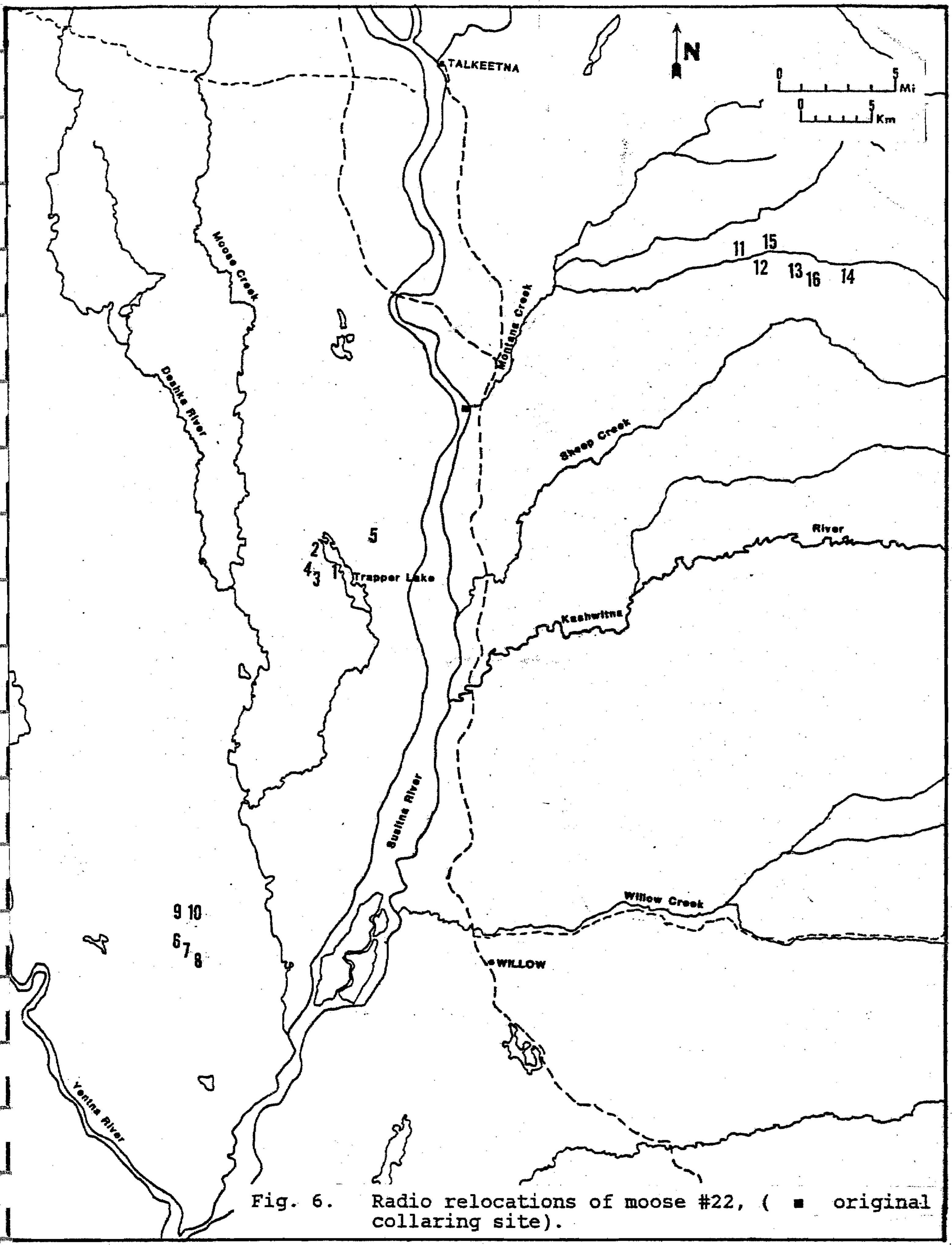

Fig. 6. Radio relocations of moose #22, (■ original collaring site).

16 October (observation 11) she was accompanied by 2 male, 3 female and 1 calf moose. I assume she migrated to the mountains for the rut and has remained at that elevation because snow depths have not covered forage and forced her to migrate to wintering areas at lower elevations. This moose exhibited the Type C migratory pattern as described earlier.

Moose #23 (Fig. 7): Female, age 3. After being collared near the mouth of Sheep Creek on sparsely vegetated islands of the Susitna River, this moose (which was not pregnant) moved 5 miles west to Trapper Lake. From 6 June to 28 July (observations 1-6), she remained alone in the vicinity of Trapper Lake, a pattern similar to moose #22. She was not heard on the 11 August flight, but on 19 August she was found in the foothills near timberline where Sheep Creek comes out of the mountains. She remained in that location with only small movements between observations through the rut and winter up to the present. On 15 December (observation 17) she did move up above timberline but on the next observation (5 January) she had moved back down into climax birch/spruce habitat. She was with a bull on the last two August observations and not again until 31 October and 14 November. Several other moose were in the vicinity throughout the rut, post-rut and winter periods. Although she has moved only between a summer and rut-winter range thus far, she is probably a Type C moose that would move to a lower area winter range if snow depths covered upland forage.

Moose #24 (Fig. 8): Female, age 2. Like moose #23, she was collared near the mouth of Sheep Creek but was pregnant at the time of collaring. Unfortunately, she immediately lost her collar. The first relocation was of her shed collar on a river bar 2 miles southeast of the collaring site. The collar was retrieved 24 September.

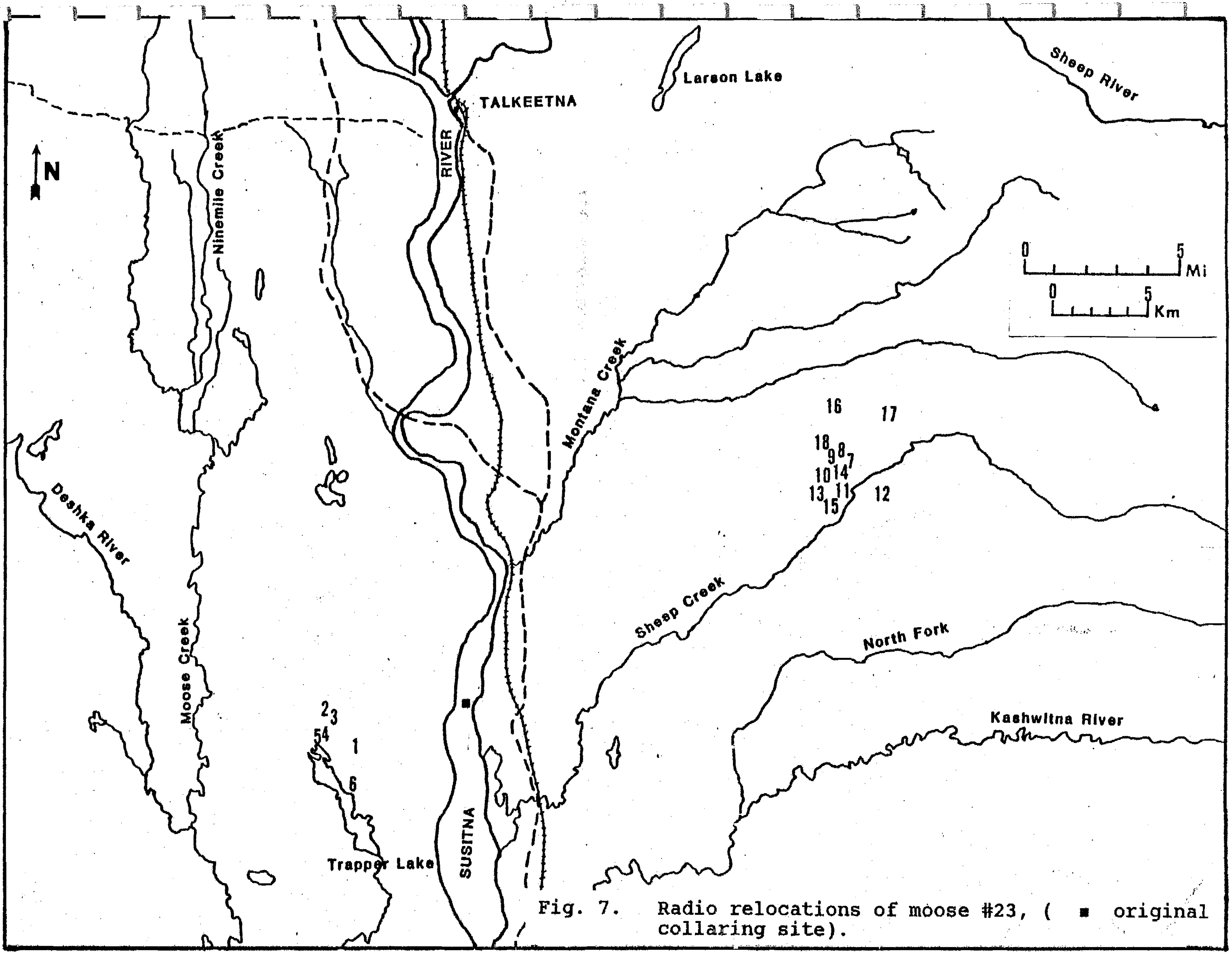

Fig. 7. Radio relocations of moose #23, (▪ original collaring site).

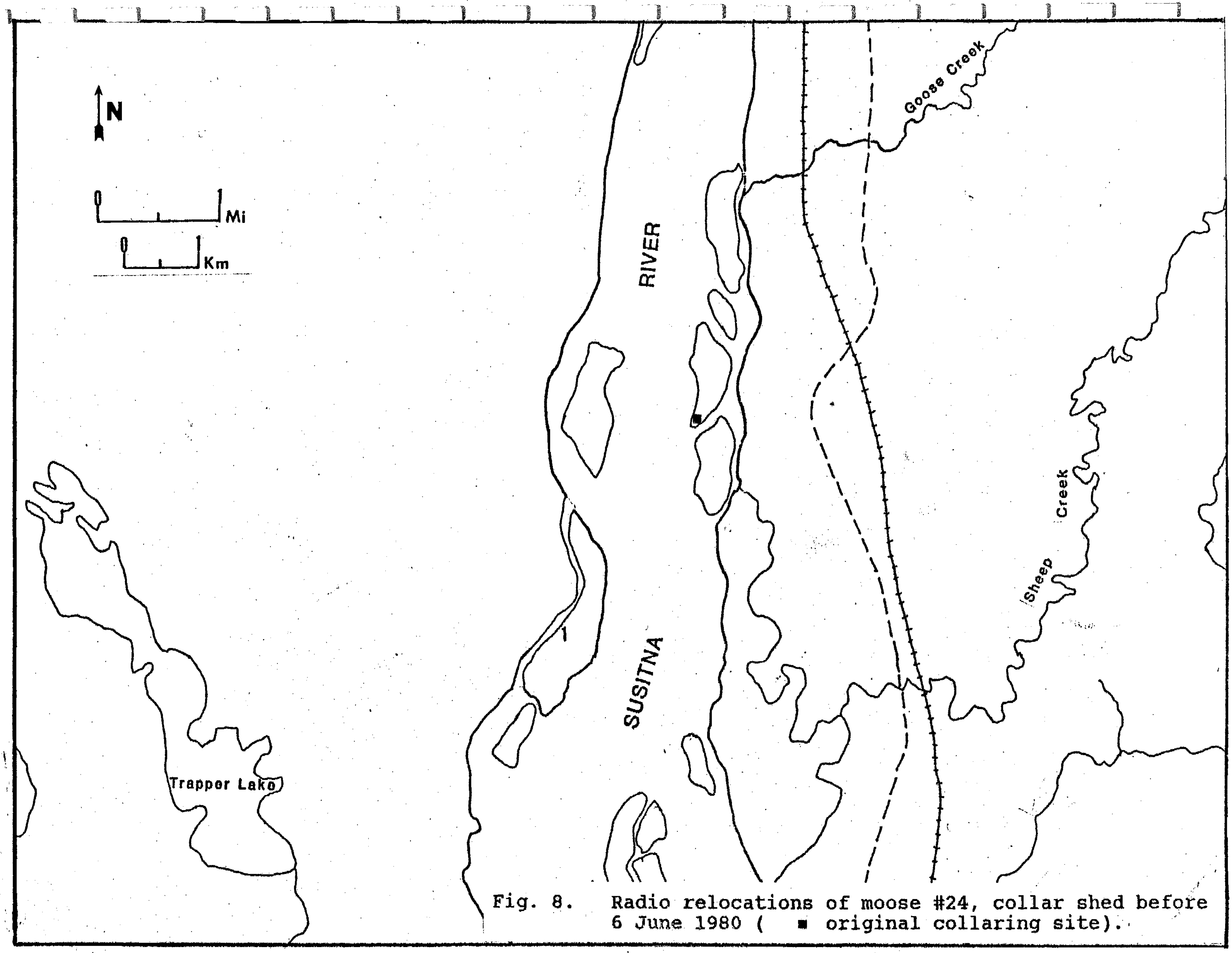

Fig. 8. Radio relocations of moose #24, collar shed before 6 June 1980 (■ original collaring site).

Moose #26 (Fig. 9): Female, age 3. This moose was pregnant when collared on a Susitna River island just above the Parks Highway bridge. She moved to the west side of the river for two observations on 29 April and 6 June. Between 6 and 19 June, she crossed the river to the east and moved 8 miles to the middle of the lowlands between the Susitna River and the Talkeetna Mountains. It is in this vicinity near Baldy Lake and the confluence of the three forks of Montana Creek that she has remained. At no time was a calf ever observed with her. She remained within about a 12 mi^2 area in mostly dense, climax birch/spruce habitat until 14 November (observation 17). Movements between the three subsequent observations were the longest since early June and were on the periphery of her core summer and rut area. By 5 January (observation 20) she had moved well south of the other relocations. This migratory pattern more suggests the Type A or resident pattern. Maximum elevation change has been from 275 feet to 1,275 feet and she has never moved farther than 10.5 miles from her collaring site on winter range.

Moose #27 (Fig. 10): Male, age 3. He was near moose #23 and #24 when radio-collared but immediately (between 17 and 29 April) migrated to the foothills of the Talkeetna Mountains north of the north fork of Montana Creek. He was not observed on every relocation flight because he made such large and unexpected movements that he could not be found. His second observation was near Sheep River 18 air miles northnortheast of the first observation. He moved back toward the south and on his fifth observation (17 July) was well up Sheep Creek canyon. After one observation out at the mouth of the canyon on 11 August, he returned to near the head of the canyon and remained through the rut. As the post-rut period progressed (from late October to mid December) he gradually moved westward down Sheep Creek canyon. On the latest observation (5 January), he was above timberline on the bench north of Sheep Creek accompanied by three other bulls. After being

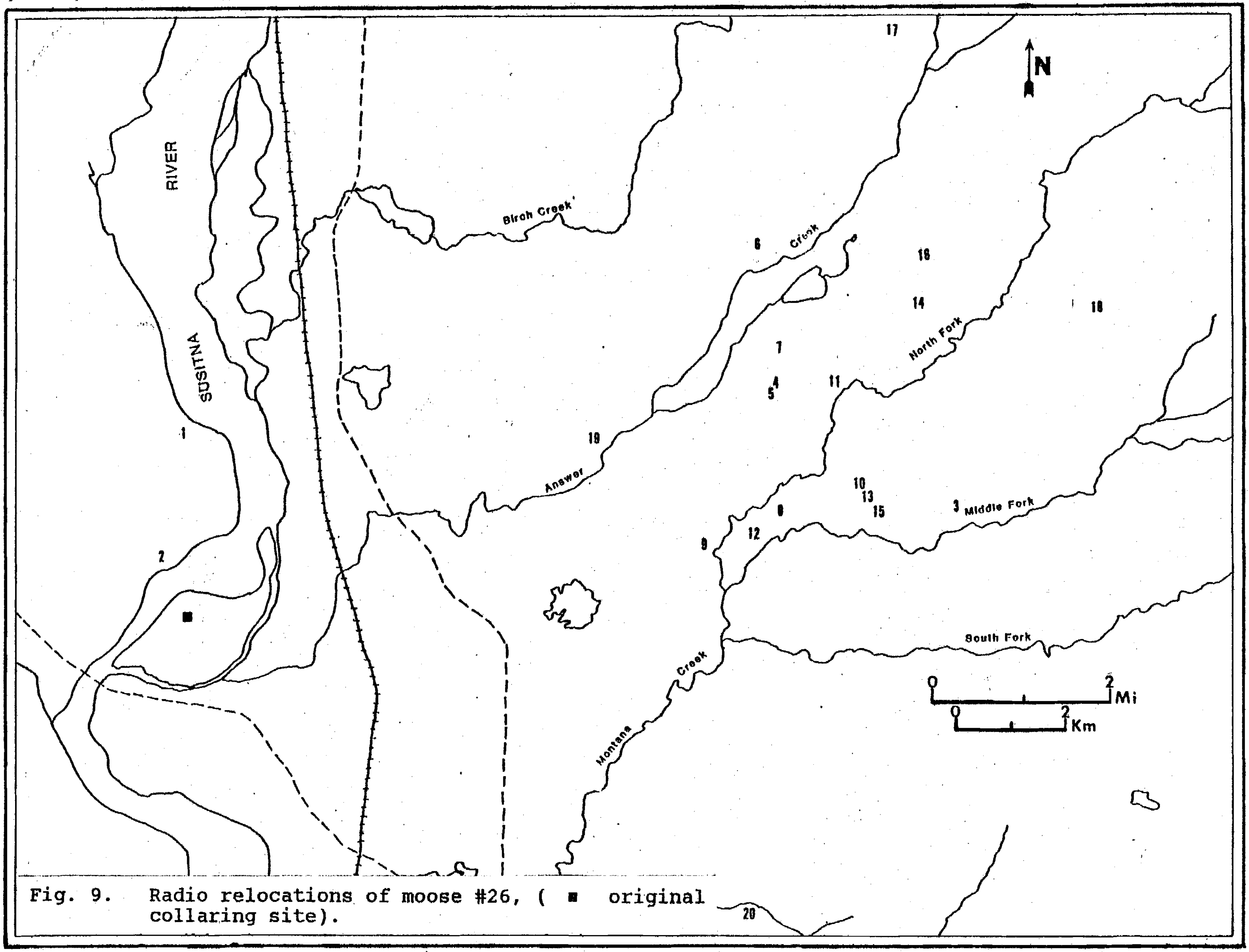

Fig. 9. Radio relocations of moose #26, (■ original collaring site).

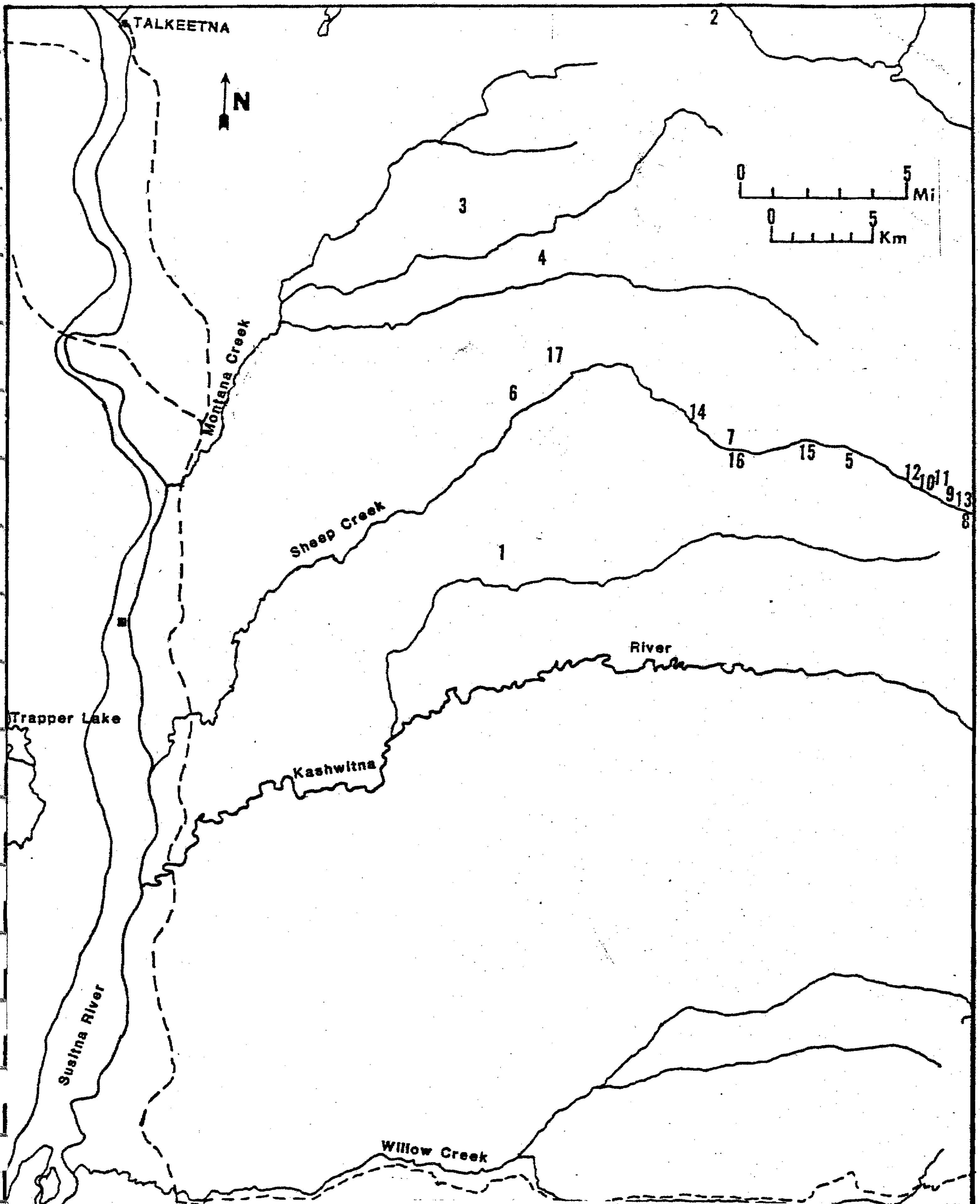

Fig. 10. Radio relocations of moose #27, (■ original collaring site).

collared at an elevation of 210 feet, all subsequent observations of moose #27 have been between 1,525 and 2,600 feet. His migratory pattern most resembles the Type B of LeResche (1974).

Moose #28 (Fig. 11): Female, age 4. When this cow was collared along the Susitna River 4.5 miles upriver from Curry, she was with her last year's calf but was not pregnant. On the next flight a dead calf was sighted on the river near the collaring site. I assumed that the calf was that of #28 and died as a result of winter-kill. No predator tracks were observed. Moose #28 moved 10 air miles downstream before losing her collar between 19-28 June. The collar was retrived 19 July.

Moose #90 (Fig. 12): Male, age 4. This bull was a definite Type A or resident moose. The elevation change between his highest and lowest points was 150 feet. His longest movement was between the collaring site north of the Parks Highway bridge and his first relocation 5 miles upriver. He then moved down to the west side of the river into habitat characterized by mature mixed birch/spruce forest interspersed with muskeg bogs. Between 8 July (observation 5) and 30 August (observation 10) he remained within 1 mi^2. As the rut progressed he began moving toward the northwest and finally crossed the Parks Highway on 18 September. He was shot by a hunter soon after crossing back to the east of the highway. His radio collar was retrieved for reuse.

Moose #91 (Fig. 13): Male, age 5. After being radio-collared near #90, this bull moved 8 miles northwest to the same type of habitat (mature birch/spruce with muskeg bogs) as that used by moose #90. He moved back and forth in a north-south direction near Ninemile Creek all summer, fall and early winter. This "home range" was 9 miles long and 3 miles wide. He has been alone during most visual relocations except during

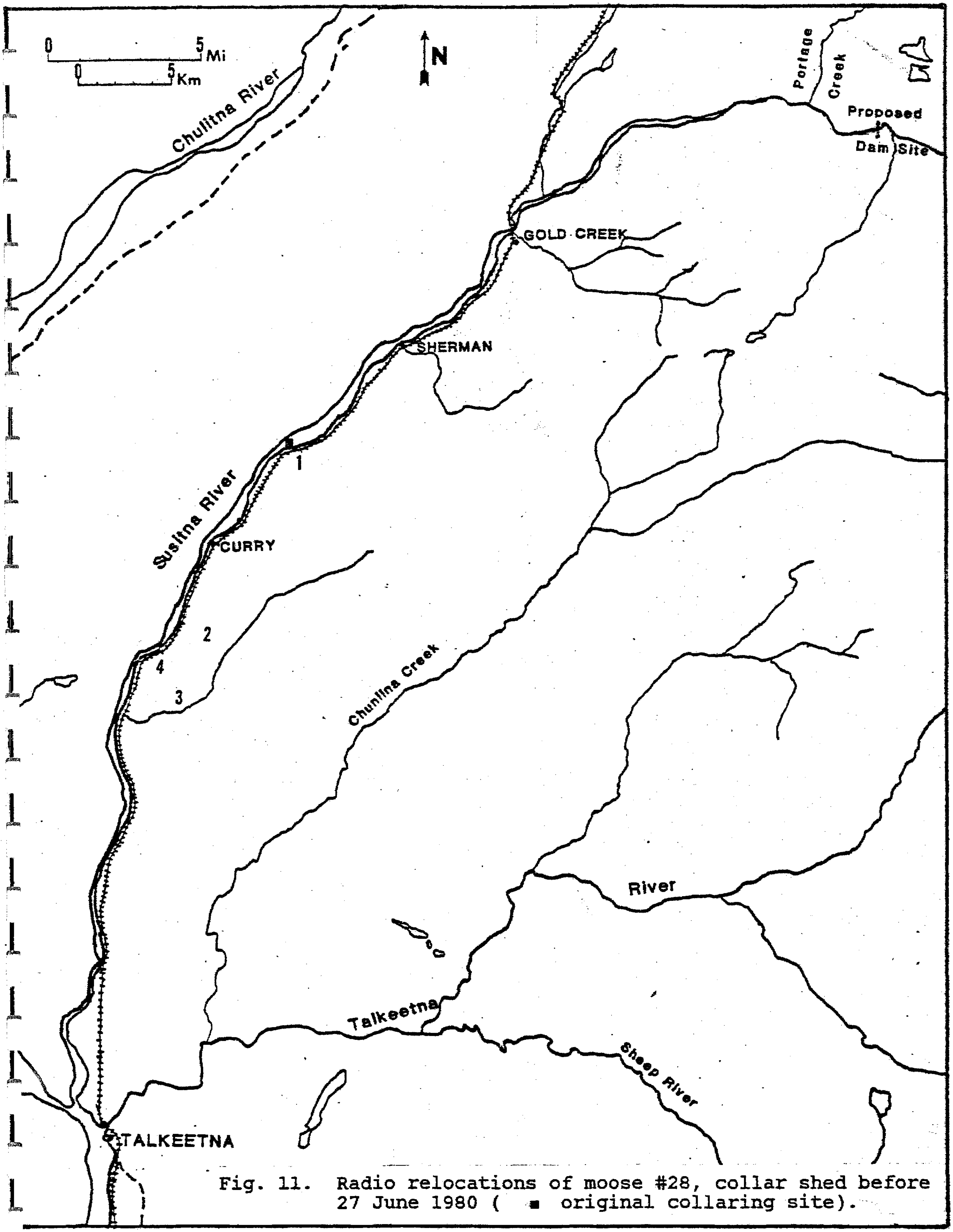

Fig. 11. Radio relocations of moose #28, collar shed before 27 June 1980 (▪ original collaring site).

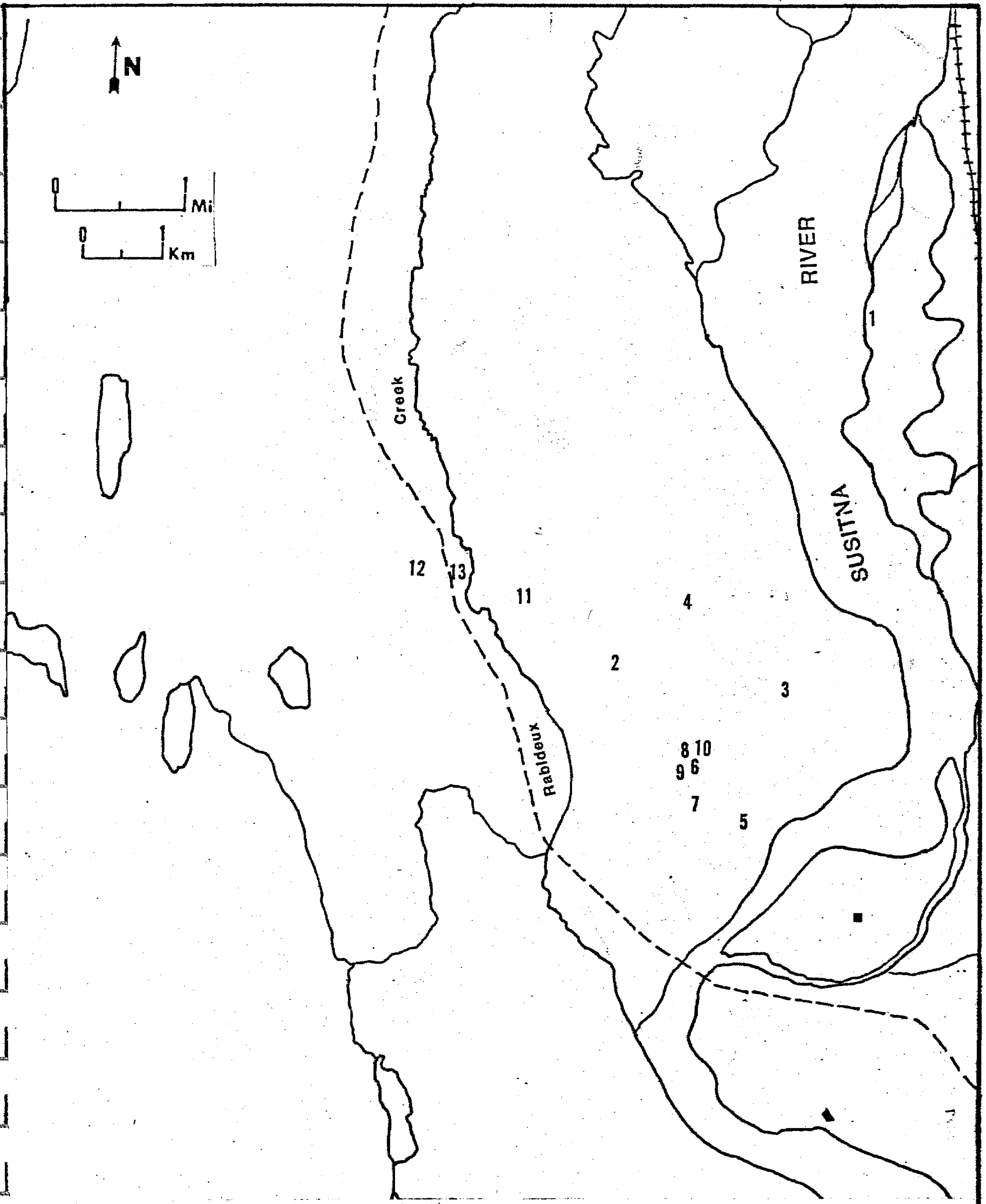

Fig. 12. Radio relocations of moose #90, moose killed by hunter in late September (■ original collaring site).

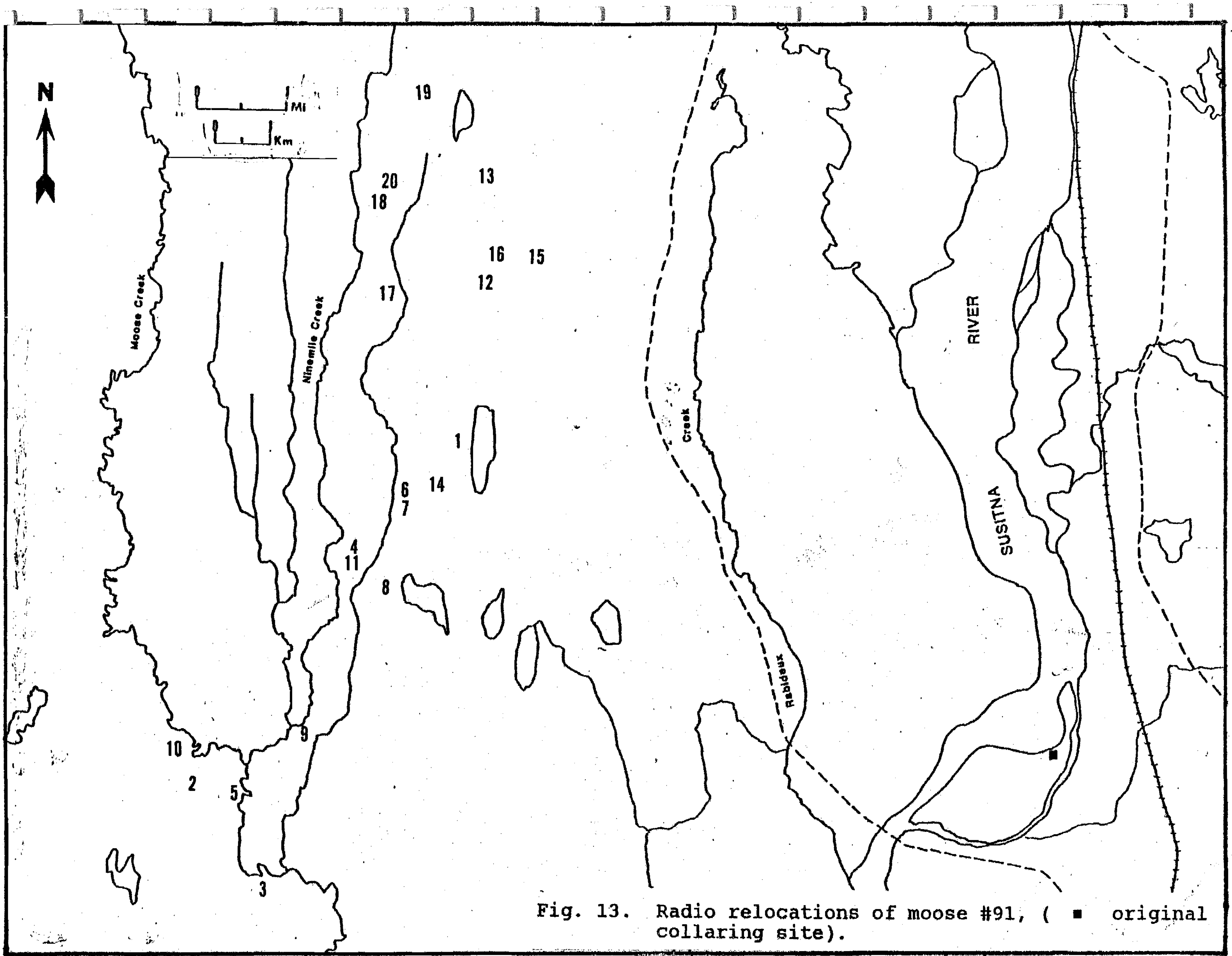

Fig. 13. Radio relocations of moose #91, (■ original collaring site).

mid-September when he was with a cow and after mid-October. On 28 November he stood on a lake with four other bulls and a cow. His movement pattern, like #90, suggests a Type A or resident moose. No significant elevation change occurred in this moose's movement pattern.

Moose #92 (Fig. 14): Male, age 3. If bull moose #90 was the most sedentary, this moose was the most migratory. After being collared 6 miles upriver from Curry, this bull was sighted once accompanying collared moose #20. He then spent a solitary summer traveling first downstream to a point 3 miles south of Curry and then upriver to almost the proposed Devil Canyon dam site. He was at the latter location on 30 August accompanied by a cow moose. Between 30 August and 10 September and between 10 September and 18 September he moved 8 and 17 miles, respectively back downriver. He remained south of Curry for six observations (11-16) before moving 10 miles back upriver on 28 November. On 15 December he was with two cows on the Susitna River floodplain, but on the last observation (5 January) he had moved from 550 feet to 1,890 feet on the bench south of the river. Although he has never been more than 3 miles from the river, he has traveled almost 30 miles between his furthest upriver and downriver points. The most moose that were in association with moose #92 were one bull and two cows on 3 October.

Population Identity, Seasonal Distribution and Movement Patterns

From limited observations on a small sample of radio-collared moose during the past 9 months of this project, it is difficult to make concrete statements about the identity of moose subpopulations using the lower Susitna River and to describe their seasonal distribution, movement patterns, home range sizes, and chronology and distances of migrations. A total of 131 radio relocations have been made, and of these, 89 (68%)

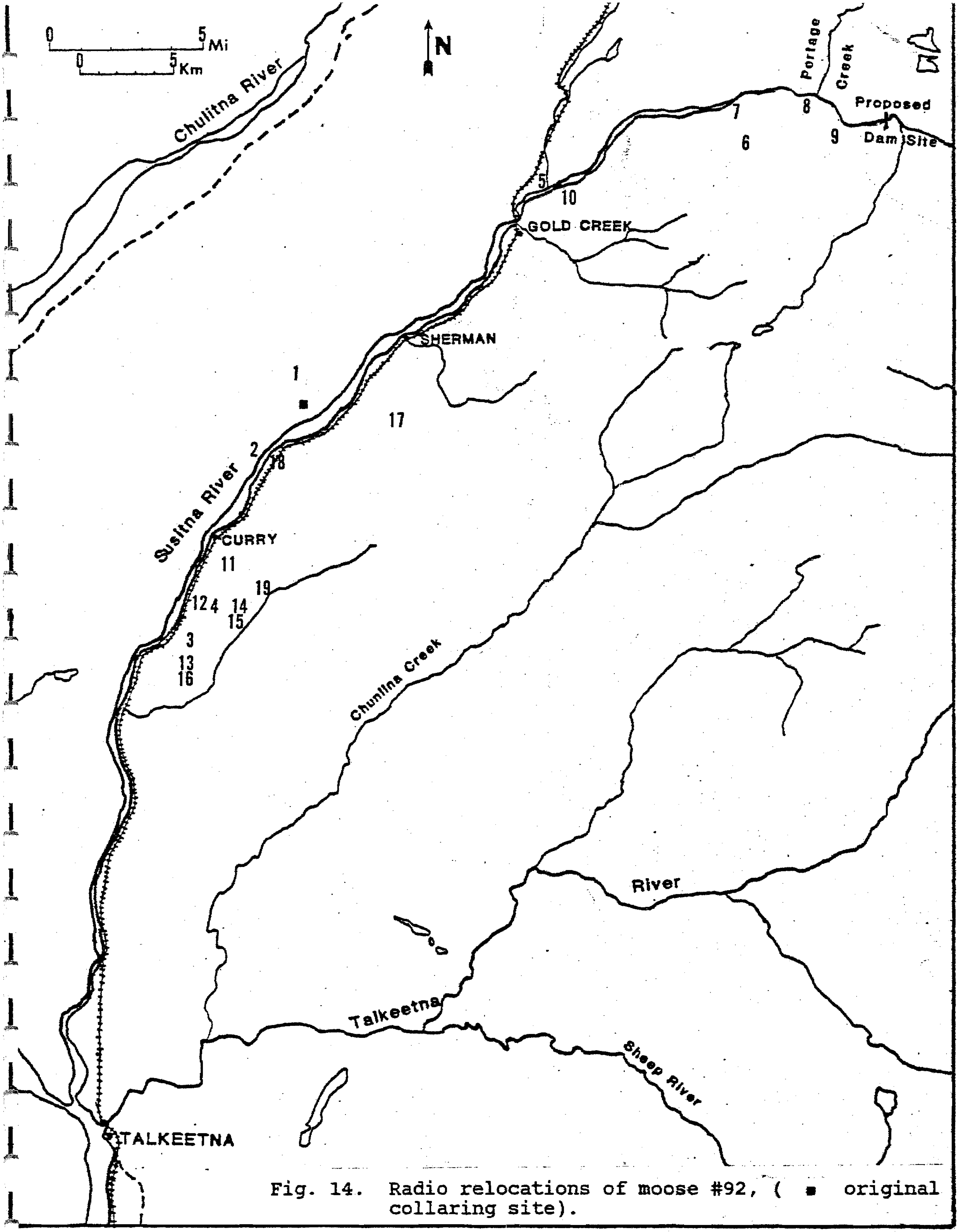

Fig. 14. Radio relocations of moose #92, (■ original collaring site).

were visual observations of the moose. All three types of migratory patterns described by LeResche were found on the study area. The bulls were either Type A (resident) or Type C (migratory between three ranges). Each of the three collared cows exhibited a different type of migratory behavior.

From moose wintering on the river below Talkeetna, it was learned that some calve, summer, rut and possibly winter in the flats west of the Susitna; some calve, summer, rut and possibly winter in the forest between the river and the mountains; while others spend spring, summer, fall and possibly winter in the western benches and drainages of the Talkeetna Mountains. No specific calving areas were recorded but several rutting areas were documented. The latter were found deep into the creek and river drainages of the Talkeetna Mountains and on the benchland near timberline at the mouths of these canyons. Rutting bulls in the lowlands aggregated less and were frequently alone or in small groups of 2-4 moose.

The only moose collared above Talkeetna that kept his collar was the bull that went up and down much of the Susitna River drainage below Devil Canyon. He did not have a specific summer, rut or winter area. Few moose, other than the radio-collared moose, were located when no snow was on the ground. Being able to see uncollared moose may have helped document calving, summer or rutting areas along this portion of the river. Further delineation of such behavioral regions will await future collaring and radio-tracking efforts.

Analysis of home range size, chronology of migration and distances of migration at this time would not be meaningful because of small sample sizes of observations. In general, the home and seasonal range size was quite varied. Because there were some "resident" (Type A) moose, home ranges were as small as approximately 25 mi^2. Seasonal ranges were often smaller. Type C moose had home ranges as large as 90 mi^2 or more. The timing and distances of migration were equally as varied. One cow moved from her summering to rutting area in early August while another did so in late September. The longest distance traveled between summering and rutting areas was 40 miles.

Home range size and migration distances were likely intermediate to those found for moose in other parts of Alaska or North America. This was a function of physiography where all life requisites were available between an area just west of the Susitna River eastward to the Talkeetna Mountain benches. Longer moose movements were unnecessary. Nearer the headwaters of the Susitna River in the Nelchina Basin, moose moved much farther between seasonal ranges (Ballard and Taylor 1980). The maximum seasonal range (winter) was 150 mi^2 and overall home range 530 mi^2. The longest movement was 140 miles. In other areas, such as Montana, seasonal ranges were less than 1 mi^2 (Knowlton 1960).

Magnitude of Use of Riverine Habitats

All the planned procedures for carrying out Objective 3 of this study (determine relative magnitude of moose use of the lower Susitna) have not as yet been completed. Part of the browse data will be presented later in this report. A census of moose on and near the river is planned for later this winter. Rausch (1958) stated that the period of peak moose abundance along the railroad between Houston and Talkeetna was February and that movement from the foothills to the railroad tracks was a basic seasonal movement and was influenced but not necessarily caused by deep snow. Therefore, the peak use of riverine habitats also will be in February or early March, and the timing of the census should correspond to this moose use. However, the magnitude of moose use of Susitna riparian habitats may be correlated with the amount of snow cover. If the open winter continues as it has in 1980-81, the degree of moose use along the river may greatly underestimate that of a more "normal" winter snowfall.

Attempts to devise methods for determining moose use of the river at seasons other than winter failed. Only general impressions and not quantitative data could be stated. It was obvious from boat trips up and down the river in late May and June that a fair (quantity unknown) number of cows calved on islands in the river. Four cows with newborn calves were observed on the river and tracks of several others were seen on mud banks of islands. Islands in other areas were frequently used for calving because they were relatively predator free (Stringham 1974).

Nothing has yet been done to determine summer use of the river. The untimely theft of the project boat and motor precluded access to the river at that time. Flooding of much of the lowland areas of the river in July likely caused moose to leave the floodplain for higher ground adjacent to the river.

In fall it also appeared (from overflights but no quantitative data) that moose did not remain on the river floodplain. However, they were observed crossing the river by ADF&G biologists. Hunter success along the river in September also indicated that moose were either on or near the river in fall. Analysis of hunter report data, however, is not feasible because hunters are often secretive about the exact location of their moose kills.

In summary, moose use of riparian habitats along the lower Susitna River is greatest in winter, particularly winters of deep snow, is at least moderate during calving and during the fall and is of an unknown level in summer.

Habitat Use

The habitats that moose were using when relocations were made including the density and height of the predominant vegetation has been recorded but not analyzed as yet. It will be more appropriate to do the analysis after more data is collected in the second year of the study. A cursory look at the data revealed that dense or medium, climax mixed birch/spruce was the habitat present on 46 percent of the observations. The remaining observations were in a variety of habitats including black spruce, muskeg bogs, alder/willow, willow, alder, cottonwood/spruce and bluejoint fields.

It was surprising to find so much use made of mature conifer/hardwood vegetation, but an obvious bias in technique may have been part of the cause. Most flights, and therefore, observations were from mid-morning to mid-afternoon. This was a time when most moose were bedded down. They may have eaten in a different habitat type earlier in the day or after the observation but for ruminating they sought more protective cover. Attempts will be made in the future (particularly summer) to make observations at all times of the day to decrease that bias.

Other habitat use data follows in the browse utilization section of the report.

Food Habits

The technique to determine what species of browse are present in moose pellets is currently being developed by Dr. Jay McKendrick, Agriculture Experiment Station, Palmer, AK. Pellets that have been collected from radio-collared moose or on the river will be saved for analysis at a later date. Also, rumen samples from moose killed during a hunt near the river have been collected for possible analysis.

Only one study has been conducted in the vicinity of the study area to determine what moose eat. Rumen samples from railroad killed moose were collected by Rausch in 1957 and analyzed by Shepherd (1958). From 122 samples, 17 different food items were identified. Willow, birch and aspen comprised 97 percent of the identifiable moose material. These moose would have been using mixed birch/spruce habitats of several successional stages near the railroad tracks where they were "collected". Along the river few birch and no aspen were found and, therefore, moose using the river would have a different diet than the above study indicated.

Condition and Productivity

Although blood, hair, morphometric measurements and pregnancy rates were taken from the 10 captured moose, data are not included here. When more moose are captured and a more valid sample is realized, the data will be summarized and compared to other areas in Alaska to assess the relative health of the lower Susitna moose herd. At that time an analysis of sex and age composition data, harvest statistics and ages of hunter and railroad killed moose may be appropriate.

Browse Availability and Utilization

When relocation flights for radio-collared moose began, it became obvious that documentation of the habitat used by moose at each observation was skeptical at best. Only a general habitat classification scheme could be used, and the habitat in which the moose was located was "guessed." Generally it was the mature vegetation species that were classified and not those being utilized by the moose. To better quantify which plants and how many of the plants that the moose were using, browse availability and utilization transects were conducted along the river.

I chose the method that obtained browse availability and percent of plants browsed over more sophisticated methods [such as Schafer's (1963) twig count method and others] for two reasons: 1. It is a simple method that required no other field assistance, and allowed for more sampling over a wider area in a relatively short period of time; 2. The results of obtaining percent of plants browsed would correlate strongly with the percent of current annual growth browsed if plants were clipped and weighed (Oldemeyer In Prep.). A partial analysis of the habitat relative abundance, browse availability and browse utilization follows. Pellet group counts have not yet been analyzed.

Habitat Relative Abundance

In doing the 12 transects on the three sections of river (Overall Study Area) 840 plots were completed. I found 60 separate habitat types using a modified Viereck and Dyrness (1980) classification system. Data from similar groups were then combined so that 20 habitat types were used in the analysis (Table 1). Dense-climax cottonwood/spruce (DClCSp) was the most frequently found habitat type (110 plots) followed closely by sparse-low cottonwood/willow/alder (SLCWA-103 plots). The next most abundant habitats were dense-medium cottonwood/willow/alder (DMCWA), medium-tall birch/spruce (MTBSp) and dense-climax cottonwood/willow/alder (DClCWA) with 78, 76 and 73 plots in each, respectively. These top five habitats contained 524 percent of all the plots. Because no browse plants were found on the bare and water habitats, those plots were excluded from the analysis that follows.

For the site specific study near the mouth of Sheep Creek, the 17 habitat types defined in the field were later combined to 12 types for analysis (Table 2). The five most abundant habitat types were DMCWA (67), dense-tall cottonwood/willow/alder (DTCWA - 58), medium-climax cottonwood/willow/alder (MClCWA - 50), medium-tall cottonwood/willow/alder (MTCWA - 44) and DClCWA (42). These five comprised 71.6 percent of the total plots. Water and logged areas and dense-climax cottonwood/ spruce had no plants or small sample sizes and, therefore, were dropped from the analysis.

Table 1. Habitat abbreviation, definition and relative abundance for moose studies on the overall study area (OSA) of the lower Susitna River.

Habitat Number	Habitat Abbreviation	Density	Height	Plant Species	Absolute Frequency (No. of Plots)	Relative Frequency (%)
1	Calam			Calamagrostis meadow	19	2.3
2	Equis			Equisetum/Willow	21	2.5
3	Bare			Bare sand/gravel/mud	24	2.9
4	Water			Water	4	0.5
5	Dist			Disturbed (bulldozed)	10	1.2
6	SLCWA	Sparse	Low	Cottonwood/Willow/Alder	103	12.3
7	SMCWA	Sparse	Medium	Cottonwood/Willow/Alder	29	3.5
8	STA	Sparse	Tall	Alder	12	1.4
9	SClBSp	Sparse	Climax	Birch/Spruce	12	1.4
10	MLCWA	Medium	Low	Cottonwood/Willow/Alder	33	3.9
11	MMCWA	Medium	Medium	Cottonwood/Willow/Alder	58	6.9
12	MTBSp	Medium	Tall/ Climax	Birch/Spruce	76	9.0
13	MTCWA	Medium	Tall/ Climax	Cottonwood/Willow/Alder	44	5.2
14	MDCSp	Medium/Dense	Climax	Cottonwood/Spruce	27	3.2
15	DMCWA	Dense	Medlum	Cottonwood/Willow/Alder	78	9.3
16	DTCWA	Dense	Tall	Cottonwood/Willow/Alder	31	3.7
17	DTA	Dense	Tall	Alder	31	3.7
18	DClCWA	Dense	Climax	Cottonwood/Willow/Alder	73	8.7
19	DClBSp	Dense	Climax	Birch/Spruce	45	5.4
20	DClCSp	Dense	Climax	Cottonwood/Spruce	110	13.1
					840	100.0

Table 2. Habitat abbreviation, definition and relative abundance for transects on Sheep Creek Study site, Downstream Moose Project.

Habitat Number	Habitat Abbreviation	Density	Height	Plant Species	Absolute Frequency (No. of Plots)	Relative Frequency (%)
1	Water			Water	15	4.1
2	Log			Logged area	7	1.9
3	SLCWA	Sparse	Low	Cottonwood/Willow/Alder	16	4.4
4	SMCWA	Sparse	Medium	Cottonwood/Willow/Alder	10	2.7
5	MLCWA	Medium	Low	Cottonwood/Willow/Alder	15	4.1
6	MMCWA	Medium	Medium	Cottonwood/Willow/Alder	34	9.3
7	MTCWA	Medium	Tall	Cottonwood/Willow/Alder	44	12.1
8	MClCWA	Medium	Climax	Cottonwood/Willow/Alder	50	13.7
9	DMCWA	Dense	Medium	Cottonwood/Willow/Alder	67	18.4
10	DTCWA	Dense	Tall	Cottonwood/Willow/Alder	58	15.9
11	DClCWA	Dense	Climax	Cottonwood/Willow/Alder	42	11.5
12	DClCSp	Dense	Climax	Cottonwood/Spruce	6	1.6
					364	100.0

* Number of times a plot was found in given habitat type.

Overall Study Area (OSA) Browse Availability and Utilization

All plots that did not contain browse plants were excluded from the analysis so that there would not be an underestimation of plant utilization by moose. Browse plants were available in 85 percent (690) of the plots. All 18 habitat types (water and bare were dropped from the 20 classified habitats) contained at least one species of moose browse. Areas disturbed by man (e.g. cleared for agriculture) and then abandoned, often produce large quantities of moose forage. Only eight plots of this type were found on the transects but the highest density of browse (3.3 plants/m^2) was recorded there. The mean for all habitats was 1.4 plants/m^2 (Table 3). The lowest density was in *Equisetum*/willow (Equis) where only 0.4 plants/m^2 were found. This habitat is frequently found along riverine slough margins and is the first successional stage when vegetation starts on undisturbed bare soil.

Oddly, utilization of browse was highest (49.2%) in the Equis habitat. There are two possible explanations for this. One is that willow was the predominant browse species in the habitat type and it was the preferred browse species. Secondly, this habitat was frequently found along moose movement corridors which increased the probability that moose would come into contact with available browse. Medium-tall cottonwood/willow/alder (MTCWA) had the second highest utilization (36.4%). Available browse was utilized fairly heavily in MTCWA because to be classified tall meant that the predominant plants in the plot were no longer moose browse. Lowest utilization was recorded in medium/dense-climax cottonwood/spruce (MDCSp - 6.9%) and sparse-climax birch/spruce (SCIBSp - 4.0%). Only one habitat, *Calamagrostis* meadows (Calam), received no utilization of forage species; however, only six plots of this habitat type contained browse.

Table 3. Availability (Avail) and moose utilization (Util) of five browse species [Willow, Cottonwood (Cott), Birch, Highbush Cranberry (HB Cran) and Rose] on the overall study area (OSA) of the lower Susitna River.

Habitat Code[4]	Total Avail[1]	Sample Size[2]	Total Util[3]	Willow Avail[1]	Sample Size[2]	Willow Util[3]	Cott. Avail[1]	Sample Size[2]	Cott. Util[3]	Birch Avail[1]	Sample Size[2]	Birch Util[3]	HB Cran Avail[1]	Sample Size[2]	HB Cran Util[3]	Rose Avail[1]	Sample Size[2]	Rose Util[3]
Calam	1.6	6	0	1.9	3	0	0.2	1	0	0.4	2	0	1.1	1	0	1.0	2	0
Equis	0.4	15	49.2	0.3	13	61.8	0.2	5	10.0	-	0	-	-	0	-	-	0	-
Dist	3.3	8	27.2	1.0	5	17.6	1.1	4	30.4	2.6	5	24.7	0.4	3	18.5	0.6	4	18.5
SLCWA	0.9	76	14.2	0.7	49	21.9	0.5	54	8.3	0.1	1	0	0.5	3	22.2	0.2	3	0
SMCWA	0.8	27	34.3	0.4	14	35.7	0.9	20	39.6	-	0	-	0.2	2	0	-	0	-
STA	1.7	10	21.3	0.2	1	100	-	0	-	0.3	1	100	1.1	9	20.5	1.5	4	21.5
SC1BSp	1.5	10	4.0	0.5	4	18.8	-	0	-	-	0	-	0.8	9	0	0.6	9	4.6
MLCWA	1.1	30	29.0	0.8	21	50.4	0.6	26	11.6	-	0	-	0.5	1	0	0.4	1	0
MMCWA	1.5	54	17.0	0.8	34	38.0	1.1	48	10.2	-	0	-	-	0	-	-	0	-
MTBSp	1.7	66	18.4	0.7	13	59.3	0.5	5	39.4	0.7	14	25.4	0.7	54	14.8	1.0	50	13.9
MTCWA	1.2	34	36.4	0.6	17	54.1	0.3	8	39.8	-	0	-	1.1	8	8.3	0.9	21	7.8
MDCSp	1.7	26	6.9	0.5	6	34.3	-	0	-	-	0	-	1.2	25	1.5	1.2	10	3.4
DMCWA	1.0	74	29.9	0.6	58	42.4	0.5	57	21.9	0.5	5	25.0	0.8	8	7.7	0.4	6	9.5
DTCWA	0.8	22	8.7	0.5	14	12.0	0.3	6	5.6	0.3	2	0	1.1	5	0	0.5	6	0
DTA	1.5	29	16.2	-	0	-	-	0	-	0.2	2	25	0.8	25	25.3	0.9	25	10.9
DC1CWA	1.7	60	16.7	0.4	9	44.4	0.1	6	16.7	-	0	-	1.6	34	24.6	0.9	47	6.1
DC1BSp	1.9	39	22.9	0.6	2	36.4	-	0	-	0.3	10	36.3	1.2	30	30.2	1.0	31	12.0
DC1CSp	1.5	104	11.0	0.5	17	13.6	0.4	22	7.3	0.5	1	40.0	1.3	78	13.4	0.8	39	12.6
Total	1.4	690	19.7	0.7	280	36.5	0.6	262	16.2	0.7	43	26.9	1.1	295	15.9	0.9	258	10.0

1. Mean number of browseable plants per square meter of habitat.
2. Number of plots in which browseable plants were recorded.
3. Mean percent of plants browsed of those available.
4. See Table 1 for code definitions.

Willow - Over the course of the lower Susitna River, willow was the most ubiquitous of the browse species for moose. It was found in all but one habitat type. That type was dense-tall alder (DTA) where the almost total canopy cover shaded out and killed many of the plants in the understory. Dead willows were frequently found in this habitat type.

The mean density of willow for all habitats combined was 0.7 plants/m^2 and densities of similar magnitude were found in many of the separate habitat types. The highest mean density (1.9 plants/m^2) was found in Calam but only 3 plots of that habitat type contained willow. One plot in this habitat had the highest willow density found - 4.7 plants/m^2. Disturbed areas (Dist) had a density of 1.0 willow plant/m^2 and the remaining habitats had browse densities less than one. Although willow was most frequently found in DMCWA (58 plots), it had a relatively low density (0.6 plants/m^2) there. Willow was frequently found in only two other habitat types: SLCWA (49 plots) and medium-medium cottonwood/willow/alder (MMCWA) - 34 plots).

The importance of willow to moose was documented by its percent utilization. In all habitats 36.5 percent of available willow was utilized. As much as 61.8 percent was utilized in Equis where only 0.3 plants/m^2 were available. Three other habitats had over 50 percent utilization: MTBSp (59.3%), MTCWA (54.1%) and medium-low cottonwood/willow/alder (MLCWA - 50.4%). The maximum sustained browsing intensity that a plant can withstand is estimated to be between 50 and 75 percent (Wolff and Zasada 1979). In sparse-tall alder (STA) 100 percent was utilized but only one plot of that habitat had willow. In DMCWA where willow was found most frequently, 42.4 percent of available willow was browsed. The only habitat where willow was present but not utilized was in Calam.

Cottonwood - The mean density for cottonwood was similar to that of willow (0.6 vs 0.7 plants/m^2), but cottonwood was found in only 13 habitat types. Cottonwood browse was most dense ($\bar{x}$ = 1.1 plants/m^2) in MMCWA where as many as 9.9 plants/m^2 were recorded. Disturbed areas also had 1.1 cottonwood plants/m^2, but there were only four plots of this habitat type that contained cottonwood.

The same habitats that most frequently contained willow also most frequently contained cottonwood (DMCWA - 57 plots, SLCWA - 54 plots and MMCWA - 48 plots). These three habitats contained 61 percent of the plots on which cottonwood was found.

Almost 40 percent utilization of cottonwood was found in three habitats: sparse-medium cottonwood/willow/alder (SMCWA), MTCWA and MTBSp. However, cottonwood was not found on many plots within those habitats. Where cottonwood was found more frequently, the percent utilization was much lower. In SMCWA, MTCWA and MTBSp there was 21.9, 8.3 and 10.2 percent utilization, respectively. Overall, 16.2 percent of the available cottonwood was utilized.

Birch - Very few birch plants were found on the floodplain of the river. The birch/spruce habitats were found only on either end of the transects when I went 100 m away from the river's edge. Birch was found on only 10 habitat types and in low densities on all habitats except Dist where a mean of 2.6 plants/m^2 were recorded. This value inflated the overall density to 0.7 plants/m^2. Otherwise, the mean density per habitat was 0.7 plants/m^2 or lower. MTBSp was the habitat type where the density was 0.7 plants/m^2 and also where the sample size was largest (14 plots contained birch). Ten of 39 plots in dense-climax birch/spruce (DClBSp) conatined birch, whereas five or fewer plots contained birch in the remaining habitats.

A relatively high 26.9 percent of available birch was utilized by moose. The two habitats with large sample sizes, MTBSp and DClBSp, had birch utilizations of 25.4 and 36.3 percent respectively. On three habitats where birch was present, there was no utilization: Calam, SLCWA and DTCWA.

<u>Highbush Cranberry</u> - The mean density of highbush cranberry in the OSA was 1.1 plants/m^2 - highest for all browse plants. Densities greater than 1.0 plant/m^2 were found on eight habitat types. This high density was likely a result of the growth pattern of highbush cranberry i.e. it was usually found in dense clumps of several to many plants each. Also, it was found on a variety of habitat types (16 of 18).

Highbush cranberry was generally found more frequently in tall or climax habitats. DClCSp and MTBSp were habitat types where highbush cranberry was found in greatest frequency. Few were found on cottonwood/willow/alder habitats except the dense-climax one. Overall, highbush cranberry was recorded on 295 plots, the highest for the five browse species.

On the other hand, utilization of highbush cranberry was one of the lowest. A mean of only 15.9 percent was utilized in all habitats. Utilizaton was highest in DClBSp (30.2%), DTA (25.3%) and DClCWA (24.6%). It was quite low (1.5%) in MDCSp and there was no utilization in five of 16 habitats.

<u>Rose</u> - The overall mean density of rose (0.9 plants/m^2) was second to that of highbush cranberry of the five browse species studied. Like highbush cranberry, rose was found on a variety of habitats (15 of 18) and was most dense (near 1.0 plants/m^2) in tall and climax forests.

The habitats where it was found most frequently were MTBSp (50 plots) DClCWA (47 plots), DClCSp (39 plots) and DClBSp (32 plots). The overall number of plots (258) in which rose was found was fourth among the five browse species, yet the top four were all close in relative abundance (varying between 258 and 295 out of 690 plots where browse was found). Therefore, rose occurred about as frequently as all three browse species except birch.

Rose, however, was lowest in utilization by moose. This is, perhaps, understandable because of the characteristics of the stem but a mean of 10.0 percent of rose stems were browsed by moose. A high of 21.5 percent utilization was found in STA and 13.9 percent was browsed in MTBSp. Eleven of 15 habitats where rose was found had at least some moose utilization.

Sheep Creek Study Site

When the three habitat types with low sample sizes were excluded, the nine remaining habitat types contained 336 plots. Of these plots, 255 (76%) contained at least one browse species. All contained cottonwood, willow and alder in varying densities and heights. Four browse species were included since no birch was found in the nine habitat types. For all browse species combined, there was a mean density of 1.7 plants/m^2 (Table 4). DMCWA had the highest browse density (2.6 plants/m^2) followed by MLCWA with 2.0 plants/m^2. Lowest was SMCWA and DTCWA with 0.7 and 0.6 plants/m^2, respectively.

Browse plants were most frequently found in DMCWA (62 plots) as well as being most dense there. Medium-climax and-tall cottonwood/willow/alder habitats were the next most common types. Sparse density habitats were the least frequently encountered.

In all habitats, about 20 percent of available plants were utilized. In MTCWA, 35.2 percent was utilized, the highest in the SCSS. Almost 20 percent of the plants were browsed in DMCWA, the habitat with the greatest density and frequency. The least utilization (2.1%) was recorded in MLCWA.

Table 4. Availability (Avail) and moose utilization (Util) of four browse species [Willow, Cottonwood (Cott), Birch, Highbush Cranberry (HB Cran) and Rose] on the Sheep Creek Study site, lower Susitna River.

Habitat Code[4]	Total Avail[1]	Sample Size[2]	Total Util[3]	Willow Avail[1]	Sample Size[2]	Willow Util[3]	Cott Avail[1]	Sample Size[2]	Cott Util[3]	HB Cran Avail[1]	Sample Size[2]	HB Cran Util[3]	Rose Avail[1]	Sample Size[2]	Rose Util[3]
SLCWA	1.0	11	10.9	0.9	7	28.6	0.9	6	0	-	0	-	-	0	-
SMCWA	0.7	7	28.6	0.6	3	33.3	0.5	6	16.7	-	0	-	-	0	-
MLCWA	2.0	12	2.1	1.3	7	2.9	1.6	9	0.5	-	0	-	-	0	-
MMCWA	1.9	30	21.8	1.3	16	48.5	1.7	17	0.7	1.2	3	2.8	1.1	3	33.3
MTCWA	1.7	37	35.2	1.8	29	42.2	0.4	2	50.0	1.4	5	13.0	0.6	7	0
MC1CWA	1.6	40	24.1	1.2	12	70.3	1.4	2	0	1.0	13	9.6	1.2	29	10.0
DMCWA	2.6	62	19.9	2.4	45	26.5	1.3	39	13.2	0.8	1	0	1.0	2	0
DTCWA	0.6	28	10.0	0.5	18	12.2	0.5	11	5.5	0.5	2	0	0.3	1	0
DC1CWA	1.7	28	14.6	0.5	3	33.3	0.3	1	0	2.5	10	35.5	0.8	23	6.5
Total	1.7	255	20.3	1.6	140	33.4	1.2	93	8.5	1.5	34	16.3	1.0	65	8.3

1. Mean number of browseable plants per square meter of habitat.
2. Number of plots in which browseable plants were recorded.
3. Mean percent of plants browsed of those available.
4. See Table 2 for code definitions.

Willow - As in the OSA, willow was an important browse species for moose in the SCSS. Willow had the highest density (1.6 plants/m^2) of all browse plants. A density of 2.4 plants/m^2 was recorded in DMCWA. The lowest density (0.5 plants/m^2) was found in both dense-tall and -climax cottonwood/willow/alder.

Willow was found in all nine habitat types and in 140 of 255 (55%) of the plots. DMCWA and MTCWA plots most frequently had willow present while SMCWA and DClCWA plots had the least willow.

About one third of available willow was utilized by moose. As much as 70.3 percent of the willow in MClCWA habitat was utilized and as little as 2.9 percent in MLCWA. In DMCWA where the most willow was found, there was a utilization of 26.5 percent.

Cottonwood - The mean density of cottonwood for all habitats in the SCSS was 1.2 plants/m^2 . MMCWA had the highest density of cottonwood (1.7 plants/m^2). The lowest densities were in DClCWA (0.3 plants/m^2) and MTCWA (0.4 plants/m^2).

Cottonwood was found in all nine habitats and, like willow was recorded most frequently in DMCWA. DClCWA, MClCWA and MTCWA had the lowest frequency of cottonwood browse present in plots.

Relatively little of available cottonwood on the SCSS was utilized. Only 8.5 percent of the cottonwood was browsed versus 33.4 percent for willow. In DMCWA, where the sample size was largest, only 13.2 percent was eaten by moose. In three habitats (SLCWA, MClCWA and DClCWA), no cottonwood was taken, and in two others (MLCWA and MMCWA), very small amounts (0.5 and 0.7%, respectively) were browsed.

Highbush Cranberry - As in the OSA, the SCSS had relatively high densities of highbush cranberry. For all habitats, 1.5

plants/m^2 were available, and in DClCWA, 2.5 plants/m^2 were present. Low densities were found in DTCWA (0.5 plants/m^2) and DMCWA (0.8 plants/m^2).

Highbush cranberry was the browse species that showed up the least frequently of the four species. It was recorded in only 34 of 255 plots. Climax habitats were where it was most frequently encountered. In MClCWA and DClCWA there were 13 and 10 plots with highbush cranberry present, respectively. Three habitats did not contain highbush cranberry: SLCWA, SMCWA and MLCWA.

Utilization of highbush cranberry was almost twice that of cottonwood (16.3% vs. 8.5%) but half that of willow (16.3% vs 33.4%) on the SCSS. By habitat, utilization varied from none to 35.5 percent. No utilization was found on two of the six habitats where highbush cranberry was found - DMCWA and DTCWA. The highest utilization was where the density was also highest - DClCWA.

Rose - Densities of rose on the SCSS were the lowest of the four browse specied found. A mean density of 1.0 plants/m^2 was recorded for all habitats. MClCWA was the habitat where the density was highest (1.2 plants/m^2), and the lowest density (0.2 plants/m^2) was in DTCWA. Like highbush cranberry, rose was found on 6 of 9 habitats and was most frequently encountered in climax forest (29 plots in MClCWA and 23 plots in DClCWA).

Although rose was found on twice as many plots as highbush cranberry (65 vs. 34), it was utilized half as much (8.3 vs. 16.3%). It was utilized on only 3 of 6 habitats, and on habitats where it was found in greatest frequency, it was utilized 10.0 percent or less of the time.

General Discussion of Browse Availability and Utilization

Results of sampling on all parts of the river, in many cases, yielded similar results to the sampling on the specific site. There were about 1.5 browse plants/m^2, and about 20 percent of those available were utilized. Willow was found in almost all habitat types and approximately one third or more of the willow was utilized. It occurred most frequently in dense-medium cottonwood/willow/alder habitat or a lower seral stage or lesser density habitat of the same species composition. Utilization of willow was high in both subclimax and climax vegetation. If willow is present, it is a preferred forage species of moose.

Cottonwood was more dense but less utilized on the SCSS than on the OSA. Like willow, cottonwood was most frequently recorded in subclimax habitat types. Utilization of cottonwood was quite variable between habitats. A partial explanation of this would be that although cottonwood was frequently found in low and medium habitats, many of the plants were in the 40-60 cm range in height and would be covered by snow in a normal winter. They would, therefore, be unavailable as forage for moose and utilization of that height of browse plant would be underestimated. The minimum height of browse should be raised to 60 cm or more in future sampling. When I dug two snow trenches on the river last winter, I found snow depths of 77 and 82 cm and all plants 40-70 cm in height were likely not utilized. Moose appeared to do little cratering under the snow because there was ample forage above the snow. However, during winters similar to that (through January) of 1980-81, the low plants will be exposed and available to foraging moose.

Although birch is not an important moose forage plant on the river floodplain, it was well utilized on upland sites. It may prove useful to determine the nutritional value of birch versus browse species on the river for possible mitigation purposes at a later date.

Both highbush cranberry and rose exhibited similar characteristics on the OSA and SCSS. Cottonwood densities were just above 1 plant/m^2, and approximately 16 percent of available browse was eaten by moose. Willow densities were about 1 plant/m^2, and utilization was at or near 10 percent. Both plants were species of climax forests and not of earlier successional stages. They were less abundant in the moose diet and, therefore, would not serve as alternative forage if much willow and cottonwood were lost as forage because of advanced succession. A comparative nutritional value study between these plants as I suggested with birch, again, would be beneficial.

Much alder was observed while conducting browse transects and at no time was it consistently taken by moose. It appeared that in a few isolated areas alder was browsed very heavily, particularly on the same alder clump. In most other areas, it was not taken at all or if it was, only in small quantities.

Another observation worth noting was that on some riverine islands, apparent excellent moose browse had not been touched during the previous winter. Moose sign--both previous browsing on the plants and pellets on the ground--revealed that in past winters that area had been used heavily by moose. The cause of this phenomenon was not apparent. Some of the islands were relatively isolated and chances of moose encountering that forage each winter may have been low. Also, poor ice conditions during the winter may have precluded the moose crossing the island. During winters of low snowfall, the number of unbrowsed areas may increase if moose find sufficient forage off the river floodplain.

Tests for Significant Differences in Analysis

When tests were run on the original data for homogenity of variances among the mean percent utilization in each habitat type, it was found that there was a wide disparity in variances and they did not follow a normal distribution. Therefore, an arcsine square root transformation was utilized. Analysis of the transformed variables revealed that there was not a significant difference among variances when a Cochrans C test was utilized on the percent utilization of total browse in the SCSS.

The arcsine square root transformation did not equalize the variances for the OSA. Further analysis is required to identify the appropriate transformation. Nonetheless, a oneway analysis of variance was calculated for the OSA. While the results are questionable in light of the deviations from the underlying assumptions, the analysis of variance technique is robust and can tolerate departures from the assumptions.

The arcsine square root transformation was used only on total browse percent utilization data and not data on a species by species basis.

A multiple range test using a least signficiant difference procedure was employed to see if there were significant differences in percent utilization among habitats. Tables 5 and 6 show those habitats where their was a significant difference at the 0.05 level for the OSA and SCSS, respectively.

In the OSA, Equis was utilized significantly more than nine other habitats. Conversely, MDCSp had such a low mean percent utilization that it was utilized significantly lower than nine other habitats. The mean percent utilization of MTCWA in the SCSS was significantly higher than four other habitats. Both MLCWA and DTCWA had such low means of percent utilization that they were significantly lower than four habitats.

Table 5. Comparison of those habitat types in the overall study area whose mean percent utilization by moose was significantly different from another habitat. Asterisk denotes pairs of habitats significantly different at the 0.05 level.

Habitats	Relative Utilization[1]	SLCWA .0036	SCIBSp .0015	MMCWA .0042	MTBSp .0055	MDCSp .0022	CTCWA .0024	DTA .0055	DCICWA .0049	DCICSp .0036
Equis	.0097	*	*	*	*	*	*	*	*	*
SMCWA	.0078	*	*	*		*	*		*	*
MLCWA	.0065	*	*			*	*			*
MTBSp	.0055	*	*			*	*			*
MTCWA	.0074	*	*	*		*	*		*	*
DMCWA	.0073	*	*	*		*	*		*	*
DTA	.0055		*			*	*			
DCICWA	.0049					*				
DCIBSp	.0066	*	*	*		*	*			*

[1] Value derived using arc sine square root transformation of mean percent utilization.

Table 6. Comparison of those habitat types in the Sheep Creek Study Site whose mean percent utilization by moose was significantly different from another habitat. Asterisk denotes pairs of habitats significantly different at the 0.05 level.

Habitats	Relative Utilization[1]	SLCWA .0023	MLCWA .0010	DTCWA .0020	DCICWA .0035
MMCWA	.0053		*	*	
MTCWA	.0075	*	*	*	*
MCICWA	.0053		*	*	
DMCWA	.0056		*	*	

[1] Value derived using arc sine square root transformation of mean percent utilization.

More statistical tests are planned for the data as time permits. Habitat types will be ranked and tests subsequently conducted to determine significant differences in rankings. At that time the pellet group data will be analyzed.

PLANS FOR FUTURE STUDY

Final Year: Phase I

In March, 14 additional moose will be radio-collared. These moose will be collared over a wider distribution along the lower Susitna River than the previous collaring operation. Moose as high upriver as Gold Creek and as far downriver as Delta Islands will be collared to be certain that all subpopulations of moose using the river will be identified.

Also, in March a random stratified census of moose will be conducted. This will determine the relative moose use of the Susitna River's floodplain versus areas near the road and railroad and the Talkeetna Mountain foothills. Smaller censuses on the river floodplain only may be conducted to determine which portions of the river are used most.

Both the above projects are dependent upon "normal" winter conditions that "force" moose down on the river floodplain. The winter of 1980-81 up until the end of January 1981 has been mild with little snow that many moose are remaining at high elevations. This is not the same distribution of moose one would expect if the winter was more "normal" with deeper snow depths.

Browse availability/utilization transects and pellet group counts will be repeated to get another year of data.

In summer, if possible, radio collars will be placed on cow moose that calve or spend time on the floodplain during that season. Snow stakes may be put out so that in winter snow depths may be read in a "fly-by" of an aircraft. This will be similar to what was done in the upstream moose project. Depths of snow that trigger movement may then be recorded and depths on the river will then be recorded at frequent intervals.

Phase II

Continuing downstream moose studies into Phase II has become increasingly important because for the past two winters (at least through January 1981), conditions have been mild and much less use of the river by moose has been noted. A winter of moderate to heavy snowfall is needed to determine how much use of river floodplain occurs when snow covers available browse in other areas. Similar studies that have been conducted under Phase I would be continued in Phase II to get a more representative sampling of moose use under varying winter conditions. To better determine the identity of moose subpopulations using the river, the number of radio-collared moose should be increased.

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SUSITNA HYDROELECTRIC PROJECT
ANNUAL PROGRESS REPORT

BIG GAME STUDIES

PART III MOOSE - UPSTREAM

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and

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ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the
Alaska Power Authority

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SUMMARY

During April 1980, 40 adult moose were captured by darting from helicopter and each was radio-collared and biological specimens were collected to evaluate the physical condition of each moose. Average age of captured adult cow moose was 9.4 years, which was significantly older than moose captured in 1977. Sixty-two percent of the moose were 10 years old or older. The average age of these moose was older than other Alaskan moose populations sampled. At least 73 percent of the cow moose examined were pregnant. This pregnancy rate was lower than that obtained in other moose studies and may have been due to a number of factors such as inexperienced palpators, low bull:cow ratios, or nutritional stress.

Blood parameters from captured moose were compared with those collected from earlier Susitna studies and other Alaskan moose populations. The physical condition of Susitna moose appears to have deteriorated since 1977. This, in conjunction with the possibility of a lower pregnancy rate and an older age structure suggests that this population is declining or is about to decline.

Forty-three radio-collared moose (three were from earlier studies) were radio located on 563 occasions. Of that total, 9.2 percent occurred at elevations scheduled to be inundated. Most moose exhibited relatively short movement patterns, spending late winter and early spring at lower elevations and occupying upland areas in summer and fall. Only one moose was observed calving in the proposed areas to be inundated. Migratory moose were located in areas east of Jay Creek except for one moose located at Watana Creek. Several migratory routes were identified. Moose river crossings on the Susitna for radio-collared animals were concentrated at the mouth of Fog Creek, between Watana and Jay Creek and above Goose Creek. The proposed impoundments did not appear to harbor any significant rutting groups of moose.

Moose parturition occurred from 22 May to 10 June. Nineteen cows produced 30 calves with 58 percent producing twins. Rates of calf porduction were comparable with those observed in 1977 and 1978. Mortality of newborn moose calves was high and comparable to that observed in 1977 and 1978 when brown bears were identified as the largest cause of mortality. Six percent of the moose observed during a winter distribution survey conducted in March 1980 were located in areas to be inundated. Tracks suggested that considerably more moose had been in these areas earlier in the winter. Track concentrations in areas which would be inundated were observed at Watana Lake, Watana Creek, Jay Creek and the Oshetna River.

Sex and age composition surveys and a random stratified census were conducted in the study area during November 1980. It was estimated that 2,046 ± 382 moose occupied the areas north and south of the proposed Watana impoundment. A crude population estimate of 1,151 moose was made for the project area lying west of Kosina and Watana Creek.

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

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page

Page

INTRODUCTION

The Susitna River Basin has long been recognized as an extremely rugged wilderness area of high esthetic appeal and an important habitat to a wide variety of wildlife species (Taylor and Ballard 1979). Most important to sport and subsistence hunters are moose (*Alces alces*) and caribou (*Rangifer tarandus*). In response to hydroelectric development proposals some very general ungulate population assessment work was begun in 1974 (USFWS 1975). This latter study was funded for 1 year and consisted of a series of reconnaissance flights to identify moose concentration areas. In 1976 limited funds became available to begin gathering baseline data on moose movements and habitat use for areas which could be impacted by the Corp of Engineers two dam proposal (Ballard and Taylor 1980). These initial studies focused on areas lying north of the Susitna River and were conducted from March 1977 through spring 1978 with limited follow-up work and to a much lesser extent from spring 1978 through spring 1979 (op. cit.). Results of these preliminary studies identified some potential problem areas and additional data requirements for better assessing the impacts of the two dam system on moose.

The most significant data gaps identified in the preliminary moose movements study were the lack of moose movement data for areas lying south of the Susitna River and accurate moose population estimates for the entire project area (Ballard and Taylor 1980). Funding for the original project terminated in spring 1979 and was not resumed until 1 January 1980 when the Alaska Power Authority contracted the Alaska Department of Fish and Game to conduct expanded moose studies which were modified from the 1978 proposal. The purpose of this report is to present our preliminary findings on moose movements, habitat use and number and trend of moose populations inhabiting areas which could be impacted by the two dam system. Although this study was funded from 1 January 1980 through 31 December 1980, in depth field studies could not be initiated until March 1980 due to the time lag between initial funding and the arrival of necessary radio telemetry equipment. Therefore, this report primarily reflects data collected from mid-April through December 1980.

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

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

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

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

METHODOLOGY

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

Captured moose were equipped with a radio collar which allowed each moose to be located from fixed-wing aircraft when desired. Visual collars, similar to those described by Franzmann et al. (1974) were riveted to each radio collar to aid in observing each moose from aircraft and to insure individual recognition. Radio collars, manufactured by Telonics (Mesa, AZ), were constructed of two layers (black urethane over butyl rubber) and had an inner circumference of 140 cm. Each radio collar was equipped with a dipole antenna which was partially enclosed between the urethane and butyl rubber layers with 22 cm of antenna protruding from the side and back of the collar. The entire unit with visual collar weighed 1,380 g. Twelve radio collars were also equipped with experimental air temperature sensors in an effort to compare moose movements with ambient air temperature. Each sensor varies the pulse width of the transmitter inversely to air temperature. Since these units are experimental and we were most interested in fall and winter temperatures only one months data exist at the time of this report and consequently they were not included.

Each moose was also ear tagged with a numbered, monel metal tag. Tags were affixed to the middle of the ear. After collaring and tagging, an attempt was made to extract a lower incisor tooth from each animal for determining its age using the methods described by Sergeant and Pimlott (1959).

Blood was extracted from the jugular vein into sterile evcacuated containers. Upon return from the field, blood was centrifuged to separate sera which were placed into 5 ml plastic vials and immediately frozen. Three ml samples were later sent to Pathologists Central Laboratories, Seattle, Washington for blood chemistry analysis (Technical Autoanalyzer SMA-12) and protenin electrophoresis (Franzmann and Arneson 1973).

Generally three or four 10 ml vials were filled 1/3 to 1/2 full. One vial contained heparin which provided whole blood for determination of percent hemoglobin (Hb) using an Hb meter (American Optical Corporation, Buffalo, New York), and packed cell volume (PCV) was determined with a micro-hematocrit centrifuge (Readocrit-Clay-Adams Company, Parsippany, N.J.). Remaining sera were stored for possible future analyses.

Physical measurements taken included total length, head length, heart girth, neck circumference and length of hind foot. An attempt was made to subjectively estimate the physical condition of each moose using the index criteria developed by Franzmann and Arneson (1973). Each moose was rectally palpated (Greer and Hawkins 1967) to determine pregnancy. Data from individual moose were placed on numbered tagging cards and each moose was assigned an individual accession number (Fig. 1).

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

MOOSE TAGGING RECORD

Moose No.________________ Location____________________

Sex______ Age_______ Date______________________

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

Number______________ Radio Frequency _________ LE______________________

Metal Tag No.____________ RE______________________

Year Born______________ W/Calf_____ Operators____________________

Blood: Yes____ No____ Tooth: Yes____ No____ Hair: Yes____ No____

Measurements: T.L._____ H.F._____ H.S._____ Girth_____ Head______ Neck_____

Excit._____ Cond._____ H.R._____ Temp._____ Amb. Temp.________

Antler Spread__________ Antler Base__________ Weight____________ PG Yes__No__

Remarks:____

____

Calf Tagged: Yes____ No____ Accession No.________________

DARTS:

No. 1

Time	Hour	Min.	Sec.
Hit	:	:	
Down	:	:	
M50-50	:		
Up	:	:	

Hit Location:____________________

Drug/Dosage:_____________________

No. 2

Time	Hour	Min.	Sec.
Hit	:	:	
Down	:	:	
M50-50	:	:	
Up	:	:	

Hit Location:____________________

Drug/Dosage:_____________________

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

Radio-collared moose were relocated from both Piper PA-18 Super Cub and STOL Cessna 180 fixed-wing aircraft. Tracking methods and equipment used were similar to those described by Mech (1974) except that our right-left switch box allowed us to listen to both antennas simultaneously. This feature often allowed us to detect and locate animals signal much sooner than if we had just listened to one antenna.

An attempt was made to locate each moose a minimum of twice per month. From mid-May through mid-July each moose which had been diagnosed as pregnant was located at 3-5 day intervals to obtain data on calf parturition and survival (Ballard et al. 1981). When radio-collared moose were found, their locations were recorded on U.S.G.S. maps (scale of 1:63,000) along with information pertaining to sex, age and numbers of associated moose and other wildlife, activity, and environmental parameters (Fig. 2). General habitat type at each moose location was also classified from fixed-wing aircraft. However, the habitat classifications used were not those described by Viereck and Dyrness (1980).

A number of serious problems exist with attempts to classify moose habitat from fixed-wing aircraft. Often the observer is only able to identify overstory vegetation. In many cases the overstory vegetation may have little relevance to why an animal has selected an area because understory vegetation varies significantly, often in association with density of overstory. Therefore, any habitat classification made from fixed-wing aircraft may not provide a meaningful index of the types preferred by moose. In 1977 an aerial moose habitat classification system based on overstory vegetation was used for describing habitat utilized by radio-collared moose (Table 1). Although the system has many shortcomings it was used for this study because we were most familiar with it, thus insuring collection of data which can be compared with earlier studies. A system to transform these classifications to

Viereck and Dyrness's system down to their level 3 classification, which is probably the most accurate classification obtainable from aircraft, will be developed in 1981.

To partially explain moose distribution and movements in relation to the proposed impoundments, it is necessary to measure several environmental parameters to determine if relationships exist. Initially, a series of climate stations at key locations was proposed to measure various weather variables which might explain seasonal moose distributions. However, costs and logistics problems precluded establishment of these stations. In cooperation with R & M Consultants and the U.S. Soil Conservation Service, eight snow depth transects were established at key areas to measure snow depths on a monthly basis. Information pertaining to design and construction of snow depth markers (Fig. 3) was provided by Mr. George Clagett, U.S.S.C.S. Location and descriptions of each marker were provided in Table 2 and Fig. 4. November snow depths are provided in Table 3. Unfortunately bears (*Ursus* sp.) damaged eight of 33 markers prior to the first reading from fixed-wing aircraft in early November 1980.

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

Moose sex and age composition counts have been conducted in the vicinity of Watana impoundment since 1955. Only one such

Date ____________________ Start ____________________

Survey type ____________________ Pilot ____________________ Stop ____________________

Observer ____________________ Keypunched /__/ Duration ____________________

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

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

Table 1. Habitat classifications utilized to classify moose habitat usage from fixed-wing aircraft from April through December 1980 in the Susitna River Basin of southcentral Alaska[1].

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

1/ Modified from Ballard and Taylor 1980.

2/ Spruce densities also classified as high, medium or low.

at 33 locations within the Susitna River study area.

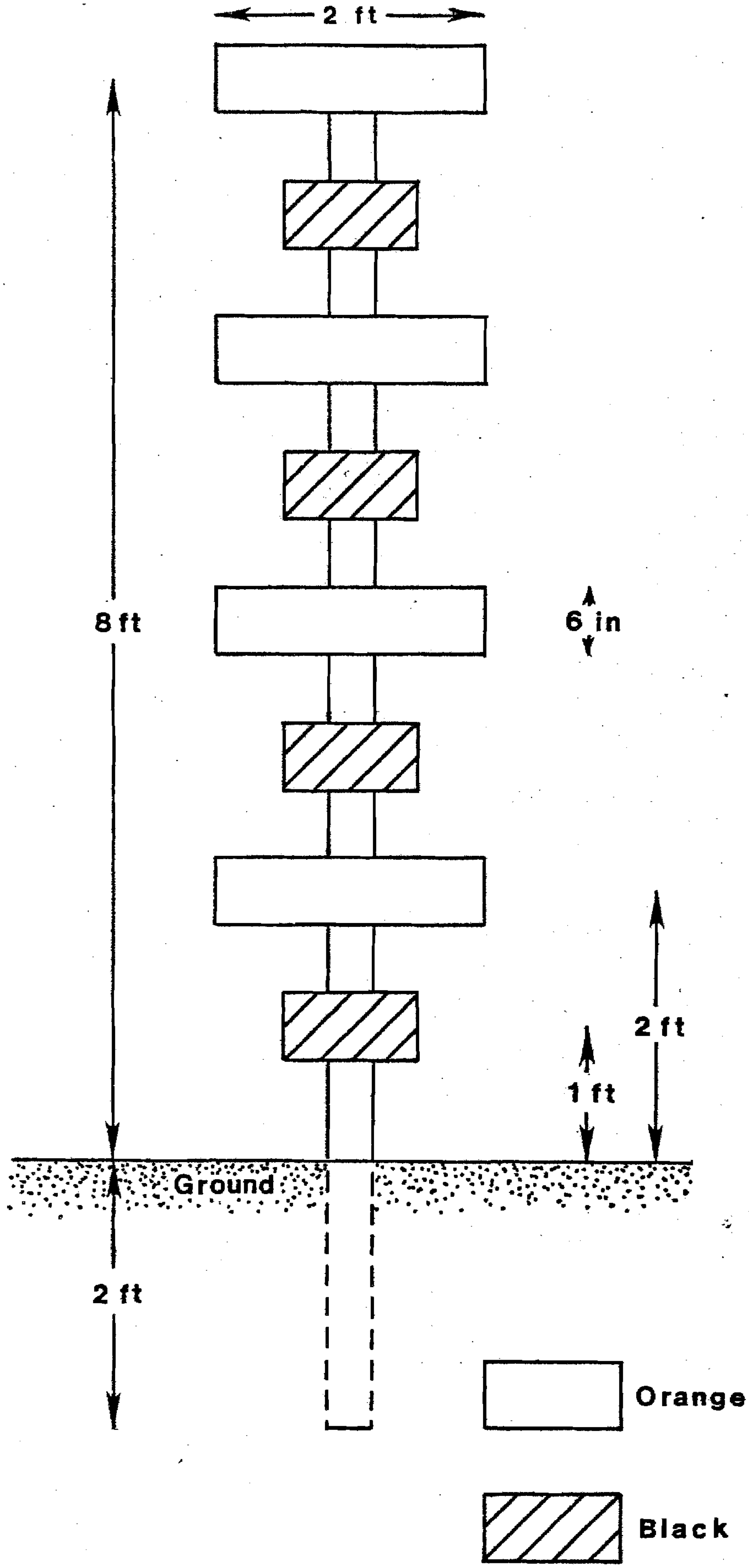

Table 2. Location and description of 33 snow depth markers erected for Susitna moose studies in the Susitna River Basin of southcentral Alaska.

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

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

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

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

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

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

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

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

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

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

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

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

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

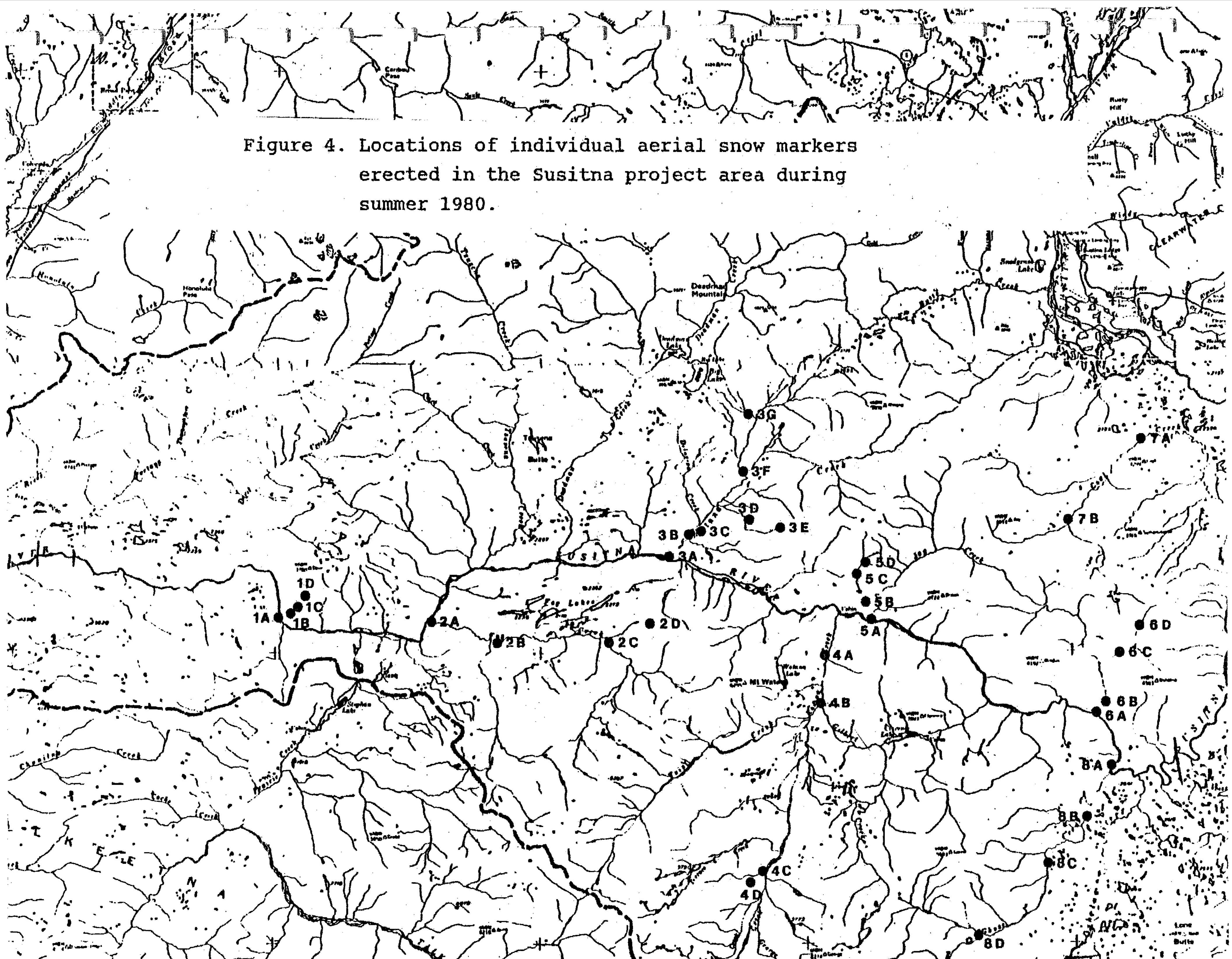

Figure 4. Locations of individual aerial snow markers erected in the Susitna project area during summer 1980.

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

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

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

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

survey has been conducted in the vicinity of the Devil canyon impoundment. These surveys were conducted similar to methods described for winter distribution surveys except for the following: Transects are flown closer together and more intensively (narrower search strips), surveys are conducted annually in late October or early November depending on snow conditions, attempts are made to survey each area with the same pilot and observer to minimize the differences between observers (LeResche and Rausch 1974), and more detailed sex and age composition data are collected.

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

Moose populations within the study area were censused in early November using quadrat sampling techniques developed by Gasaway (1978), Gasaway et al. (1979), and Gasaway and Dubois (unpub. report). The census was conducted immediately following moose sex and age composition surveys. Due to deteriorating snow conditions only CA's 7 and 14 were censused to provide an estimate of the numbers of moose which could potentially be influenced by the Watana impoundment. No census was conducted for areas outside of CA's 7 and 14; however, remaining potential impact areas were stratified into high, medium and low densities. The density classifications were based upon numbers of moose observed, continuity of moose habitat, and moose tracks observed during a cursory aerial survey similar to that performed in CA's 7 and 14 before they were censused. This stratification procedure allowed gross estimation of population numbers in uncensused areas by using density estimates from areas which were censused and similarly stratified.

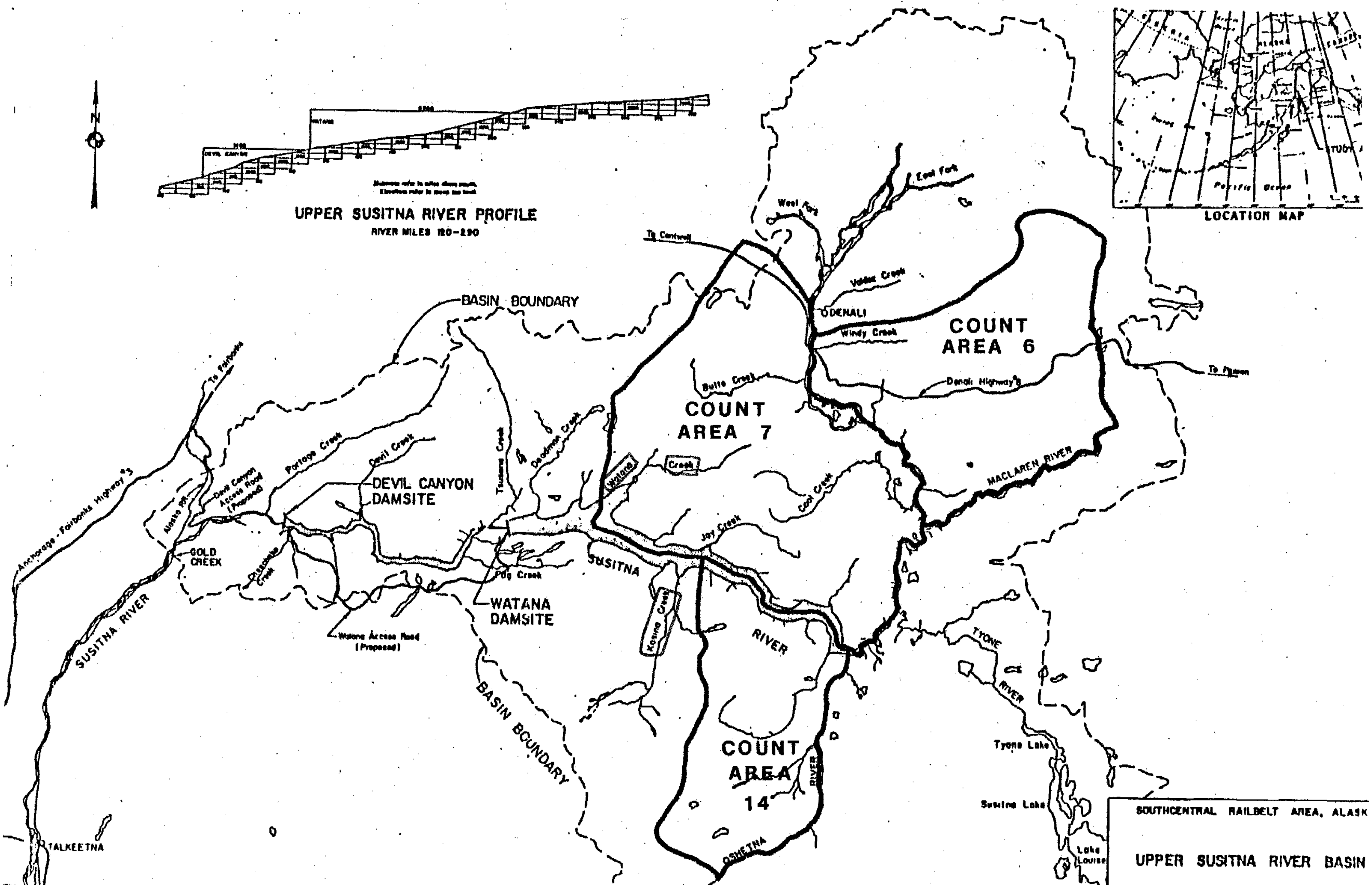

Figure 5. Boundaries of moose count areas previously surveyed from 1955 through 1980 in the Susitna Hydroelectric Project study area of southcentral Alaska.

STUDY AREA

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

Vegetation, topography and general climate of the area has been described by Skoog (1968), Bishop and Rausch (1974), Ballard and Taylor (1980), and Ballard (1981) and thus no further descriptions are needed until vegetation studies under Subtask 7.12 are completed.

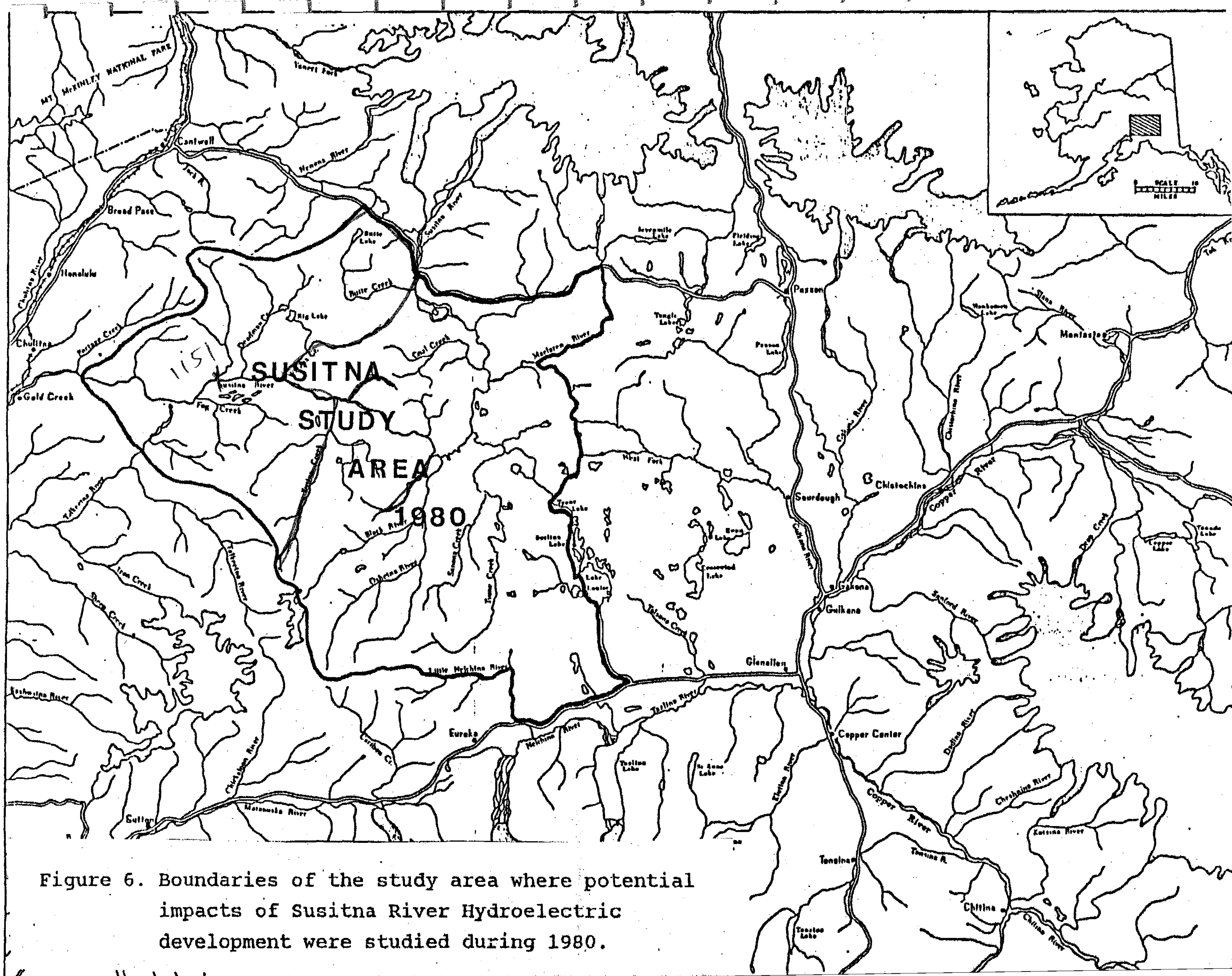

Figure 6. Boundaries of the study area where potential impacts of Susitna River Hydroelectric development were studied during 1980.

RESULTS AND DISCUSSION

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

Mean induction time for all captured moose was 16.4 minutes (S.D. = 10.5) ranging from 5 to 52 minutes (Table 4). Longer induction times were the result of moose not responding to the first dart, requiring additional drug dosages to be administered. In most cases a second injection of 2-4 cc's M-99 was necessary. Mean induction time for moose which responded to the first dart was 11.7 minutes (S.D. = 4.7) ranging from 5 to 32 minutes while moose requiring multiple darts responded in an average of 28.7 minutes (S.D. = 11.8, range 12-52 minutes).

Two cow moose (#'s 620 and 646) were known to have died, apparently as a result of capture activities resulting in a 5 percent mortality rate. This rate is comparable with mortality rates reported in other Alaska moose studies where M-99 has been employed (Gasaway et al. 1979; Smith and Franzmann 1979) and continues to be considerably less than that obtained from use of succinylcholine chloride (Didrickson et al. 1977; Ballard and Taylor 1980) and does not influence subsequent calf survival as suspected for the latter drug (Ballard and Tobey in review).

Average age of cow moose tagged in spring 1980 was 9.4 years (S.D. = 3.8) while the three bulls averaged 4.3 years (S.D. = 0.6). Mean ages of cow moose tagged in the upper Susitna River Basin in 1976 and 1977 (Ballard and Taylor 1980)

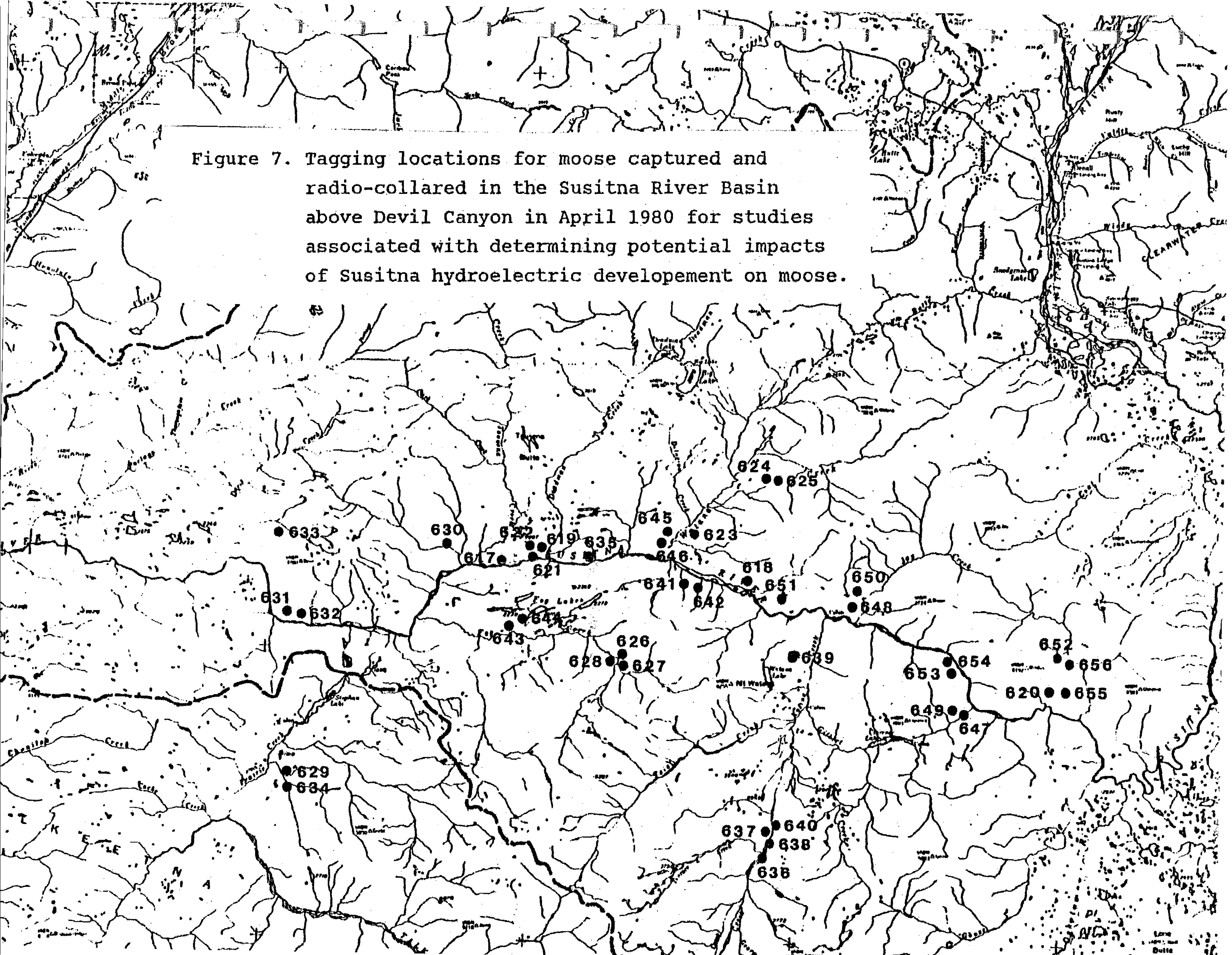

Figure 7. Tagging locations for moose captured and radio-collared in the Susitna River Basin above Devil Canyon in April 1980 for studies associated with determining potential impacts of Susitna hydroelectric developement on moose.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

*ATS = Air Temp Sensing.

were compared with those captured in 1980 and were found to be significantly (t test $P<0.05$) younger. The 1976 and 1977 ages were adjusted upward to correspond with the 1980 tagging period. Cow moose in 1976 averaged 7.5 years (S.D. = 3.4) of age while those in 1977 averaged 7.0 years (S.D. = 3.8). In 1976-77 cow moose 10 years of age or older represented 25 percent of the sample; however, in 1980 they represented 62 percent of the sample. In 1976 and 1977 moose from 2 to 4 years of age comprised 21 and 40 percent, respectively, of the captured moose while in 1980 they comprised 21 percent. Differences between the age structures was most evident for moose 5 to 9 years of age. These findings indicate that the age structure of the adult cow segment has become older since 1976-77. Although reasons for this shift are uncertain, predation and mortality due to the severe winter of 1978-79 appear likely.

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

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

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

Condition Assessment

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

Blood values for 34 individual moose sampled in April 1980 are presented in Table 5. In previous studies, blood parameters suggested that moose from the Devils Mountain area may have been in poorer physical condition than those examined elsewhere in the Basin. Small sample sizes, however, prevented any firm conclusions from being made. To examine this hypothesis further, blood samples from moose sampled in 1980 were divided into groups above and below the proposed Watana dam (Table 5). Five blood values which Franzmann and LeResche (1978) believed were the most useful for assessing condition were compared. They were as follows: Packed cell volume (PCV), hemoglobin (Hb), calcium (Ca), phosphorus (P) and total protein (TP). No significant differences (t test, $P>0.01$) were detected for these five parameters, suggesting that moose above and below the proposed Watana reservoir exhibited similar trends of condition.

Blood parameters from moose captured in 1980 were also compared with those collected previously in GMU 13 and elsewhere in Alaska (Table 6). Samples in Table 6 are listed in order of high to low PCV values which Franzmann and LeResche (1978) believed was the most useful parameter for assessing condition class. They believed the following blood values represented adult moose in average or better condition: PCV - 50 percent; Hb - 18.6 g/100 ml, calcium - 10.4 mg/100 ml, phosphorus - 5.2 mg/100 ml, total protein - 7.5 g/100 ml, albumin - 4.5 g/100 ml, beta globulin 0.7 g/100 ml, and glucose - 140 g/100 ml. Seven of eight of these values in 1980 were below these desirable levels. Mean PCV and Hb values from each sampling period were compared by t test. PCV values for 1980 Susitna moose were significantly different ($P<0.05$) from those obtained at the Copper River Delta, GMU 13 in 1975 and 1977, GMU 15C, GMU 5, the Moose Research Center and GMU 9. No

Table 5A. Blood values from adult moose radio-collared downstream from Watana dam site, April 1980.

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

Table 5A (cont.). Blood values from adult female moose radio-collared downstream from Watana dam site, April 1980.

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

Table 5B. Blood values from adult female moose radio-collared upstream from Watana dam site, April 1980.

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

Table 5B (cont.). Blood values from adult female moose radio-collared upstream from Watana dam site, April 1980.

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

Table 6. Comparison of moose blood and morphometric condition parameters from Alaskan populations sampled in late winter and spring (sample size in parenthesis, table modified from Smith and Franzmann 1979).

Blood Values		Copper River Delta (Mar.1974) Mean	SD	GMU 13 (Mar.1977) Mean	SD	GMU 13 (Apr.1975) Mean	SD	GMU 15C (Apr.1975) Mean	SD	GMU 14C (Feb.1976) Mean	SD
Calcium	mg/dl	10.38	0.74(44)	11.23	0.80(49)	10.91	0.86(58)	9.61	0.98(29)	10.33	0.81(19
Phosphorus	mg/dl	5.50	0.69(44)	4.48	1.03(49)	5.63	0.99(59)	4.72	1.08(29)	4.74	1.51(18
Glucose	mg/dl	147.0	37.5(44)	152.4	26.6(49)	127.8	20.2(59)	91.3	16.2(29)	109.9	16.3(18)
Total Protein	g/dl	7.07	0.57(45)	7.14	.63(54)	7.43	0.40(61)	6.70	0.83(30)	7.20	0.54(18
Albumin	g/dl	3.82	0.39(45)	-	-	5.21	0.39(61)	4.21	0.51(30)	4.80	0.41(18
Beta globulin	g/dl	0.72	0.09(45)	-	-	0.60	0.11(61)	0.55	0.12(30)	0.60	0.07(18
Hemoglobin	g/dl	19.8	0.5(46)	18.8	1.38(25)	19.7	0.7(60)	18.7	1.5(29)	15.4	1.2(17)
PCV	%	53.2	4.2(46)	50.2	3.5(51)	49.2	3.7(60)	45.9	3.9(29)	43.4	2.8(19)
Total Length (females)	cm	301.5	81.(23)	288.5	18.0(38)	295.6	10.9(115)	288.5	15.3(210)	-	-
Chest Girth (females)	cm	201.3	13.8(25)	195.4	12.7(34)	191.3	14.3(105)	182.2	16.3(194)	-	-
Hind Foot (females)	cm	81.5	1.8(16)	-	-	80.0	2.9(79)	79.9	3.8(203)	-	-
Shoulder Height (females)	cm	-	-	-	-	185.5	11.1(7)	174.9	14.1(65)	-	-

Table 6 (cont.).

Blood Values		GMU 13 Susitna Study Area (Apr., 1980) Mean	SD	Yakutat (Mar. 1980) Mean	SD	GMU 13 (Mar.1979) Mean	SD	Moose Research Center (Feb.,Mar.,Apr.) Mean	SD	GMU 9 (Apr.1977) Mean	SD
Calcium	mg/dl	10.24	0.47(33)	10.98	0.57(41)	9.52	1.14(13)	9.81	0.64(39)	10.80	0.43(57
Phosphorus	mg/dl	5.17	1.26(33)	3.71	1.06(41)	4.90	0.84(13)	3.90	1.09(39)	4.35	0.86(57
Glucose	mg/dl	128.36	20.74(33)	143.8	23.1(41)	107.9	21.0(13)	116.2	26.1(39)	158.1	22.2(57)
Total Protein	g/dl	6.88	0.50(33)	7.45	0.43(41)	5.65	0.60(13)	6.60	0.44(39)	7.79	0.43(57
Albumin	g/dl	4.85	0.31(33)	5.38	0.30(41)	-	-	3.76	0.46(39)	5.05	0.28(57
Beta globulin	g/dl	0.48	0.27(33)	0.62	0.09(41)	-	-	0.58	0.10(39)	0.74	0.11(57
Hemoglobin	g/dl	17.55	1.45(30)	16.7	1.3(42)	16.9	1.5(11)	15.9	2.2(39)	16.4	1.3(54)
PCV	%	42.77	5.22(30)	40.6	3.6(42)	40.6	3.6(11)	39.9	4.6(39)	39.0	5.4(56)
Total Length	cm	288.5	15.3(34)	289.2	13.0(39)	286.0	17.5(13)	282.6	9.1(254)	302.1	6.8(54)
Heart Girth	cm	200.3	17.2(33)	202.6	12.2(39)	188.1	14.2(13)	179.5	11.1(252)	201.1	12.2(53)
Hind Foot	cm	80.9	4.4(31)	79.4	13.7(37)	84.1	5.5(13)	79.3	1.9(246)	80.8	1.8(12)
Shoulder Height	cm	-	-	-	-	-	-	175.9	8.1	-	-

significant differences (P>0.05) were detected between 1980 PCV values and those obtained in GMU 13 in 1979, when moose were nutritionally stressed due to winter severity, and for GMU 14C. Similar differences and similarities were detected for Hb values. Past moose studies in GMU 13 have historically demonstrated higher PCV values than those found in other more populations around the State described as nutritionally stressed (Ballard and Taylor 1980). However, the 1980 values are comparable to these populations. Since winter 1979-80 was not considered severe, we surmise that condition of Susitna moose has declined since 1977. If correct, this may indicate that range conditions have also deteriorated. The significantly lower blood values for 1980 moose in conjunction with a possible lower incidence of pregnancy and a significantly older age structure for adults suggests that this moose population either is declining or is about to decline.

Movements

Between late April and 31 December 1980, 563 radio locations were obtained for 43 radio-collared moose. Of the 43 moose five were recaptures of moose which had been tagged in 1976 and 1977 (moose #'s 618, 620, 623, 631 and 651) and three were previously radio-collared moose which still had functioning radio collars in 1980 (#'s 662, 663 and 664). An average of 13.1 radio locations per moose (S.D. = 4.4) were obtained (Table 7) during the first year of study. However, few radio locations were obtained from mid-November through December due to inclement weather.

The radio-collared moose exhibited all of the types of movements described by LeResche (1974) for moose in North America. Home ranges for these moose were not calculated because 7 months of data is inadequate to determine seasonal home ranges. Also these data had not been digitized (see biometrician's annual report). Digitized locations will allow

Table 7. Summary of radio locations, calf production and use of proposed impoundment areas for radio-collared moose located from 11 April to 4 December 1980 in the Susitna River Basin of southcentral Alaska.

											Number Locations in Area to be Inundated[1/]			Month of Obs. in Areas to be Inundated			
Moose Number	No. Times Located	Period of Obs.	Number Times Crossed Susitna River 4/15/80-12/4/80	Dates of Crossing	Date 1st Observed w/Calves	Calving Habitat	Number Calves	Date Last Observed w/Calves	Number Calves Lost	Number Surviving Calves	Devils Canyon	Watana	% of Obs.	Devils Canyon	Watana	% Months of Study	Misc. Notes
120617	20	4/11-11/13	0	--	--	--	--	--	--	--	0	1	5	--	Apr	14	
120618 (8573)	13	4/11-11/19	0	--	--	--	--	--	--	--	0	5	39	--	Apr,May, Jun,Aug	57	
120619	16	4/11-11/19	1	Betw 5/13-6/4	--	--	--	--	--	--	0	3	19	--	Apr,May Oct	43	
120620 (8576)	2	4/11-4/22	--	--	--	--	--	--	--	--	0	0	0	--	--	0	Dead 4/22
120621	1	4/11	--	--	--	--	--	--	--	--	0	1	100	--	Apr	100	Lost collar
120622	18	4/11-11/13	0	--	6/2	med. med. spruce	1	6/2	1	0	1	0	6	Apr	--	14	
120623 (5527)	10	4/11-11/9	0	--	--	--	--	--	--	--	0	1	10	--	Apr	14	
120624	14	4/13-12/4	0	--	5/25	upland willow	1	6/26	1	0	0	0	0	--	--	0	
120625	6	4/13-6/26	0	--	--	--	--	--	--	--	0	1	17	--	May	50	Dead 6/26 possibly bear predation
120626♂	13	4/13-11/19	0	--	--	--	--	--	--	--	0	3	23	--	May,Jun, Sep	43	
120627♂	12	4/13-8/26	3	Betw. 4/22-5/14 6/26-7/10 7/28-8/1	--	--	--	--	--	--	0	7	58	--	May,Jun Jul,Aug	100	Hunter kill 9/11
120628	16	4/13-11/19	0	--	5/22	upland willow	2	5/22	2	0	0	0	0	--	--	0	

1/ Assumes normal pools of 1450' for Devil Canyon impoundment and 2200' for Watana impoundment.

Table 7 (cont.). Summary of radio locations, calf production and use of proposed impoundment areas for radio-collared moose located from 11 April to 4 December 1980 in the Susitna River Basin of southcentral Alaska.

Moose Number	No. Times Located	Period of Obs.	Number Times Crossed Susitna River 4/15/80-12/4/80	Dates of Crossing	Date 1st Observed w/Calves	Calving Habitat	Number Calves	Date Last Observed w/Calves	Number Calves Lost	Number Surviving Calves	Number Locations in Area to be Inundated[1/]: Devils Canyon	Watana	% of Obs.	Month of Obs. in Areas to be Inundated: Devils Canyon	Watana	% Months of Study	Misc. Notes
120629	15	4/18-11/13	0	--	5/31	med. med. spruce	2	5/31	2	0	0	0	0	--	--	0	
120630	13	4/11-11/13	0	--	6/10	med. tall spruce	2	6/10 1 living	1	1	0	0	0	--	--	0	
120631 (8580)	14	4/18-11/13	0	--	--	--	--	--	--	--	1	0	7	May	--	14	
120632	12	4/18-9/10	0	--	--	--	--	--	--	--	0	0	0	--	--	0	Lost collar 7/14-8/12
120633	3	4/18-6/10	0	--	--	--	--	--	--	--	0	0	0	--	--	0	Lost collar 4/22-5/13
120634	15	4/18-11/13	0	--	5/31	dense med. spruce	1	5/31	1	0	0	0	0	--	--	0	
120635	16	4/19-11/13	1	Betw.4/22-5/31	5/31	Tall birch	2	5/31	2	0	0	2	13	--	Apr	14	
120636	14	4/19-12/4	0	--	--	--	--	--	--	--	0	0	0	--	--	0	
120637	16	4/19-12/4	0	--	5/31	upland willow	2	6/26 1 living	1	1	0	0	0	--	--	0	
120638	13	4/19-12/4	0	--	--	--	--	--	--	--	0	0	0	--	--	0	
120639	18	4/19-12/4	0	--	<7/14	upland willow	1	7/14	1	0	0	1	6	--	Apr	14	No obs. from 6/10-7/14
120640	13	4/19-12/4	0	--	6/2	upland willow	1	living	0	1	0	0	0	--	--	0	
120641	17	4/20-12/4	0	--	5/31	upland tundra	2	6/26 1 living	1	1	0	3	18	--	Apr,May	29	
120642♂	14	4/20-11/19	0	--	--	--	--	--	--	--	0	2	14	--	Apr,Sep,	29	
120643	18	4/20-11/3	0	--	--	--	--	--	--	--	0	0	0	--	--	0	
120644	14	4/20-11/13	0	--	6/2	tall med spruce	2	6/2	2	0	0	1	7	--	Apr	14	

Table 7 (cont.). Summary of radio locations, calf production and use of proposed impoundment areas for radio-collared moose located from 11 April to 4 December 1980 in the Susitna River Basin of southcentral Alaska.

Moose Number	No. Times Located	Period of Obs.	Number Times Crossed Susitna River 4/15/80-12/4/80	Dates of Crossing	Date 1st Observed w/Calves	Calving Habitat	Number Calves	Date Last Observed w/Calves	Number Calves Lost	Number Surviving Calves	Number Locations in Area to be Inundated[1/]: Devils Canyon	Number Locations in Area to be Inundated[1/]: Watana	Number Locations in Area to be Inundated[1/]: % of Obs.	Month of Obs. in Areas to be Inundated: Devils Canyon	Month of Obs. in Areas to be Inundated: Watana	Month of Obs. in Areas to be Inundated: % Months of Study	Misc. Notes
120645	14	4/20-12/4	0	--	5/25	sparse med. spruce	2	6/6	2	0	0	7	50	--	Apr, May, Jun, Sep	57	
120646	3	4/20-5/18	0	--	--	--	--	--	--	--	0	2	67	--	Apr	100	Dead from collaring or wolf pred.
120647	18	4/22-12/4	2	Betw. 5/25-5/27, 5/27-5/31	--	--	--	--	--	--	0	2	11	--	Apr, May	29	
120648	14	4/22-12/4	0	--	6/27	upland willow	1	living	0	1	0	0	0	--	--	0	No obs 6/6-6/27
120649	14	4/22-12/4	0	--	5/25	upland willow	1	5/25	1	0	0	0	0	--	--	0	
120650	16	4/22-12/4	0	--	5/27	?	1	living	0	1	0	0	0	--	--	0	
120651 (8588#2)	13	4/22-12/15	0	--	--	--	--	--	--	--	0	3	23	--	Apr, May	29	
120652	16	4/23-12/4	0	--	6/2	upland willow	2	6/2	2	0	0	0	0	--	--	0	
120653	14	4/23-12/4	0	--	5/27	upland willow	2	5/27	2	0	0	1	7	--	Apr	14	
120654	14	4/23-12/4	0	--	--	--	--	--	--	--	0	4	29	--	Apr, May, Jun, Aug	57	
120655	14	4/23-12/4	0	--	--	--	--	--	--	--	0	0	0	--	--	0	
120656	16	4/23-12/4	0	--	<6/27	upland willow	2	6/27(2) 1 living	1	1	0	0	0	--	--	0	No obs 6/2-6/27
120662 (8583)	10	6/4-11/13	0	--	N/A	N/A	N/A	--	--	--	0	0	0	--	--	0	
120663 (8031)	10	8/7-12/4	0	--	N/A	N/A	N/A	--	--	--	0	0	0	--	--	0	
120664 (8035)	11	6/13-12/3	0	--	N/A	N/A	N/A	--	--	--	0	0	0	--	--	0	
TOTAL																	
43	563		7	--	--	--	30	--	23	7	2	50	9.2	--	--	--	
x̄	13.1		1.8	--	--	--	1.6	--	--	--	--	--	--	--	--		
S.D.	4.4		1.0	--	--	--	.6	--	--	--	--	--	--	--	--		

accurate calculation of such values and will also permit construction of individual maps depicting home range size and seasonal usage patterns. Data from this and previous movement studies (Ballard and Taylor 1980) will be combined and analyzed for the final Phase I report.

Figures 8 through 13 depict the general areas occupied by radio-collared moose and the observed calving locations during this study period. Most moose appeared to be relatively sedentary, occupying tributary drainages of the Susitna River. Moose movements were relatively short, consisting of altitudinal movements which generally corresponded to LeResche's Type B movements. Generally most moose occupied lower elevations (1,600-1,800 ft) during April and early May and occupied progressively higher areas as summer progessed into fall. During the October rut most moose occupied higher elevations in subalpine tundra. Although more data are needed, we suspect many of these moose will have overlapping summer and winter ranges. Several moose (including #623, 624, 635, 648 and 650) appeared to be migratory, having separate summer and winter ranges. These latter moose exhibited movement patterns similar to LeResche's Type C group. As found in earlier preliminary moose studies (Ballard and Taylor 1980) most migratory moose inhabiting drainages including and lying east of Jay Creek were migratory.

Because tagging was not initiated until mid-April, it is possible that some migratory moose had left the area and were not captured. However, movement data collected to date suggest that moose occupying areas adjacent to the Susitna River near the two proposed impoundments consist primarily of one resident population which is comprised of numerous small subpopulations which occupy individual drainages. Several subpopulations seasonally share winter range with migratory moose. Moose from the following areas migrate and share range with resident (overlapping winter and summer range) moose; moose from Butte

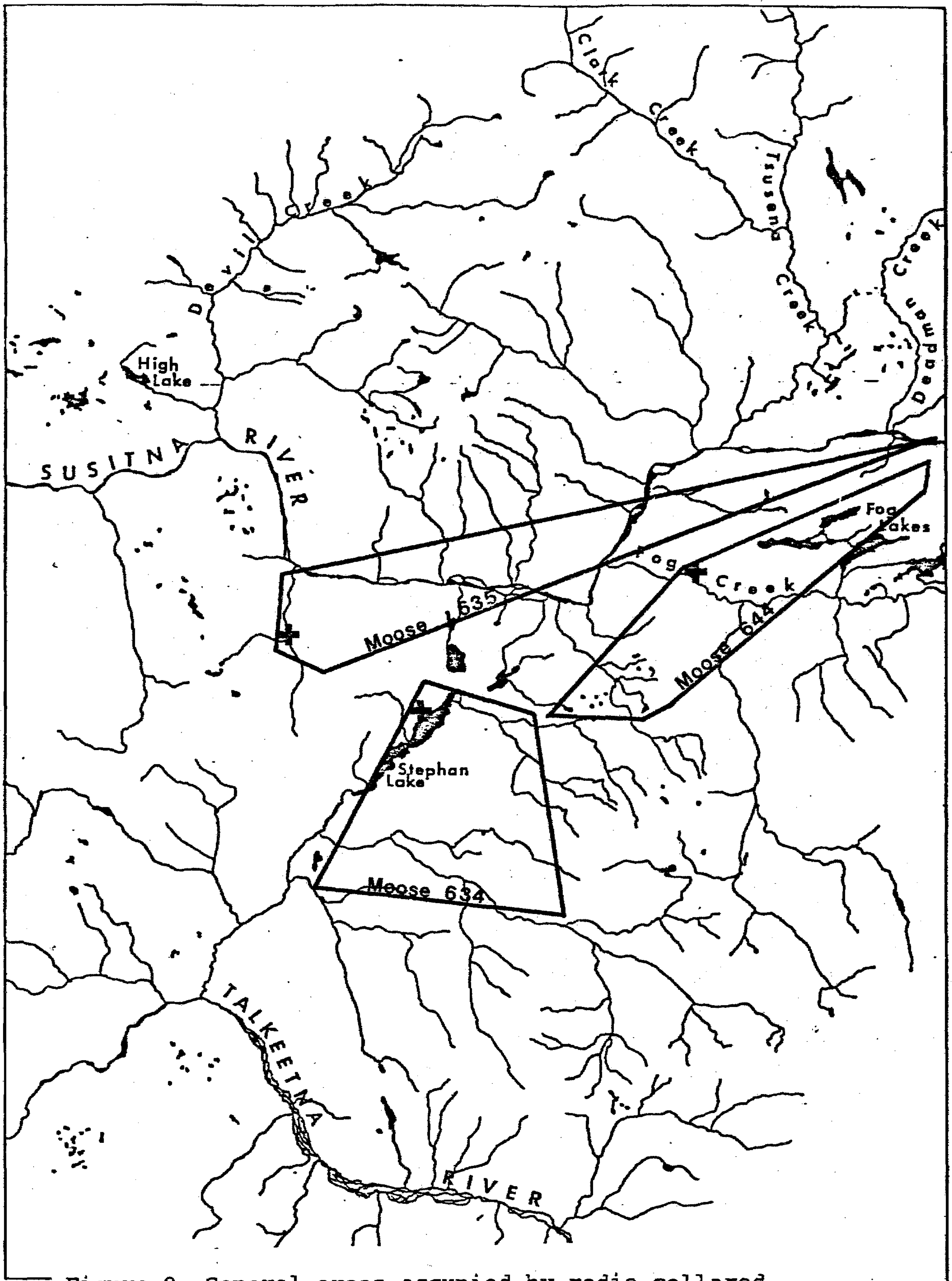

Figure 8. General areas occupied by radio-collared moose 634, 635 and 644 from mid April through mid November in the Susitna River Basin

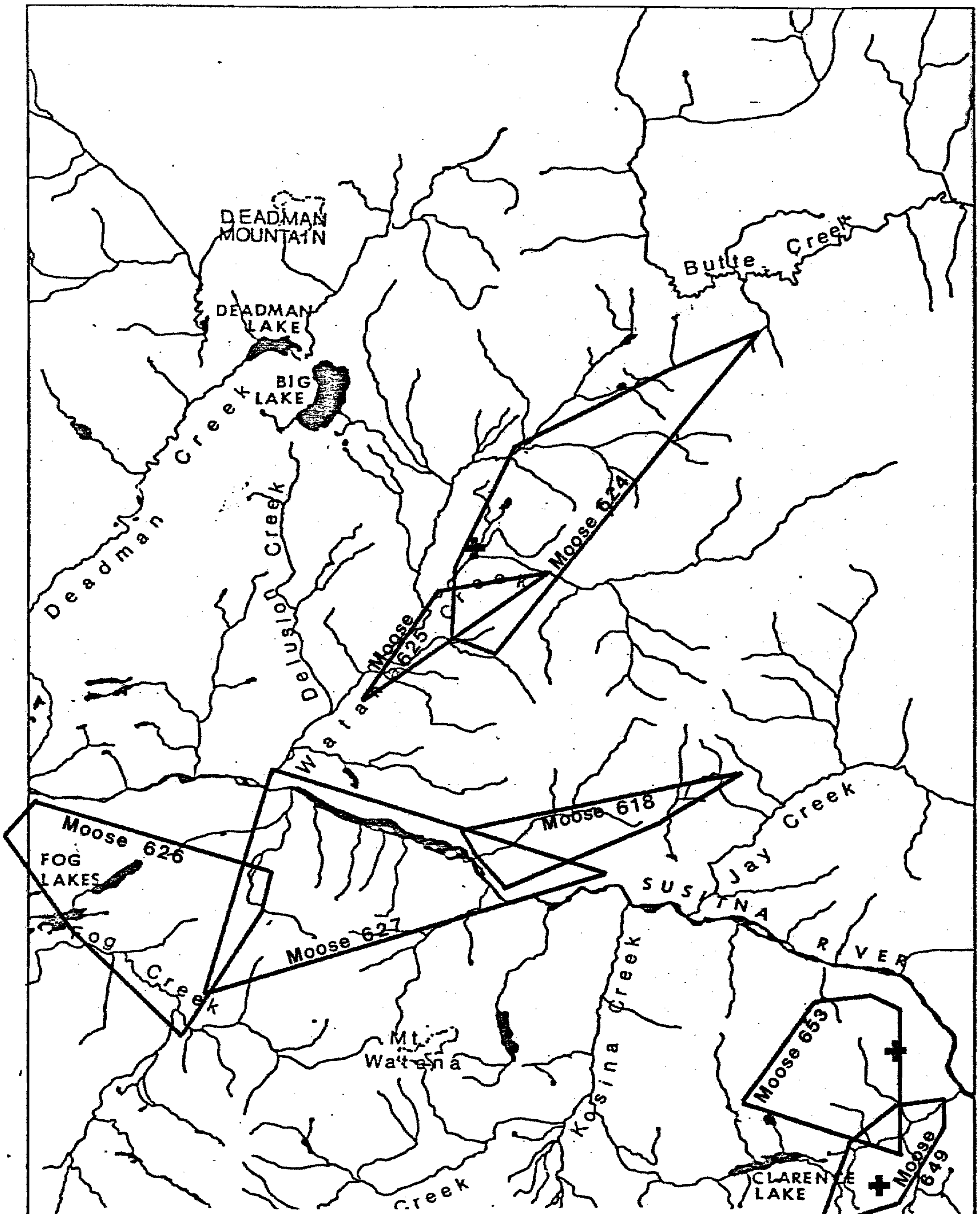

Figure 9. General areas occupied by radio-collared moose 618, 624, 625, 626, 627, 649 and 653 from mid April through mid November in the Susitna River Basin above Devil Canyon in southcentral Alaska.

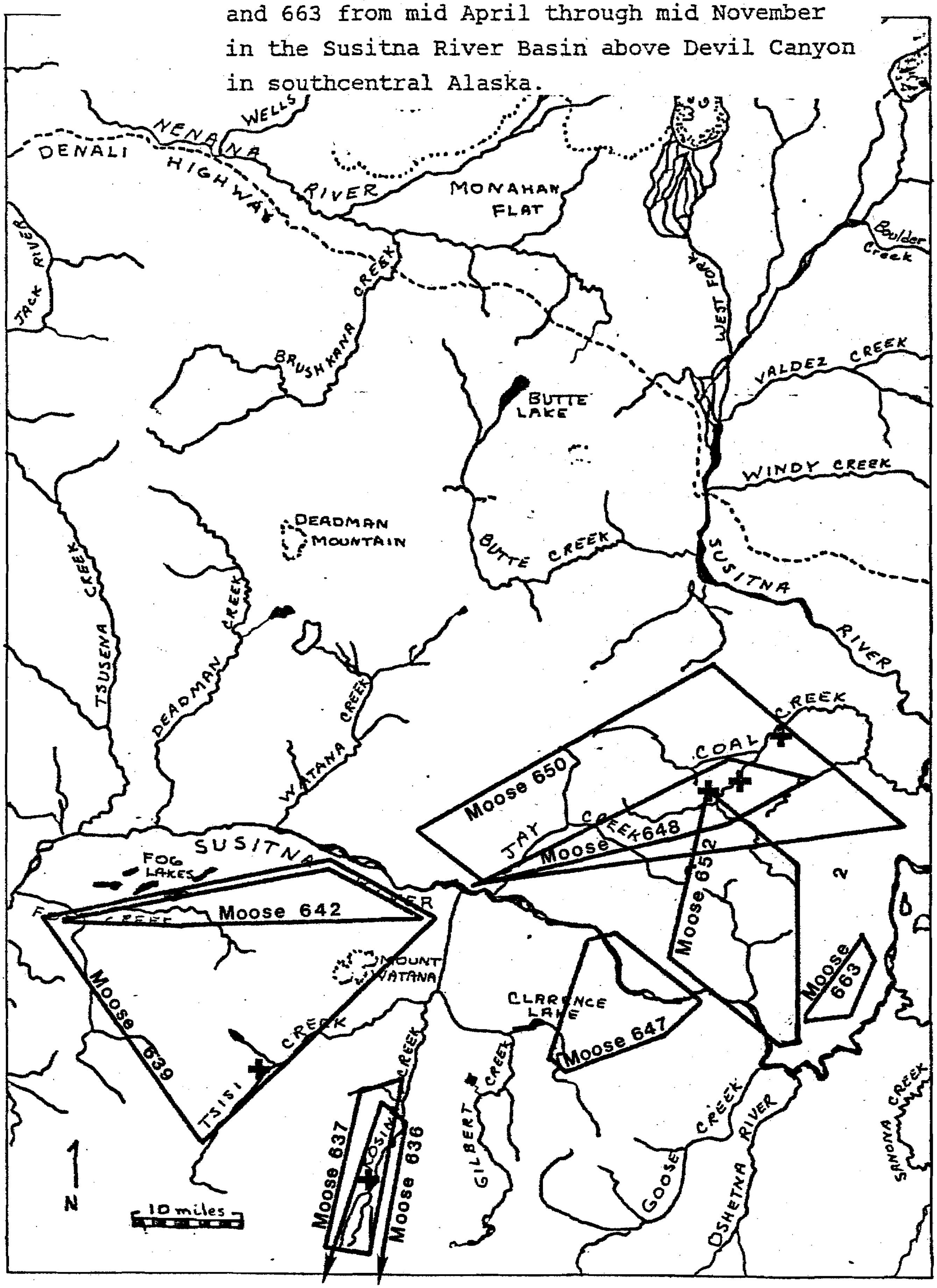

Figure 10. General areas occupied by radio-collared moose 636, 637, 639, 642, 647, 648, 650, 652 and 663 from mid April through mid November in the Susitna River Basin above Devil Canyon in southcentral Alaska.

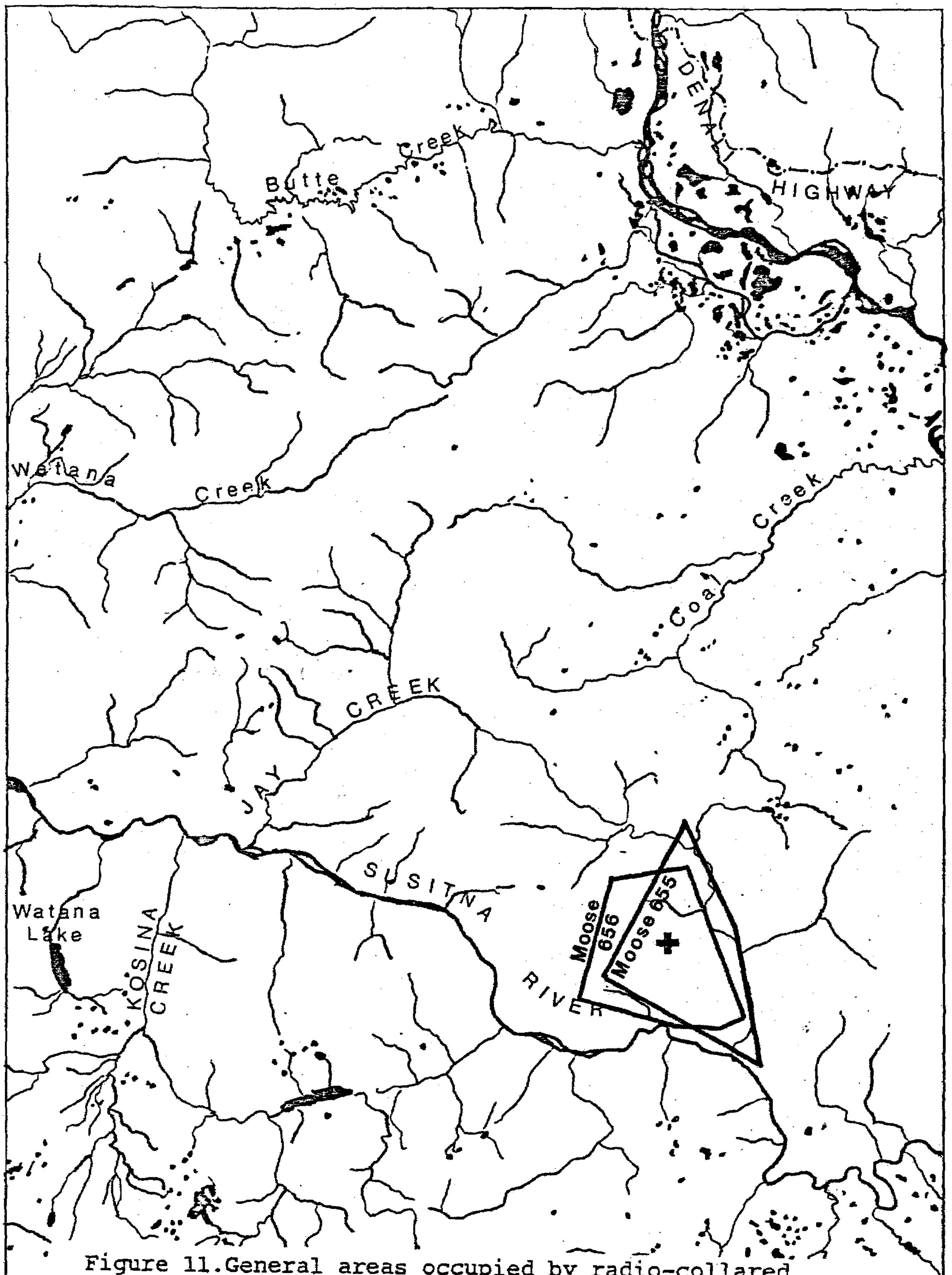

Figure 11. General areas occupied by radio-collared moose 655, and 656 from mid April through mid November in the Susitna River Basin above Devil Canyon in southcentral Alaska.

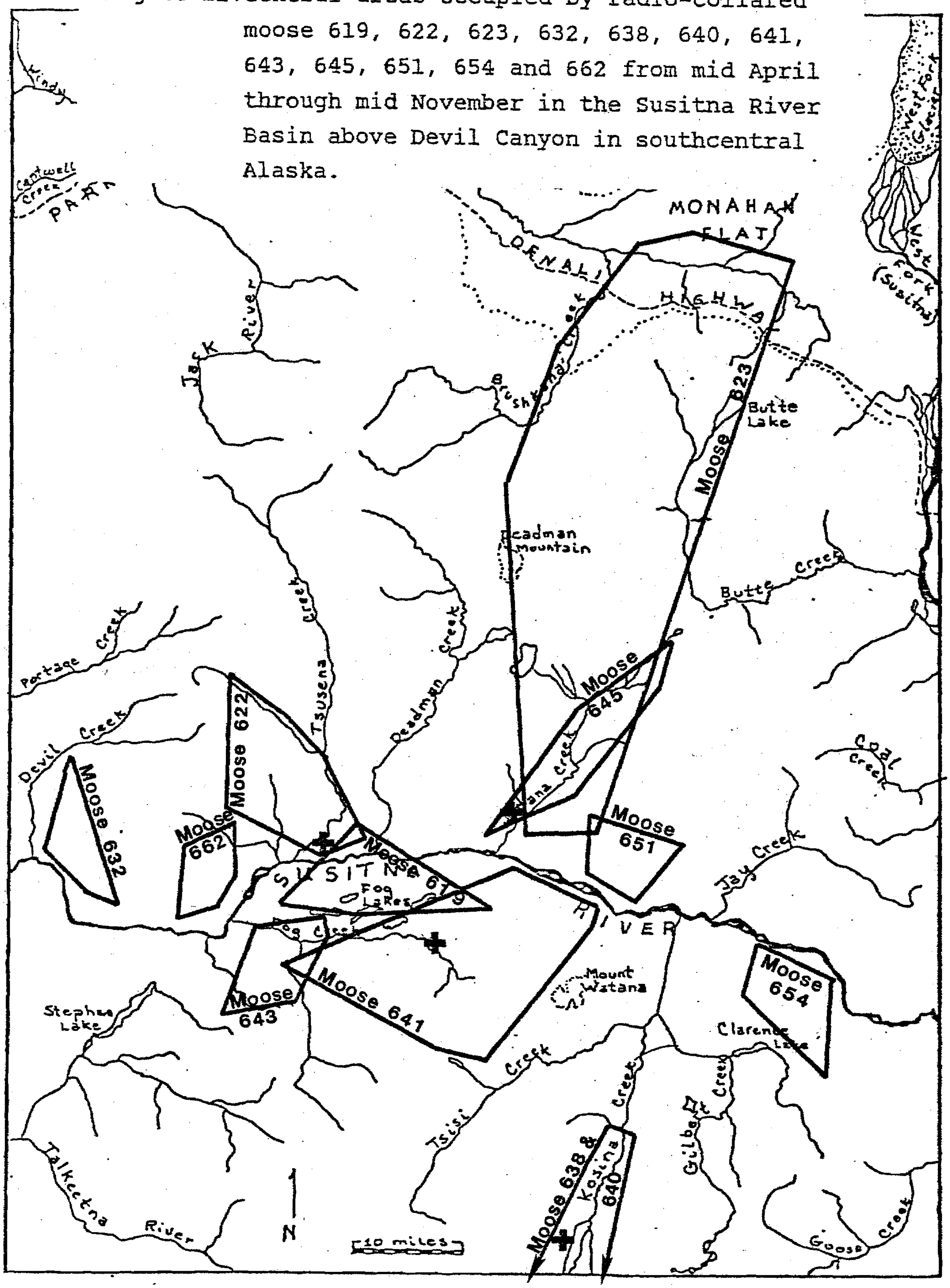

Figure 12. General areas occupied by radio-collared moose 619, 622, 623, 632, 638, 640, 641, 643, 645, 651, 654 and 662 from mid April through mid November in the Susitna River Basin above Devil Canyon in southcentral Alaska.

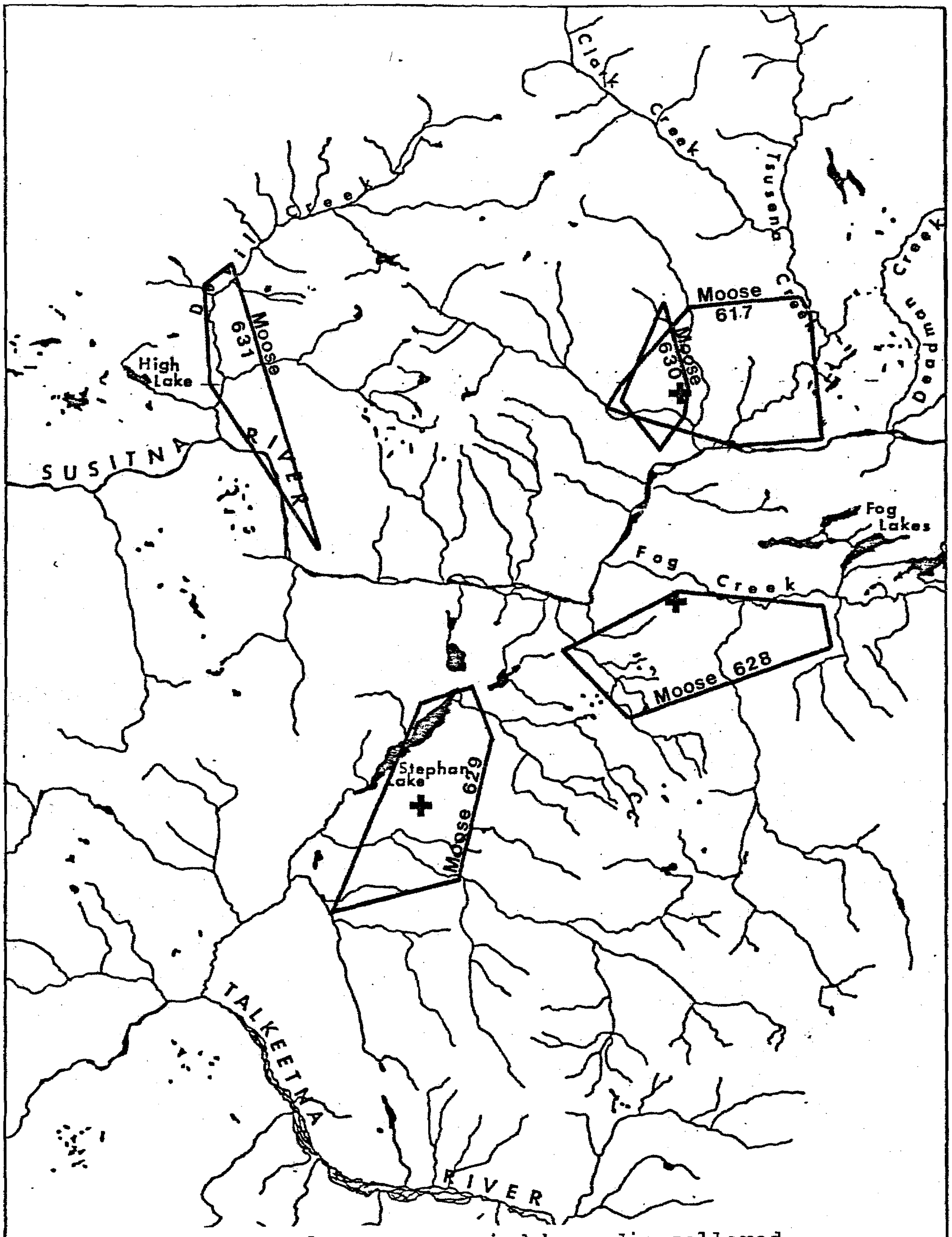

Figure 13. General areas occupied by radio-collared moose 617, 628, 629, 630, and 631 from mid April through mid November in the Susitna River Basin above Devil Canyon in southcentral Alaska.

Creek, Clearwater Creek and the upper Maclaren River migrate down the Susitna River and winter on the lowland areas between the mouths of Goose Creek and the Tyone River. Moose originally tagged for mortality studies in the upper Oshetna and Black River (Ballard and Gardner 1980) also moved down to this lowland area. Therefore, this moose wintering area supports at least three subpopulations. Moose from upper Butte Creek and perhaps small subpopulations from Monahan Flats winter at lower Watana Creek. Suspected migraton and major movement corridors are depicted in Fig. 14. Moose from the Kosina Creek area may represent a separate resident subpopulation.

Movement patterns observed thus far appear to closely follow tributary drainages of the Susitna River and most run a north-south direction. Two moose, however, have exhibited an east-west movement pattern along the Susitna River (#635 and visual collar #80, (Ballard and Taylor 1980) suggesting that at times moose follow the Susitna River.

During this study four radio-collared moose crossed the Susitna River on at least seven occasions (Table 7) with one bull #627) making three of the crossings. From October 1976 through December 1980, 22 radio-collared moose have crossed the river a minimum of 40 occasions. Although monitoring of these moose was not often enough to pinpoint crossing locations, consecutive observations for the 22 moose where river crossings had occurred were plotted to determine if crossings were grouped along any particular portion of the river (Fig. 15). This analysis suggests that moose crossings were concentrated on the Susitna River in the following areas: Mouth of Fog Creek to the area opposite Stephan Lake, from the mouth of Deadman Creek upstream for approximately 5 miles, Watana to Jay Creek, and from Goose Creek upstream to Clearwater Creek. Why moose cross the Susitna River at these particular locations and whether other major crossing areas exist is not known at this time.

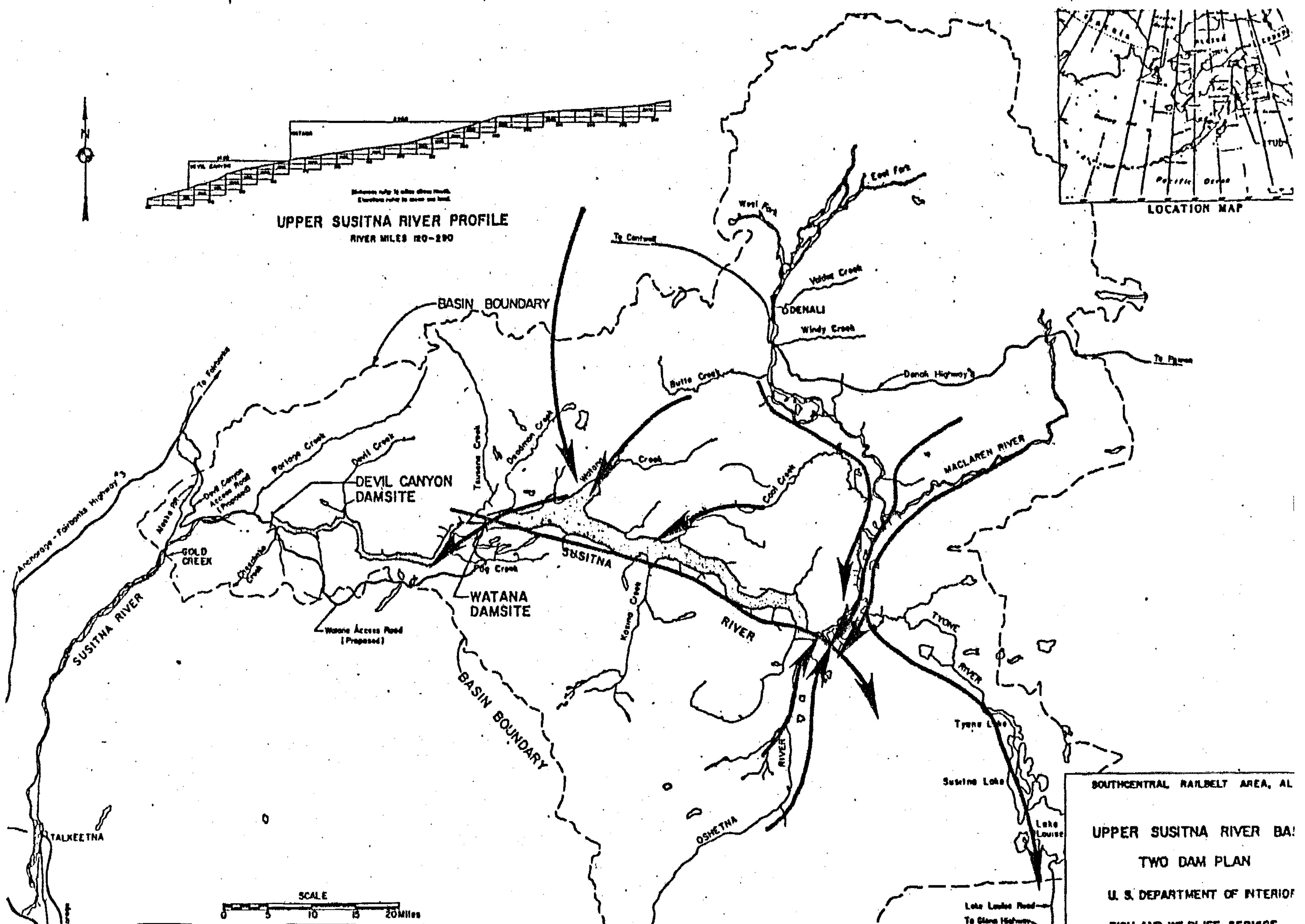

Figure 14. Moose migration and movement routes along the Susitna River above Devil Canyon,

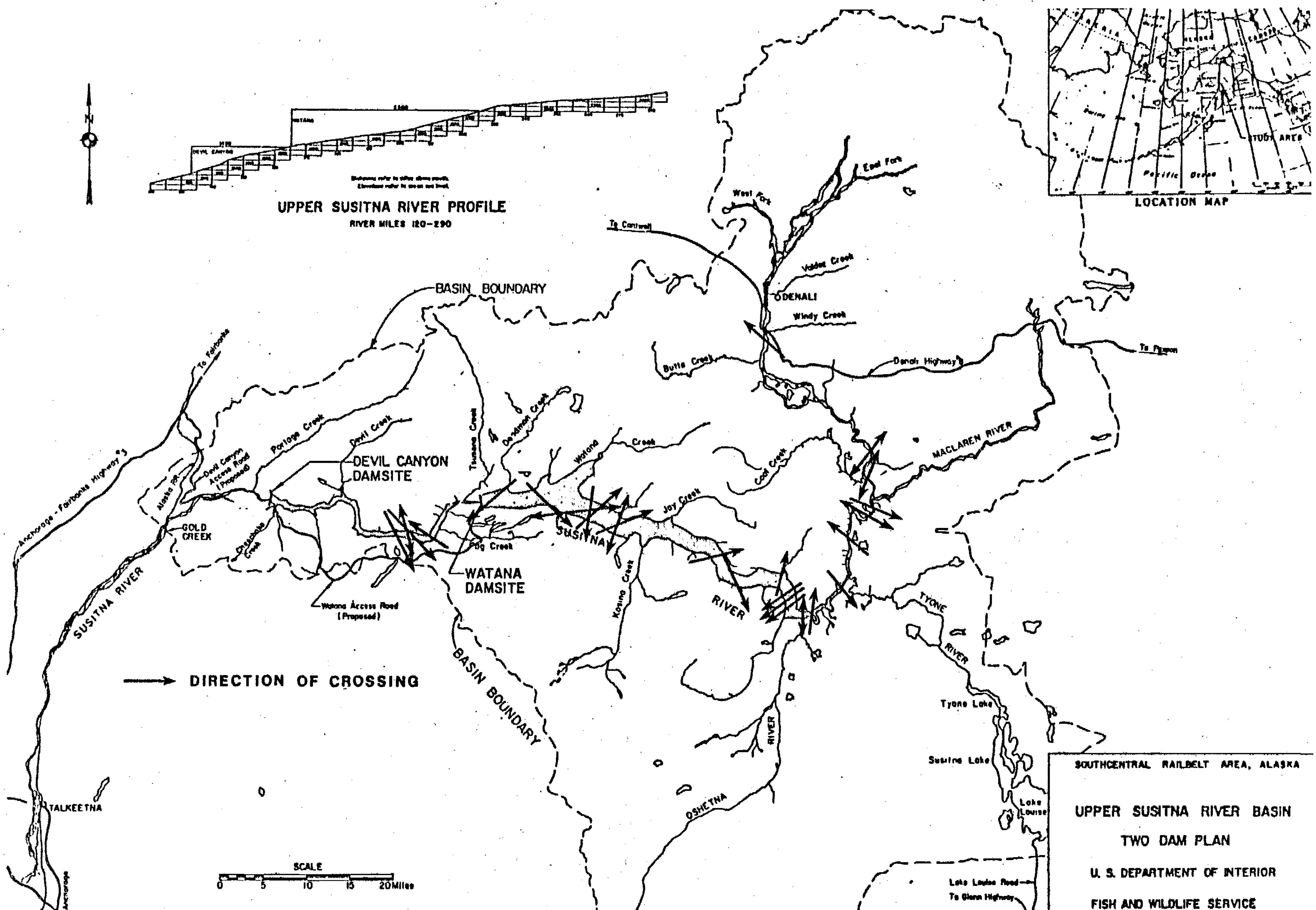

Figure 15. Locations of Susitna River crossings by radio-collared moose from 1976-1980 in southcentral Alaska.

Use of Proposed Impoundment Areas

Table 7 summarizes the numbers and seasonal use patterns of moose which had portions of their home range in areas scheduled to be inundated by the Devil Canyon-Watana dam proposal. For this analysis it was assumed that the elevation of the normal pool was 1450 ft for the Devil Canyon impoundment and 2200 ft for the Watana impoundment. Of the 563 radio locations obtained for 43 moose, 52 (9.2%) occurred at elevations which would be inundated at normal pool level by the two proposed reservoirs. Two of seven (29%) moose (includes #662) which frequented the Devil Canyon impoundment area were observed at elevations which would be inundated by the proposed reservoir. In contrast, 19 of 36 (53%) of the moose radio located in the vicinity of the Watana impoundment were observed at elevations which would be inundated. Radio-collared moose were observed in the proposed impoundment areas from April through October, 60 percent of the locations occurred from April through July.

Breeding Concentrations

Breeding concentrations were determined by plotting groups of 10 or more moose which included at least one bull and one radio-collared moose from late September through early November 1980 (Fig. 16). Greatest concentrations of moose occurred in October. All observed concentration areas occurred in upland areas. No concentrations were observed in areas which would be inundated by the proposed impoundments.

Calving Areas

Moose parturition in 1980 occurred from 22 May to 10 June with peak parturition occurring between 25 May and 2 June. These dates follow the pattern of earlier studies (Ballard and Taylor 1980) except that parturition was probably a few days early. Observed calving locations are displayed in Figs. 8-13. Based

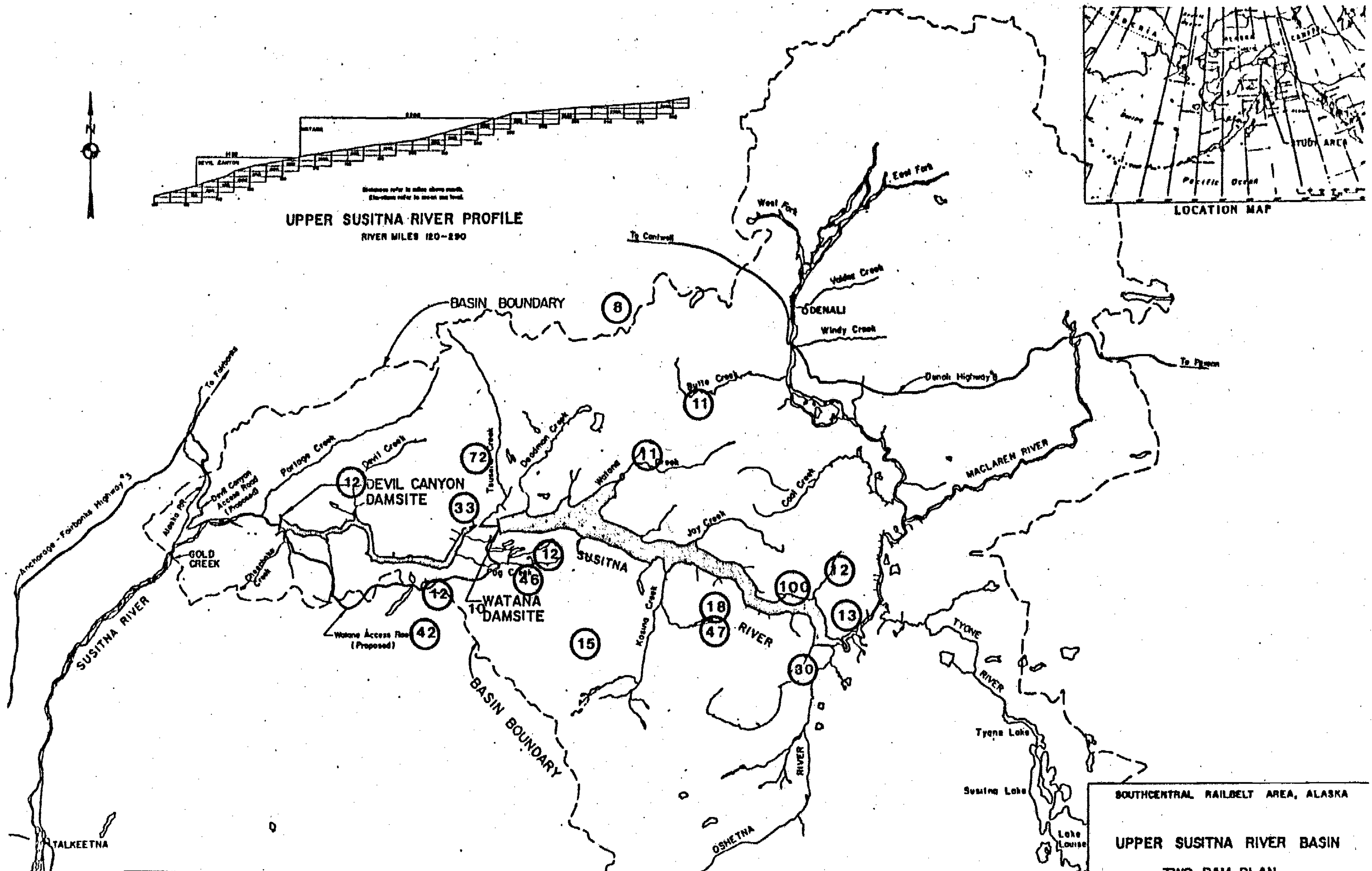

Figure 16. General location and numbers of moose observed in breeding aggregations associated with radio-collared moose from late September through early November 1980 in the Susitna River study area.

upon sightings of radio-collared moose, only one potential calving concentration area was identified. Moose from lower Jay Creek and at least one from the Susitna River bend traveled to Coal Creek for parturition. Only one radio-collared moose calved within the normal pool areas of either the Devil Canyon or Watana impoundments. Radio-collared moose exhibited a propensity for upland willow type habitats (11 of 18 radio locations) or relatively open spruce habitats for parturition. They did not appear to select the riparian spruce habitats along the Susitna River.

Winter Distribution

A moose winter distribution survey was conducted from 4 through 25 March 1980 in portions of the Susitna River Basin containing subpopulations of moose which could be influenced by the proposed project. One thousand eighty-six moose were counted in 26.1 hours of survey effort. Undoubtedly not all moose in the area were observed during this cursory survey. General distribution of observed moose is depicted in Fig. 17. Approximately 60 moose (6%) were observed at elevations which would be inundated at normal pool level. Only two moose were observed in Devil Canyon pool area while the remainder were in the Watana impoundment with 38 (66%) concentrated at Watana Creek. Although relatively few moose were observed along the Susitna River bottomlands, large concentrations of tracks indicated that moose had utilized these areas earlier in the winter. Additionally heavy cover in these low areas decreased the liklihood of observing moose which were present. Large track concentratons were observed at the mouths of Watana Lake, Watana Creek, Jay Creek and the Oshetna River. Tracks and subjective observations suggested that most moose had moved from the lowland areas which were covered by relatively deep snow to higher windswept elevations where snow cover was nearly absent.

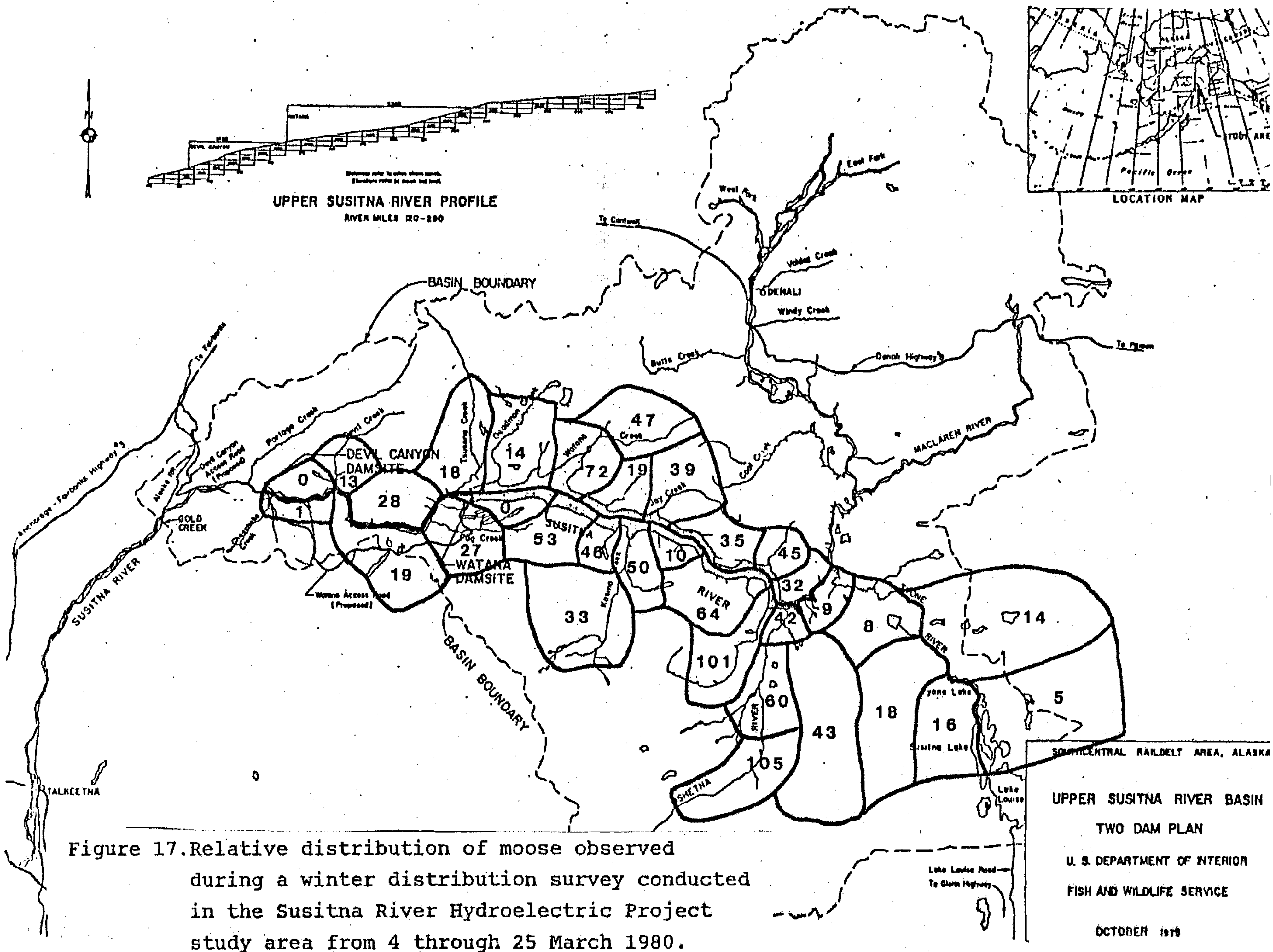

Figure 17. Relative distribution of moose observed during a winter distribution survey conducted in the Susitna River Hydroelectric Project study area from 4 through 25 March 1980.

Fall Distribution

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

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

Fall Sex and Age Composition

Between 31 October and 8 November 1980 moose sex and age composition flights were conducted in count areas 6, 7 and 14 (Fig. 5). The areas counted corresponded to count areas which have been surveyed annually since 1955. Sex and age composition count data and the resulting ratios for the period 1955 through 1980 are summarized in Tables 8 through 10.

History of the Game Management Unit 13 moose population has been described by Rausch (1969), Bishop and Rausch (1975),

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

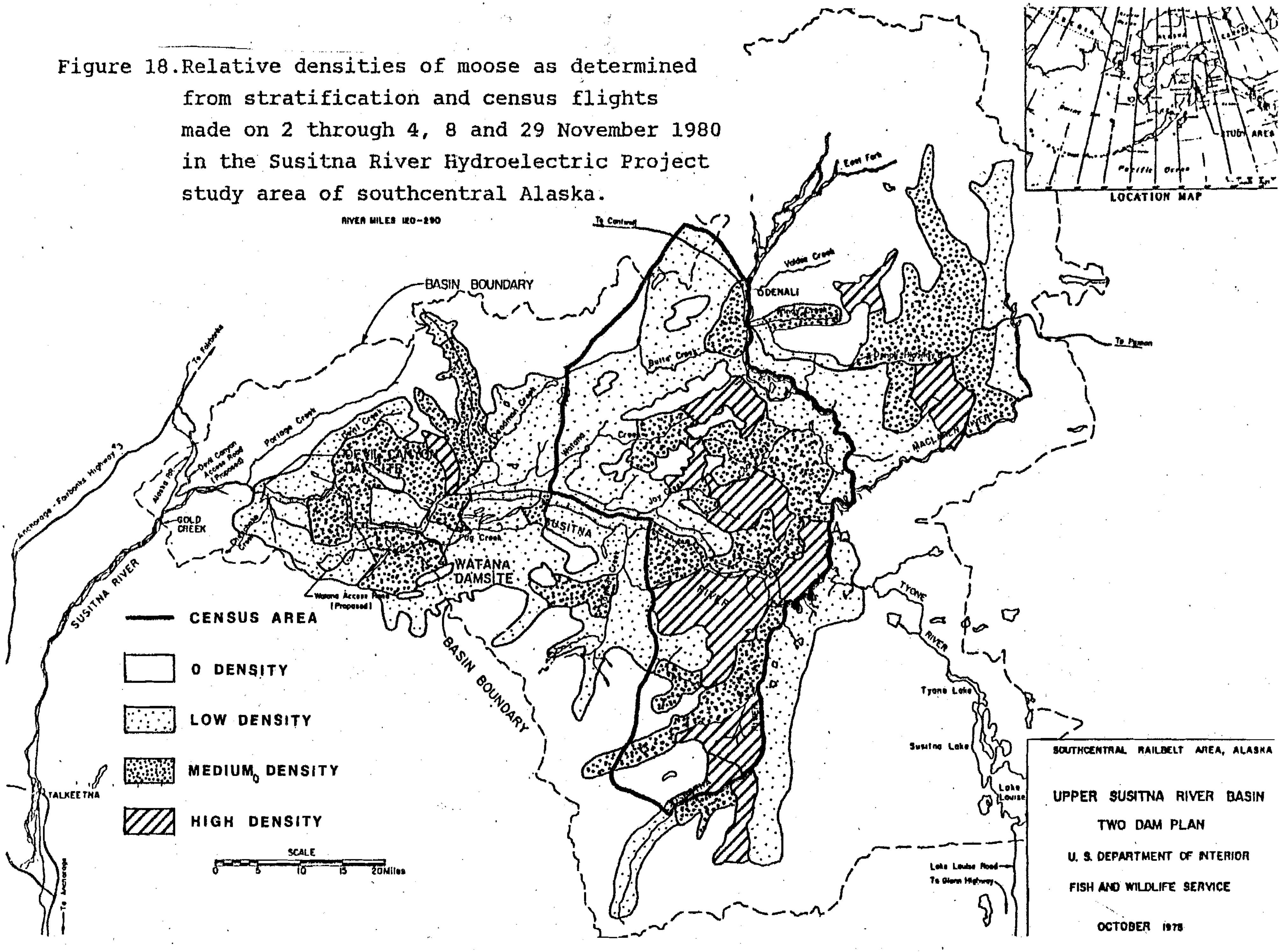

Table 8. Summary of moose sex and age composition data collected annually each fall since 1955 in Count Area 6 north of the Maclaren River in Game Management Unit 13 of southcentral Alaska.

Date	Tot.♂ Per 100 ♀	Sm. ♂ Per 100 ♀	Sm. ♂ Per 100 Lg ♂	Sm.♂ % in Herd	Sm.♂ Per 100 ♂ Calves	Calves Per 100 ♀	Incidence of Twins Per 100 ♀ w/calf	Calf % in Herd	Animals Per Hour	Total Sample
1955*	84.1	26.1	45.1	11.0	121.0	43.2	5.6	19.0	-	400
1956*	61.6	14.6	31.0	7.7	103.8	28.1	0.0	14.8	50	351
1957*	43.3	6.4	17.3	3.5	33.3	38.3	10.2	21.1	128	256
1958*	44.9	11.8	35.7	6.4	58.6	40.2	6.9	21.7	114	957
1959	N O	D A T A								
1960*	57.2	18.7	48.4	9.0	80.5	46.4	4.0	22.4	104	343
1061	70.1	27.3	63.8	12.5	112.8	48.4	16.0	22.2	78	424
1962	44.2	-	-	-	-	28.3	4.6	16.4	101	414
1963*	35.6	11.9	50.0	6.5	51.0	46.6	7.4	25.6	160	798
1964*	33.3	5.6	20.0	3.1	25.0	44.4	20.0	25.0	96	96
1965*	30.4	9.9	48.1	6.3	76.7	25.8	1.5	16.5	126	806
1966*	27.7	5.0	21.9	3.2	35.6	28.0	3.5	17.9	76	658
1967	29.7	5.4	22.1	3.4	37.4	28.8	0.8	18.1	86	681
1968	29.7	5.0	20.0	3.2	37.6	26.3	2.4	16.9	59	504
1969	35.7	13.6	61.2	7.8	81.1	33.5	2.8	19.3	46	384
1970	26.6	8.7	48.7	6.2	122.6	14.2	6.9	10.1	26	308
1971	30.0	4.2	16.7	2.8	37.0	22.8	3.9	14.9	39	362
1972	10.1	3.8	61.5	2.9	33.3	23.1	0.0	17.3	38	277
1973	20.7	7.3	54.8	5.2	77.3	19.0	2.3	13.6	20	324
1974	16.0	7.8	94.4	5.2	45.3	34.4	9.0	22.9	32	328
1975	17.6	7.8	80.0	5.7	84.2	18.5	5.6	13.6	31	279
1976	20.6	8.5	69.6	5.8	69.6	24.3	4.6	16.8	28	274
1977	16.7	5.6	50.0	3.7	32.9	33.8	13.2	22.4	46	352
1978	24.1	9.1	61.1	6.0	63.8	28.6	11.7	18.8	46	368
1979	14.6	3.0	25.9	2.2	23.7	25.3	9.3	18.1	39	326
1980	15.1	7.5	100.0	5.2	50.6	29.7	8.1	20.5	50	423

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

Table 9. Summary of moose sex and age composition data collected annually each fall since 1955 in Count Area 7 in Game Management Unit 13 of southcentral Alaska.

Date	Tot.♂ Per 100 ♀	Sm. ♂ Per 100 ♀	Sm. ♂ Per 100 Lg ♂	Sm.♂ % in Herd	Sm.♂ Per 100 ♂ Calves	Calves Per 100 ♀	Incidence of Twins Per 100 ♀ w/calf	Calf % in Herd	Animals Per Hour	Total Sample
1955*	160.2	46.9	41.4	15.2	196.3	47.8	8.0	15.5	60	348
1956*	74.3	14.2	23.5	7.2	123.0	23.0	0.0	11.6	32	223
1957	N O	D A T A								
1958	N O	D A T A								
1959	N O	D A T A								
1960	N O	D A T A								
1961	N O	D A T A								
1962	N O	D A T A								
1963*	47.7	6.2	14.8	3.3	32.0	38.5	0.0	20.7	151	121
1964*	39.7	10.7	37.1	6.3	68.4	31.4	2.8	18.4	65	207
1965*	59.8	13.7	29.6	7.8	168.4	16.2	0.0	9.2	65	412
1966	48.3	6.3	15.1	3.8	62.8	20.1	0.0	11.9	33	293
1967	41.0	7.0	20.7	4.4	68.3	20.6	2.5	12.8	77	642
1968	N O	D A T A								
1969	N O	D A T A								
1970	34.7	8.9	34.4	5.0	42.2	42.1	8.6	23.6	43	864
1971	26.3	8.4	47.1	5.3	50.8	33.2	7.1	20.8	50	624
1972	20.6	2.7	15.1	2.0	31.0	17.5	3.7	12.6	53	665
1973	21.9	8.2	60.2	6.0	101.0	16.3	2.9	11.8	70	890
1974	12.6	4.2	50.0	3.0	29.6	28.3	6.3	20.1	48	672
1975	10.0	4.3	77.4	3.4	54.5	15.9	4.8	12.7	38	695
1976	12.3	4.3	54.9	3.2	40.3	21.6	7.1	16.1	46	865
1977	10.8	4.2	64.4	3.0	29.6	28.7	6.0	20.6	60	954
1978	14.8	8.0	117.3	5.9	79.2	20.2	4.1	15.0	65	1030
1979	8.8	2.4	36.6	1.8	20.3	23.3	5.8	17.7	60	838
1980	13.3	7.8	143.2	5.6	62.3	25.1	1.1	17.9	51	946

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

Table 10. Summary of moose sex and age composition data collected annually each fall since 1955 in Count Area 14 in Game Management Unit 13 of southcentral Alaska.

Date	Tot.♂ Per 100 ♀	Sm. ♂ Per 100 ♀	Sm. ♂ Per 100 Lg ♂	Sm.♂ % in Herd	Sm.♂ Per 100 ♂ Calves	Calves Per 100 ♀	Incidence of Twins Per 100 ♀ w/calf	Calf % in Herd	Animals Per Hour	Total Sample
1955*	105.6	29.6	38.9	10.5	80.8	73.2	10.6	26.0	-	200
1956	NO DATA									
1957	72.5	11.7	19.2	5.2	46.5	50.3	4.9	22.6	127	381
1958*	86.8	11.2	14.8	5.0	60.3	37.0	7.4	16.6	98	441
1959	NO DATA									
1960*	71.7	20.0	38.7	8.6	70.6	56.7	21.4	24.5	38	139
1961*	62.0	26.7	75.6	12.2	95.8	55.7	7.6	25.6	173	555
1962*	56.3	18.2	47.7	10.1	152.7	23.8	1.8	13.2	92	416
1963	NO DATA									
1964	NO DATA									
1965	28.6	10.8	60.6	7.2	100.0	21.6	0.0	14.4	79	278
1966*	20.0	9.0	82.4	5.9	53.8	33.5	0.0	21.8	63	238
1967	39.0	6.8	21.2	3.9	40.0	34.1	2.9	19.7	118	355
1968*	9.4	4.0	75.0	2.8	22.2	36.5	3.8	25.0	154	108
1969	17.5	6.2	55.2	4.0	31.1	40.1	2.0	25.4	54	405
1970	19.4	3.7	23.5	2.2	16.7	44.4	2.1	25.9	80	185
1971	27.1	8.4	44.7	5.7	81.0	20.7	5.0	14.0	37	300
1972	21.4	9.2	75.0	6.2	72.0	25.5	0.0	17.4	54	288
1973	22.0	7.1	47.7	5.1	82.4	17.3	2.0	12.4	56	411
1974	15.4	5.1	50.0	3.4	29.1	35.2	3.7	23.4	40	500
1975	9.9	4.3	78.6	3.3	40.0	21.7	1.9	16.5	65	333
1976	9.2	4.6	100.0	3.6	46.4	19.9	3.0	15.4	50	447
1977	NO DATA									
1978	20.5	9.2	80.6	6.6	100.0	18.3	2.0	13.2	50	379
1979	NO DATA									
1980	13.7	9.6	235.7	7.4	117.9	16.2	3.8	12.5	51	447

Remarks: *Area boundary change - check maps

McIlroy (1974) and Ballard and Taylor (1980). Briefly the GMU 13 populations was increasing in the 1950's and peaked about 1960. After the severe winter of 1961-62, the population began declining and continued to decline with severe winters occurring in 1965-66, 1970-71, 1971-72, and 1978-79. Fall calf-cow ratios in addition to nearly all other ratios declined sharply and reached a record low for the basin in 1975. Although the decline was attributed to a variety of factors, predation by wolves was suspected of preventing the moose population from recovering during mild winters. Sex and age composition data for CA's 7 and 14 basically have exhibited the same patterns described for the unit. Although only one composition count has been conducted in the Devil Canyon area during this time period, it appears likely that this area has also followed the same general pattern.

Beginning in 1975 predator densities were experimentally reduced north of the Susitna and Maclaren Rivers and therefore, some of the moose ratios in Tables 11 through 13 may reflect changes in predator densities. However, these changes were not considered significant except in 1979 when calf:100 cow ratios were increased in the northern portions of CA 7 due to reductions in brown bear density (Ballard and Spraker 1979; Ballard et al. 1980; Ballard et al. 1981). Since 1975 the moose population appears to have increased slightly even though calf survival has remained relatively low.

Sex and age composition data derived from stratification surveys, sex-age composition counts, and the random stratified census in fall 1980 varied among the different types of surveys (Table 11). In particular census data indicated the calf:100 cow ratios generated from composition surveys are lower, while bull:cow ratios are generally higher than observed during the census. This pattern has been observed in other areas (Gasaway pers. comm.).

Table 11. Comparison of moose sex-age ratios and aggregations derived from three different types of surveys which were conducted in the Susitna River Hydro Project Study Area during 1980.

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

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

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

Population Estimates

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

Table 12 summarizes calculations utilized to estimate the fall moose population in CA's 7 and 14 east of Jay and Kosina Creeks to the Susitna River in the project area during the census. Of the 945 mi^2 census area, 35 percent was classified as low moose density, 38 percent as medium moose density and 27 percent as high moose density. Based upon census data, each stratification was estimated to contain the following number of moose/mi^2: low--1.125, medium--1.847 and high--3.726. The estimated fall population for CA's 7 and 14 was 1,986 ± 371, (90% CI).

Not all moose were observed at a survey intensity of 4.4 minutes/mi^2 (Gasaway and Dubois, unpub. report). Consequently, portions of 10 sample areas were randomly chosen and were resurveyed at a sampling intensity of approximately 12 minutes/mi^2 in an effort to generate a sightability correction factor (Table 13). With the additional surveying effort it was estimated that during the census approximately 98

Table 12. Summary of moose census data and subsequent population estimates for Count Area 7 and 14 derived from surveys conducted from 5 through 8 November 1980 along the Susitna River in southcentral Alaska.

Moose Density Stratum	Low	Medium	High	
Number of sample area censused	11	9	6	
Total number of sample areas in each stratum	26	27	18	
Area of each stratum - mi^2	333.8	355.3	256.1	= 945.2 mi^2
Moose density per stratum	1.125	1.847	3.726	
Population estimate per stratum	375	656	954	
Total population estimate 90% CI = 1986 ± 371				
Sightability correction factor = 1.03				
Corrected population estimate = 2046 ± 382				

Table 13. Summary of sample areas resurveyed to determine sightability correction factor for the Susitna moose census conducted from 5 through 8 November 1980 in southcentral Alaska.

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

Correction factor = 1.03

percent of the moose were being observed yielding a correction factor of 1.03. Therefore, the corrected population estimate for CA's 7 and 14 was 2,046 ± 382, (90 percent CI) of which 22 percent were calves.

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

Using methods similar to those described in the preceding paragraph, relative moose densities in CA 6 were also stratified. This was done because CA 6 has a migratory population of moose which overwinter in the vicinity of the mouth of the Oshetna River. On 9 November a total of 205 moose were observed in 3 hours of survey flown in a Piper Super Cub. Relative density and distribution of these moose were depicted in Fig. 18. Of the 470 mi^2 stratified, 204 mi^2 (43%) were classified as low moose density, 207 mi^2 (44%) were classified as medium moose density and only 59 mi^2 (13%) were classified as high moose density. Extrapolating the average moose densities per stratum derived for CA's 7 and 14 (Table 12) to the mi^2 of each stratum in CA 6, we grossly estimated that area's fall moose population at 830 animals.

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

During winter 1980-81 a thorough census of moose wintering areas close to impoundment areas is planned. Results from this census should aid in assessing the numbers of moose to be displaced by the reservoirs.

Calf Production and Survival

Calf moose comprised 13 percent of the moose observed during the distribution survey in March 1980. This low calf percentage reflects poor calf survival during 1979-80 due to predation (both bear and wolf) and perhaps some winter mortality (starvation). Farther upstream above the Denali Highway where both bear and wolf densities had been experimentally lowered (Ballard et al. 1980), calf moose comprised 33 percent of the moose counted in late May 1980, reflecting increased calf survival due to the lower predator densities.

Of 32 radio-collared cow moose which were intensively monitored from mid-May through mid-June 1980, 19 were subsequently observed with 30 calves for an observed calving rate of 0.94 calves/cow. Fifty-eight percent of the cows producing calves had twins. These rates of calf production were quite comparable with those observed in 1977 and 1978 (Ballard and Tobey in review).

Mortality of newborn moose calves was high. By 1 August 1980, 23 (77%) of the calves were missing. Rates of 1980 calf loss were compated with those observed in 1977 and 1978 (Fig. 19). Although causes of moose calf mortality were not determined in

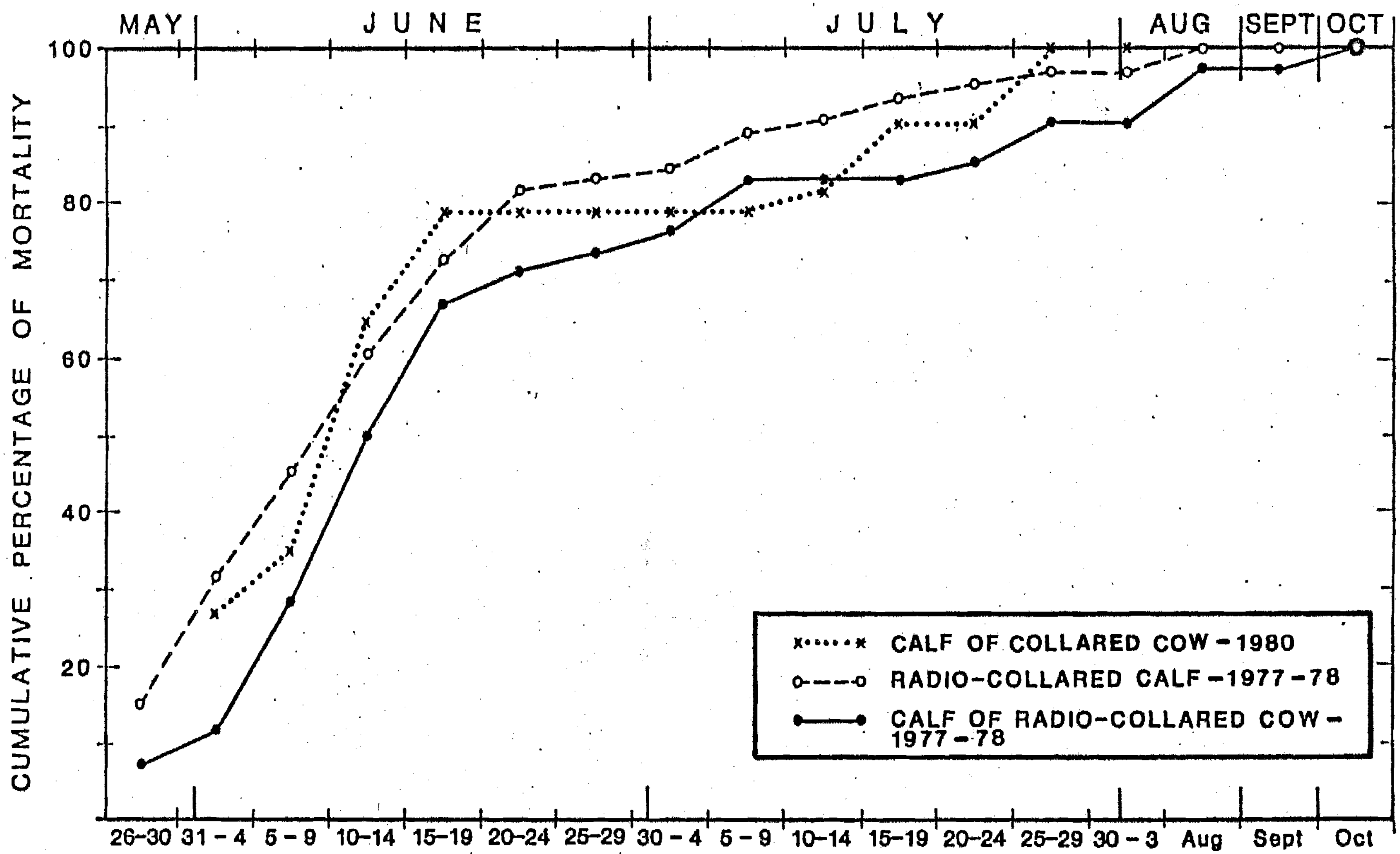

Figure 19. Dates of mortalities of collared and uncollared moose calves during 1977, 1978 and 1980 in the Nelchina and upper Susitna Basins, Alaska (modified from Ballard et al. 1981.

1980, the pattern of loss was quite similar to that observed in 1977 and 1978 where predation by brown bear (*Ursus arctos*) was responsible for 79 percent of the calf deaths (Ballard et al. 1981). The similar loss pattern suggests that predation is continuing to reduce calf survival and may be preventing the moose population from increasing.

Potential Impact of Proposed Poject on Moose

The most obvious impact of the proposed project is the direct loss of habitat through inundation. Studies to date suggest that the areas to be inundated are utilized by moose during winter and spring. Moose concentration areas occurred at Stephan Lake, Fog Creek, Tsusena Creek, Watana Creek, Jay Creek, Clarence Lake, the gauging station and along the Susitna River above Goose Creek. Loss of winter and spring habitat will result in a reduced moose population for the area.

These areas do not appear to be important for calving or breeding purposes. How long and how often moose utilize the impoundment areas is not yet known. It does appear, however, that the period of time moose occupy the impoundment areas is heavily dependent on winter severity. During winter 1979-80 moose had moved away from these areas prior to early March. Based on total snowfall, winter 1979-80 was not considered severe. During severe winters we would anticipate larger densities of moose occupying the proposed impoundment areas for longer periods of time. Therefore, the loss of winter habitat during a severe winter could have a larger impact on the moose population than during a mild or average winter.

Fall moose numbers in the study area were estimated at approximately 3,200. An additional 830 moose were estimated to inhabit the area above the Maclaren River. Obviously not all of these moose utilize the impoundment area. Further refinement of numbers of moose actually utilizing the proposed impoundments during winter may be accomplished in either February or March 1981 when radio-collared moose move into the area. At that time moose in the impoundment areas will be censused. However, until a severe winter occurs it will be impossible to measure moose usage of the area under extreme conditions when habitat within the impoundments may be the most critical for survival. An estimate of the numbers of moose which only occasionally utilize the impoundment will be made by extrapolating the percentages of radio-collared moose which use the area to the fall population estimate.

Available data indicate that the Watana impountment is likely to have a greater impact on moose than the Devil Canyon impoundment. Moose distribution, movement, and population estimate data collected thus far suggest that relatively few moose inhabit the Devil Canyon impoundment area.

The eventual fate of moose which become displaced by the impoundments can not be accurately predicted at this time because the carrying capacity of currently available habitat is unknown. Casual observations of browse plants suggest that the area may be at its carrying capacity even though calf survival can be significantly increased when relief from predation is provided (Ballard et al. 1980). If it is assumed that the area is currently at its maximum carrying capacity then total mortality of displaced moose due to starvation could be assumed. The impact could be greater if a time lag exists between displacement and mortality. If displaced moose move into adjacent areas already at carrying capacity, they could potentially overbrowse the remaining range and create a lower carrying capacity for the animals in those areas. This would probably result in decreased calf production and increased adult mortality through starvation for moose adjacent to but not directly influenced by the impoundments.

Moose studies conducted since 1976 have documented at least 40 crossings of the Susitna River in the vicinity of the proposed impoundments. Observed crossings have been concentrated near the mouth of Fog Creek, between Watana and Jay Creeks, and along the susitna between Goose and Clearwater Creeks. Creation of impoundments at these crossing areas could potentially alter moose crossings for resident moose and could act as a barrier for migratory moose. Observations in other areas of GMU 13 indicate that natural lakes do not impede moose movements. However, these natural lakes do not exhibit the icing characteristics which are predicted to occur for the Watana impoundment (Hanscom and Osterkamp 1980). Creation of ice shelves, particularly in the widely fluctuating water levels of the Watana impoundment, could prevent moose from attempting to cross the river. Also, ice shelving could result in increased mortality due to the steepness of the shelves on the periphery of the impoundments which could prevent moose from escaping. Many of the potential problems could possibly be eliminated if fluctuations in water levels could be substantially reduced.

Another impact of the project could be the effect on moose and moose habitat of the alteration of the local climate due to the creation of the impoundments. For example, Henry (1965) predicted changes in precipitation would occur in portions of the Yukon Basin following the creation of Rampart Dam Reservoir. Also, in more southerly locales it has been demonstrated that large bodies of water have a warming effect on the local environment; in effect, lengthening the fall season and delaying spring. Although the two proposed impoundments are relatively small in relation to the Rampart Project, small changes in climate might be more pronounced because of the steepness of the Susitna River Valley. If changes in climate result in either more precipitation in terms of snow or a lengthening of spring thaw, an increase in moose mortality and a decrease in productivity would probably occur since these seasons of the year are critical to moose survival. Studies, perhaps, similar to those of Henry's (1965), should be initiated to predict climate changes and their impact on plant phenology in an effort to better assess the potential impact on moose.

The proposed projects may, to an unpredictable extent, increase the numbers of moose dying from accidental causes. Creation of mud flats in the upper impoundment will probably result in increased calf mortality due to calves getting mired in mud. As mentioned earlier, ice shelving may prevent moose which attempt to cross the river from moving away from the impoundment because of the height of the shelves resulting in death due to starvation.

Preliminary Recommendations

Based upon the preliminary results obtained from this and previous studies, the impacts of the Watana impoundment on moose will be of greater magnitude than those of the Devil Canyon impoundment. Alternatives to the Watana reservoir should be fully investigated and considered. If the Watana impoundment is economically feasible and necessary, both reductions in the normal pool level and stabilizaton of water levels to the maximum extent possible would lessen the project's impact on moose.

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SUSITNA HYDROELECTRIC PROJECT
ANNUAL PROGRESS REPORT

BIG GAME STUDIES

PART IV CARIBOU

Kenneth W. Pitcher

ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the
Alaska Power Authority

March 1, 1981

SUMMARY

The Nelchina caribou herd which occupies 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 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 are 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 continously since about 1948 and records previous to that time have been reviewed. The primary methodology for this study is the repetitive relocation of radio-collared caribou. Population estimates are made with a modified version of the aerial photo-direct count-extrapolation census procedure.

Late winter distribution of caribou in 1980 was in the Chistochina-Gakona River drainages, the western foothills of the Alphabet Hills and the Lake Louise Flat. The two main routes to the traditional calving grounds in the northern foothills of the Talkeetna Mountains were across the Lake Louise Flat into the calving area via the lower Oshetna River and across the Susitna River in the area from Deadman Creek to the big bend of the Susitna. Calving occurred between the Oshetna River and Kosina Creek from 3,000 to 4,500 feet elevation. The main summering concentration of Nelchina caribou occurred in the northern and eastern slopes of the

Talkeetna Mountains between Tsisi Creek and Crooked Creek, primarily between 4,000 and 6,000 feet. Most caribou were located on the Lake Louise Flat during the rut. During early winter the herd was split in two groups; one in the Slide Mountain-Little Nelchina River area and the other was spread from the Chistochina River west to the Gakona River through the Alphabet Hills to the McLaren River.

It appeared (based on only 8 months data) that at least two small subherds with separate calving areas existed, one in the upper Talkeetna River and one in upper Nenana-Susitna drainages. Insufficient data were available to evaluate the status of the Chunilna Hills group.

The Nelchina caribou herd was estimated to contain 18,558 animals in October 1980. Herd composition was estimated at 49.0 percent cows, 30.3 percent bulls and 20.7 percent calves.

It was apparent from historical records (and to a lesser degree from movements of radio-collared animals) that the proposed Watana impoundment would intersect a major migratory route. It seems possible that the impoundment could be a barrier to movement and potential source of mortality particularly during spring migration when females are in relatively poor condition and various combinations of ice shelving, ice sheets, overflow, ice floes and wind-blown glare ice could occur. The impoundment could tend to isolate the northwestern corner of the Nelchina range an area which has been heavily used in the past. Access routes; roads, railroads and air fields, could affect caribou movements depending on locations and amount of use. The proximity of the calving grounds to the Watana impoundment is of concern because of its importance to the herd and the possibility that increased human access and activity could result in reduced use.

The Devil Canyon dam site and impoundment, if built alone, appears to have virtually no potential to impact Nelchina caribou. Conversely the Watana site would almost certainly have negative impacts although the extent cannot be predicted.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Nelchina caribou (*Rangifer tarandus*) herd, one of 22 herds in Alaska (Davis 1978), has been important to sport and subsistence hunters because of its size and proximity to population centers in southcentral Alaska. Between 1954 and 1980 over 100,000 caribou were killed by hunters (Skoog 1968; unpublished data Alaska Department of Fish and Game).

The herd occupies an area of approximately 20,000 mi^2 (Fig. 1) bounded by four mountain ranges: the Alaska Range to the north, the Wrangell Mountains on the east, the Chugach Mountains to the south and the Talkeetna Mountains to the west (Hemming 1971). The Nelchina range contains a diverse variety of habitats ranging from spruce-covered lowlands to steep, barren mountains. Human development is largely limited to the peripheries of the Nelchina range and consists primarily of the Alaska Railroad, Parks Highway, Denali Highway, Richardson Highway, trans-Alaskan Pipeline and Glenn Highway.

Because of its importance and accessibility, the Nelchina herd has been the most intensively studied caribou herd in Alaska (Doerr 1979). The U.S. Fish and Wildlife Service initiated research in 1948 and continued through 1959 under the direction of Chatelain, Scott and Skoog (Skoog 1968). The Alaska Department of Fish and Game has been continually involved with the Nelchina herd since statehood including intensive research and population, harvest, distribution, disease and range monitoring (Skoog 1968, Lentfer 1965, McGowan 1966, Glenn 1967, Hemming and Glenn 1968, 1969, Pegau and Hemming 1972, Neiland 1972, Pegau and Bos 1972, Pegau et al. 1973, Bos 1973, 1974, Alaska Department of Fish & Game Survey and Inventory Reports 1970-1980). Skoog's (1968) doctoral dissertation, a major work on caribou biology, deals largely with the Nelchina herd.

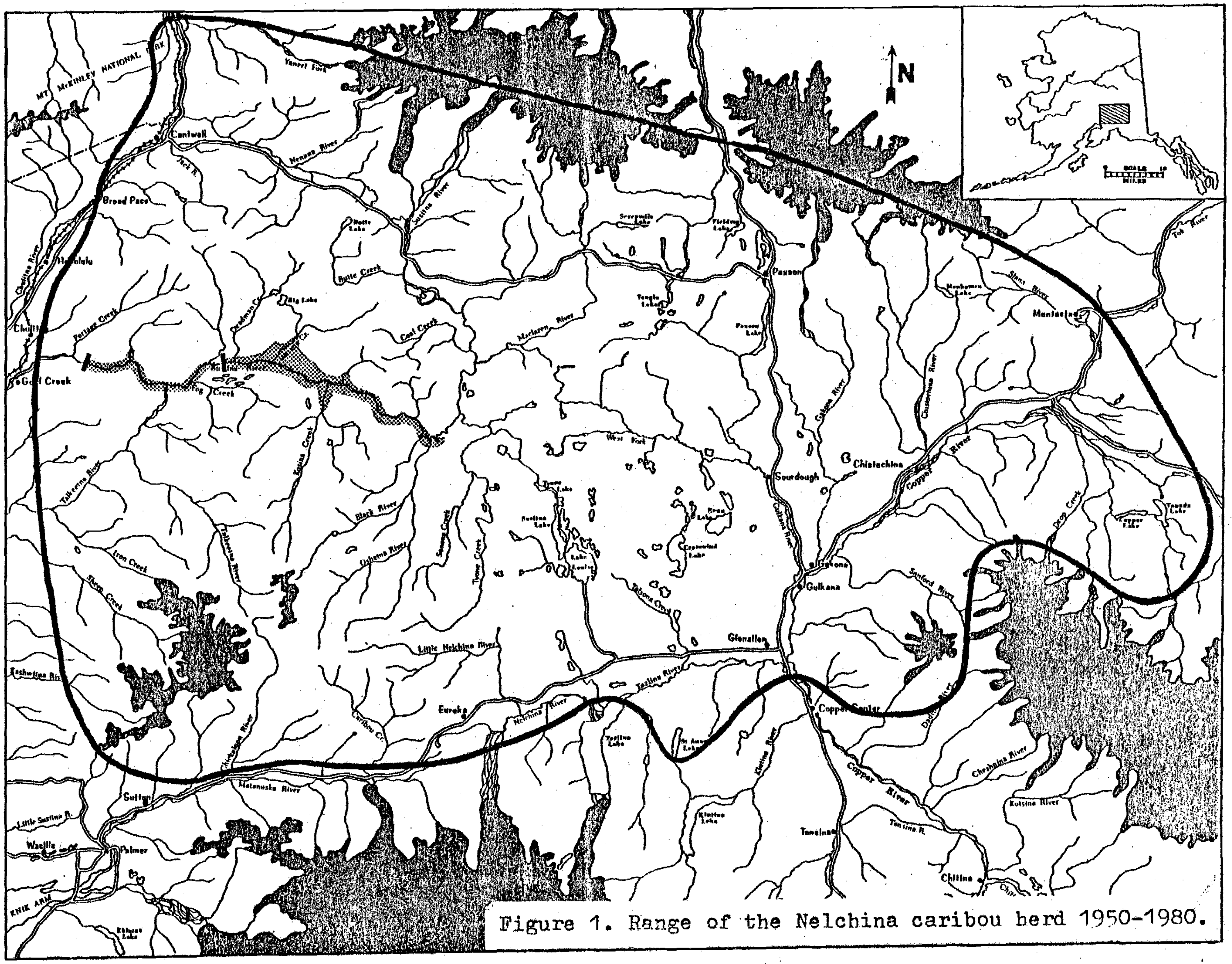

Figure 1. Range of the Nelchina caribou herd 1950-1980.

There is currently under study a proposal to construct a large hydroelectric project on the Susitna River in the western portion of the Nelchina caribou range. Impacts of the development, which may include two dams and impoundments, access roads and electrical transmission lines, on the Nelchina herd are unclear. Habitat loss due to inundation does not appear to be a serious consideration as <1% of the total Nelchina range would be involved. Skoog (1968) concluded that caribou useage of this area was largely limited to transient animals although they occasionally spend time in the area in spring using snow free areas. The proposed Watana impoundment could serve as a barrier to migrating caribou. The area along the Susitna River between Deadman Creek and Jay Creek has served as a traditional migration route both during spring migration and the post-calving shift (Hemming 1971). Ice shelving along the edges of the reservoir has been suggested as a potential source of mortality to migrating caribou (Hanscom and Osterkamp 1980). Roads, railroads and electrical transmission lines have all been reported to disrupt caribou movements (Klein 1971, Vilmo 1975, Cameron et al. 1979). Disturbance associated with construction and maintenance of the hydroelectric facilities could result in a reduction of caribou use of nearby areas as shown for the Prudhoe Bay oil fields (Cameron et al. 1979). Proximity of the traditional calving grounds to the Watana impoundment is of some concern because of the importance of the area to the Nelchina herd and increased human activity in the area implicit to development. Suspected "subherds" in the general area of the proposed impoundment could become more isolated by development of the Susitna hydroelectric project depending on their movement patterns and routes and their reactions to the impoundments and related developments.

Overall objectives of this project are to evaluate the potential impacts of proposed Susitna hydroelectric development on the Nelchina caribou herd and to suggest possible mitigating actions. Specific objectives include: (1) determination of movement patterns, migration routes and timing of major movements with emphasis on activities occurring in the vicinity of proposed development; (2) delineation of subherds (based on separate calving areas); (3) estimation of numbers and sex and age of the main Nelchina herd and suspected subherds; and (4) determination of habitat utilization of Nelchina caribou.

Complicating the interpretation of data gathered during short-term studies of caribou migratory routes is the well recognized tendency for changes in use of winter and summer ranges (Skoog 1968). The analysis of data resulting from this study will have to rely heavily on historical information. It is fortunate that results of intensive research by Skoog (1968) and others on the Nelchina caribou herd are available and they will be used extensively in the analysis.

METHODOLOGY

Data on movement patterns, migration routes, timing of major movements, subherd status and habitat use were collected by periodic relocations of radio-collared animals. 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 152.000-153.000 MHz range, purchased from Telonics Inc., were used. Radio-collared caribou were relocated from a fixed-wing aircraft (Cessna 180 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. Forty-one caribou were radio-collared. However, as of 10 December, 12 collars had either been shed or the animals had died leaving 29 functioning transmitters on four males and 25 females. These included three animals in the upper Susitna area, two in the Talkeetna River and 24 in the main Nelchina herd.

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) a composition count 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). 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 (Doerr 1979).

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

where

FP = estimated fall population;

N_a = number of animals in the postcalving aggregation;

P_f = proportion of females in post-calving aggregation;

S_f = survival 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 are used to survey the aggregations and the caribou herds were either be 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 and the herd during the breeding season 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 gentalia (presence or absence of the vulva).

Methodology for data storage, retrieval and analysis is included in the annual report for data management:biometrics (wildlife ecology/big game). Because the computerized data management system is not fully operational and field data are only available for an 8 month period (15 April-15 December 1980) most analyses in this report must be considered preliminary.

The study area consists of the entire range of the Nelchina caribou herd as detailed in the Introduction (Fig. 1). However, monitoring frequency of radio-collared animals will be more frequent when they are in the vicinity of the proposed impoundments.

RESULTS AND DISCUSSION

Distribution and Movements

When field operations began in mid-April 1980 the main wintering concentration of caribou was spread over an area extending west and south from the Chistochina River to the Gakona River, along the southern foothills of the Alphabet Hills and throughout the Lake Louise Flat (Fig. 2). Smaller numbers were also present in drainages of the upper Nenana, Susitna and Talkeetna Rivers and the Chunilna Hills (Fig. 2). Generalized routes of the spring shift (20 April-20 May) between wintering areas and the calving grounds are shown in Figure 2. Two routes were primarily used; animals moved from the Lake Louise Flat into the foothills of the Talkeetna Mountains in the vicinity of the Oshetna River and caribou crossed the Susitna River north to south in the area from the big bend of the Susitna to Deadman Creek.

The majority of females (including 21 of 26 radio-collared females) utilized the traditional calving grounds between the Oshetna River and Kosina Creek in the northern foothills of the Talkeetna Mountains (Fig. 2). Twelve of the 21 radio-collared females were seen with calves. The two females collared in the headwaters of the Talkeetna River remained there through calving (and through the study period to date). One of these females reared a calf. Three of four females collared in the upper Susitna-Nenana drainages remained there through the calving period. Two of these females were known to produce calves. The calving period appeared to be about the same as previously reported, 15 May to 10 June (Hemming 1971).

Since 1949, the first year for which records are available, Nelchina caribou have utilized an area of about 1,000 square miles in the northern Talkeetna Mountains for calving (Skoog 1968, Hemming 1971, Bos 1974). While the precise areas

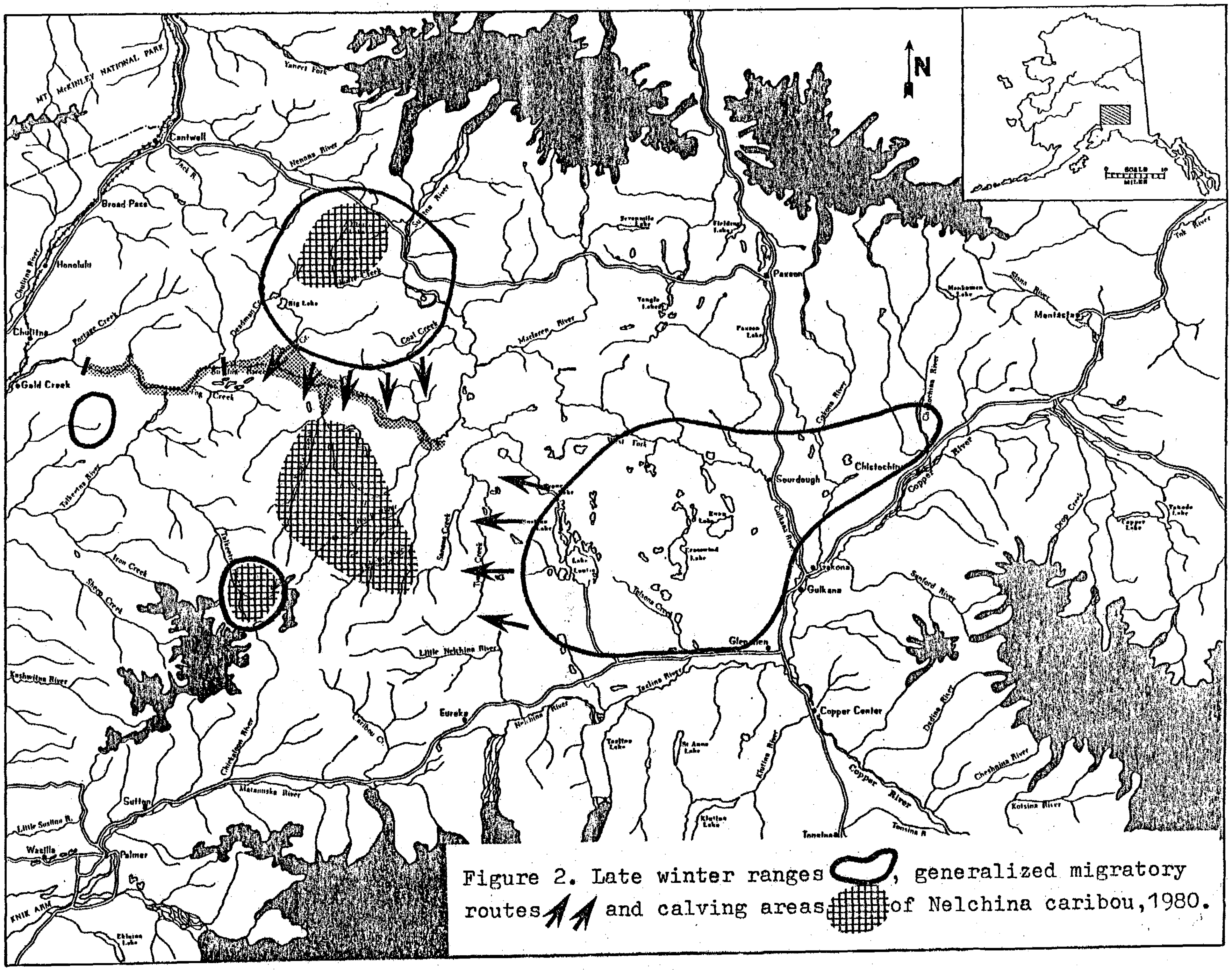

Figure 2. Late winter ranges, generalized migratory routes and calving areas of Nelchina caribou, 1980.

utilized have varied, calving has taken place between Fog Lakes and the Little Nelchina River between about 3,000 and 4,500 feet elevation. The only deviations have been during years with extremely heavy snow accumulations when some calving took place during the migration to the traditional calving grounds (Skoog 1968, Lentfer 1965, Bos 1973).

The main summering concentration of Nelchina caribou occurred in the northern and eastern slopes of the Talkeetna Mountains between Tsisi Creek and Crooked Creek (Fig. 3). The upper Oshetna and Little Oshetna Rivers appeared to be the center of the summer range. The caribou generally ranged considerably higher in elevation than during calving, primarily between 4,000 and 6,000 feet. One radio-collared animal was found at 6,800 feet. Additional summering caribou were found in the upper Talkeetna River, the Chulitna Mountains and the Butte Lake-Brushkana Creek area (Fig. 3). Additionally, groups of summering bulls were found in the Jay Creek-Coal Creek area, the Clearwater Mountains, The Alphabet Hills, The Chunilna Hills and the Amphitheater Mountains. Skoog (1958) referred to additional summer "bull pastures" in the upper Nenana, Chickaloon and Talkeetna River drainages.

Historically, the female-calf segment of the Nelchina herd has primarily summered in two areas; the eastern Talkeetna Mountains and across the Susitna River in the Brushkana, Butte, Deadman, Watana, Jay and Coal Creeks complex (Skoog 1968, Hemming 1971). In 1960 and 1961 some females and calves summered in the Alphabet Hills and Amphitheater Mountains (Skoog 1968). Postcalving and summer movements of varying proportions of the female-calf segment (ranging from 0-100%) from the calving grounds and summer range in the Talkeetna Mountains across the Susitna River occurred in most years between 1950 and 1973. Timing of major movements ranged from mid-May through July. Crossings apparently occurred between Deadman Creek and the big bend of the Susitna.

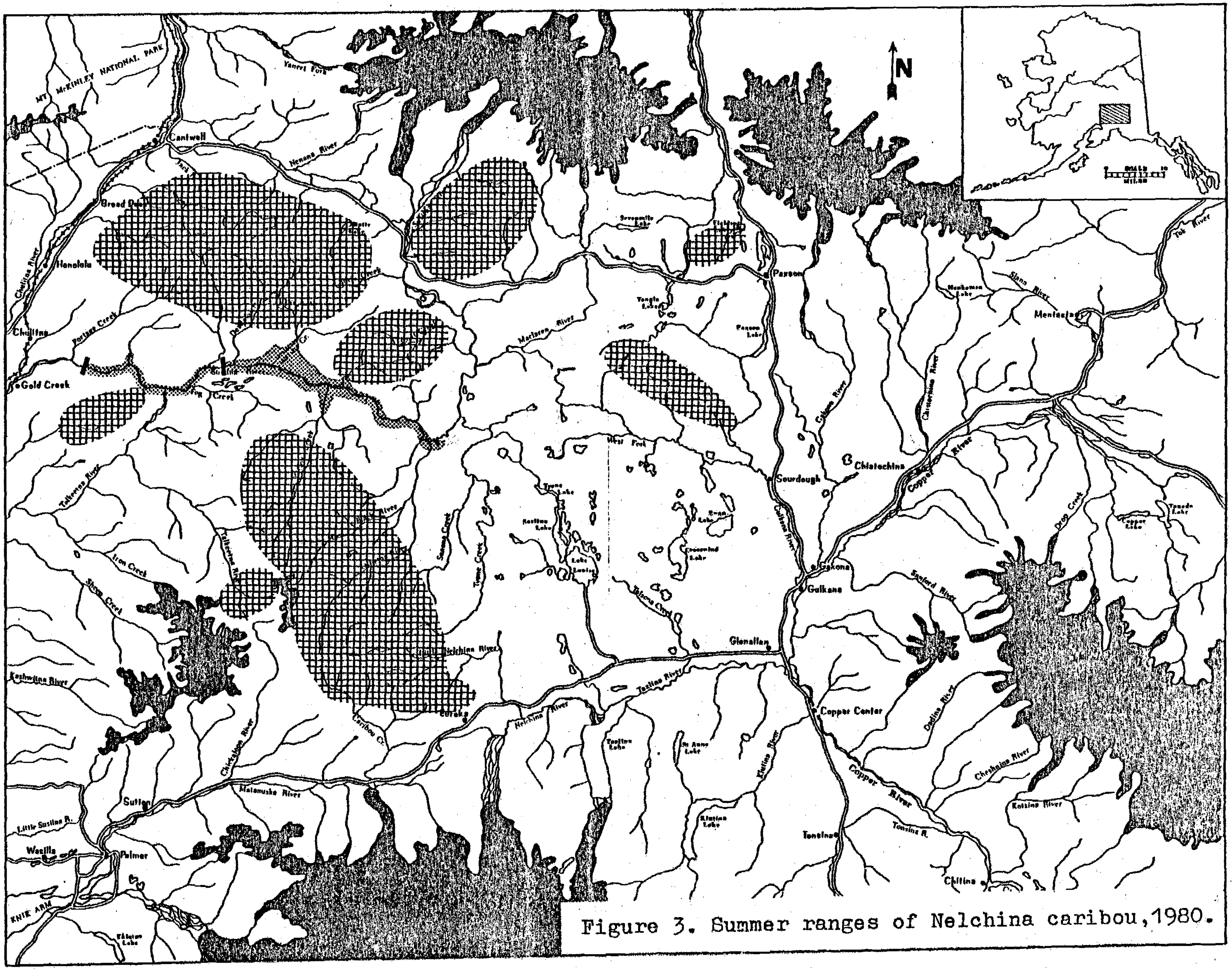

Figure 3. Summer ranges of Nelchina caribou, 1980.

In mid to late August a portion of the main summering concentrations moved out of the Talkeetna Mountains onto the western portion of the Lake Louise Flat and in some cases into the Alphabet Hills. The exact routes of movement were not determined, however it seemed that while a few animals may have crossed the Susitna River in the area of the proposed Watana impoundment most probably moved onto the Flat further to the east. Through September the distribution remained relatively stable with the main herd divided between the northeastern Talkeetna Mountains, the Lake Louise Flat and the Alphabet Hills.

During the rutting pause the "main" Nelchina herd was found almost exclusively on the Lake Louise Flat (Fig. 4). Several hundred animals were located on Slide Mountain in the southeastern corner of the Flat. The Talkeetna River and upper Susitna-Nenana radio-collared animals were not relocated during the rut, however they were assumed to have remained in their normal ranges as they were found there both before and after the rut and were not found with the main Nelchina herd.

During early winter (2-5 December 1980, last survey) there were two main groups: the largest group was spread from the Mclaren River east through the Alphabet Hills and along the west fork of the Gulkana River across the Richardson Highway and trans-Alaskan pipeline to the Chistochina River; the other group was in the Slide Mountain-Little Nelchina River area (Fig. 5). A few additional caribou were scattered through the Lake Louise Flat. The upper Susitna-Nenana and Talkeetna River groups remained in their normal ranges.

Nelchina caribou have utilized numerous winter ranges during the past 30 years ranging from upper Nenana-Yanert Fork drainages to the Talkeetna River east to the Mentasta and Wrangell Mountains (Skoog 1968, Hemming 1971).

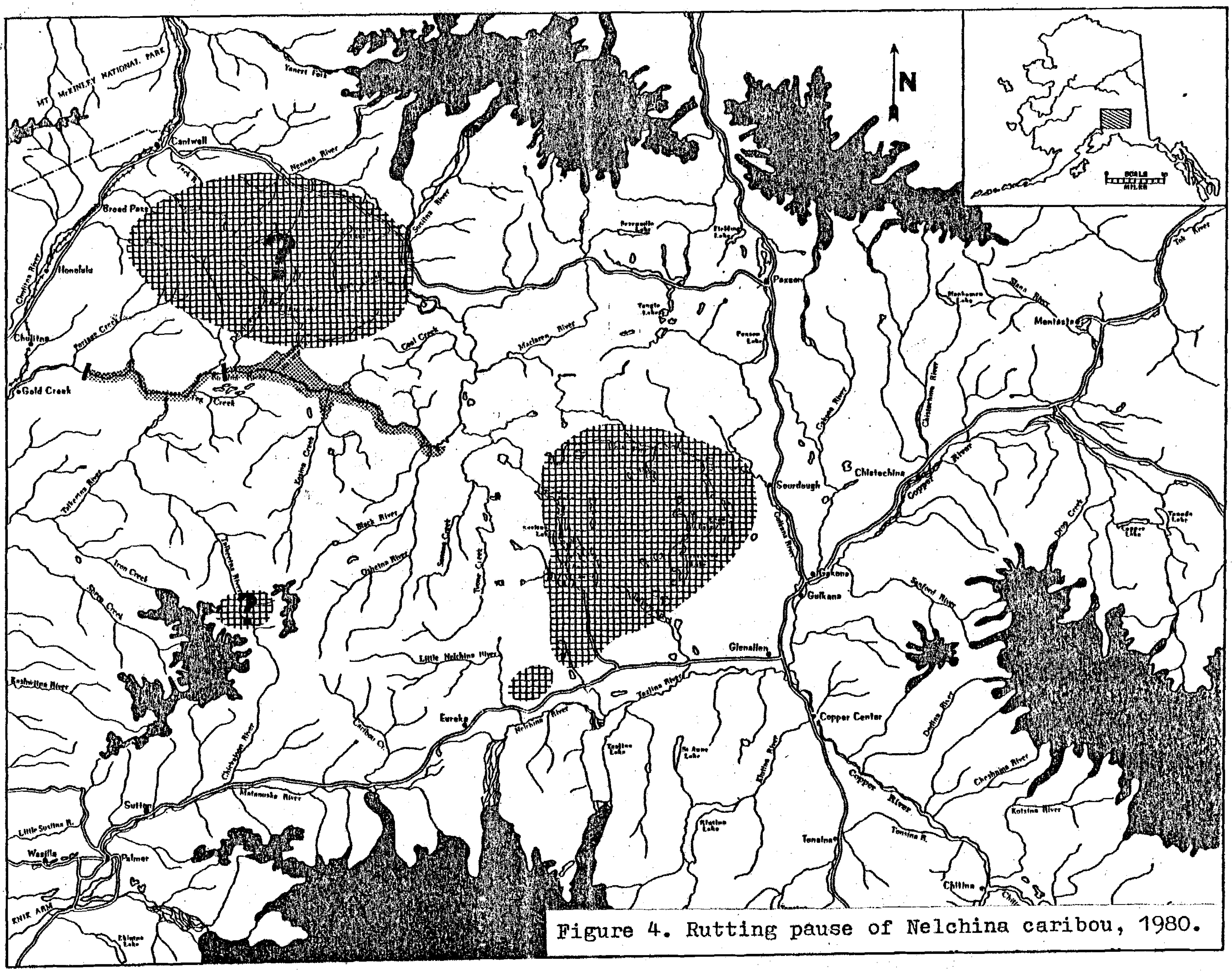

Figure 4. Rutting pause of Nelchina caribou, 1980.

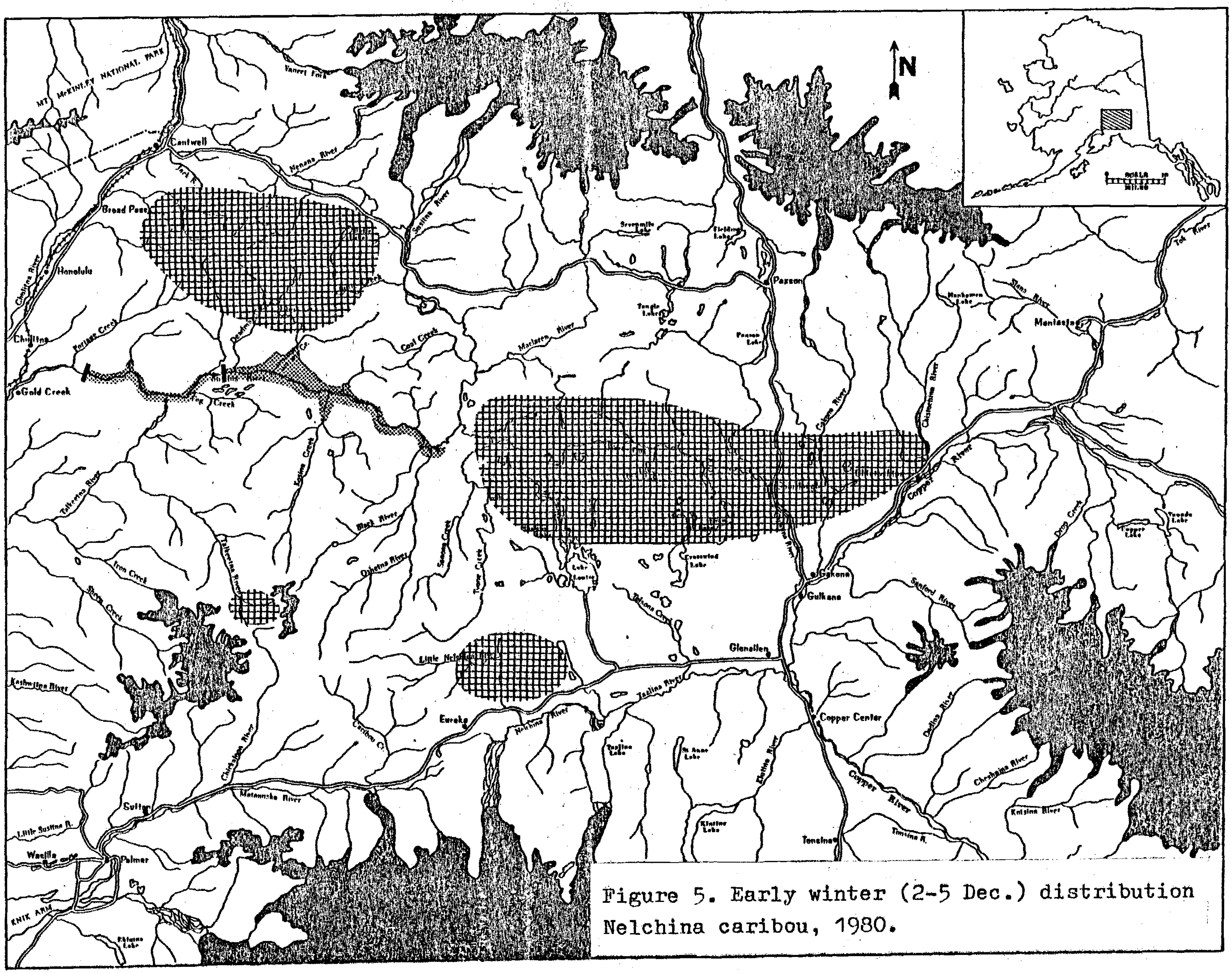

Figure 5. Early winter (2-5 Dec.) distribution Nelchina caribou, 1980.

Subherds

Eide (1980) suspected that subherds with separate calving areas existed in several areas of the Nelchina range. He based this conjecture on reports of sighting of animals, including young calves, in these locations during all seasons including the calving period. Locations of these possible subherds were the Watana Creek Hills (upper Susitna-Nenana drainages), the Talkeetna River, Chunilna Hills, Alaska Range and Gakona River (Fig. 6). Because of their proximity to the proposed hydroelectric development and potential for increased isolation radio-collars were placed on animals in three of the suspected subherds; Talkeetna River, Chunilna Hills and upper Susitna-Nenana River drainages. Because of the changeable nature of caribou movements and the short duration of the study the results are preliminary and may be interpretated differently when additional data are available.
Talkeetna River: two adult females and one adult male were collared in late April. All remained in the area throughout the study period. One collared female raised a calf. Several other females with calves were seen. The bull summered in the Talkeetna Mountains west of the main river but returned to the headwaters in the fall. The tentative conclusion is that this is probably a legitimate resident subherd composed of <400 animals. Chunilna Hills: one adult bull and one adult female were collared in late April. The female died within a month after capture. The bull remained in the Chunilna Hills through the fall. No sighting of females and young were made during the calving period. Insufficient data are available to speculate on subherd status. Upper Susitna-Nenana: four adult females and one adult male were radio-collared in early May. One of the females migrated to the main Nelchina calving area, summered in the Talkeetna Mountains, migrated back through the upper Susitna-Nenana area in the fall and rejoined the main Nelchina herd during the rut and early winter on the Lake Louise Flat. The other three females remained in the upper

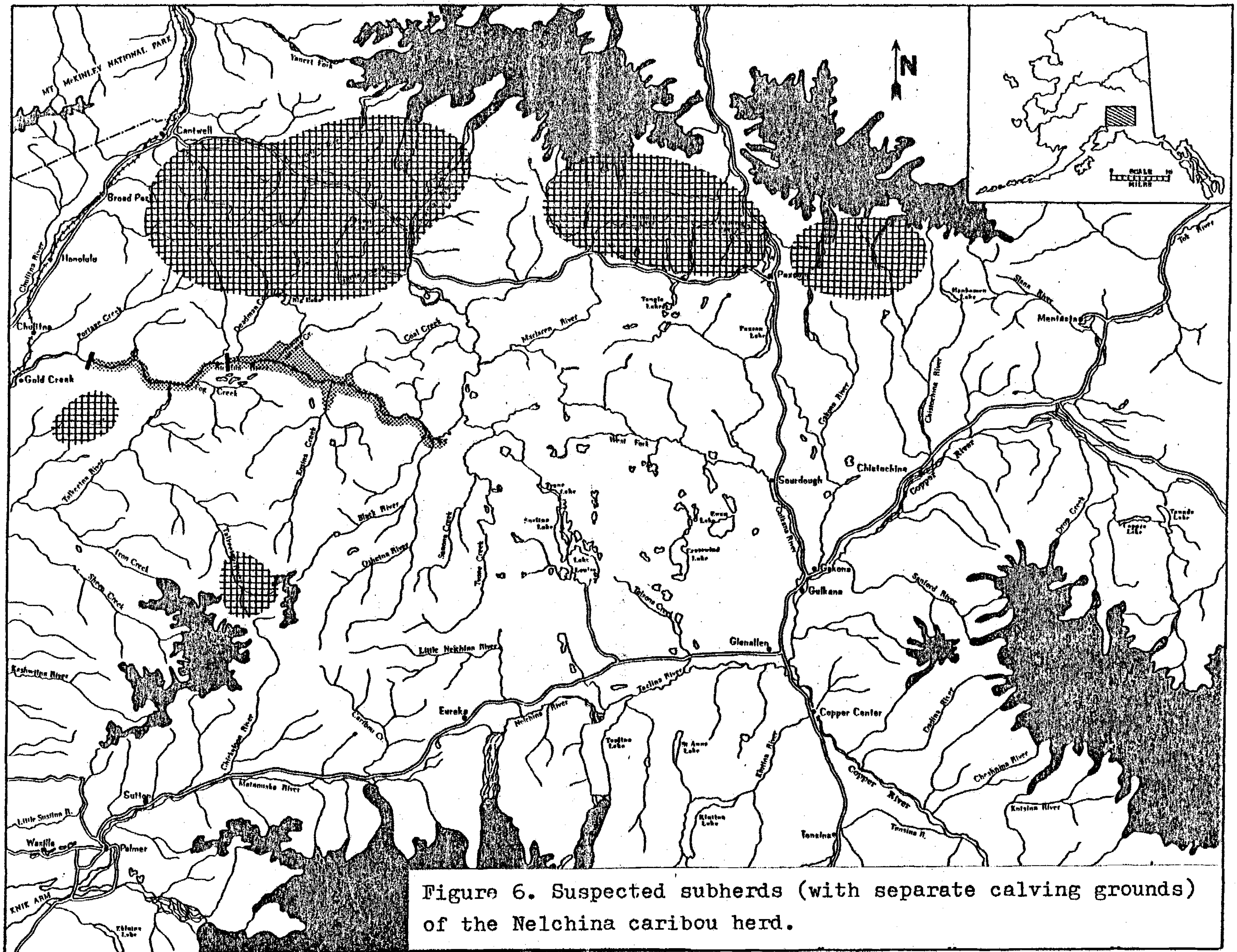

Figure 6. Suspected subherds (with separate calving grounds) of the Nelchina caribou herd.

Susitna-Nenana area throughout the study period, two producing calves. Other females with calves were seen. The bull summered in the Clearwater Mountains then joined the main Nelchina herd during the rut in the Lake Louise Flat. One of the main Nelchina radio-collared adult bulls summered in the upper Susitna-Nenana area before rejoining the main Nelchina herd on the Lake Louise Flat during the rut. It seems likely that a resident subherd of <1,000 caribou exists in this area, however the situation is confounded by movements of animals from the main Nelchina herd through the area and by use of the area by summering bulls from the main Nelchina herd.

Population Size and Composition

Census activities were conducted from 2-5 July 1980. Reconnaissance flights showed that the post-calving female:calf segment of the main Nelchina herd (including 19 of 20 radio-collared females considered to be main Nelchina animals) was in an area of about 260 square miles in the southeastern Talkeetna Mountains (Fig. 7). The area was subdivided into three areas based on geographical features and apparent composition of animals. A total of 17,061 caribou were counted; 9,771 in area A, 2,383 in area B and 4,907 in area C. Composition data from the three areas (Table 1) indicated significant differences (X^2=143.15, $P<0.001$) in the proportions of males, females and calves. The composition sampling effort was not proportional to the numbers of caribou in each of the subareas therefore the data were weighted (Table 1) to provide the most precise estimate of composition possible. An additional 244 caribou (including cows and calves) were found in peripheral areas and were assumed to have the same composition as the weighted estimate. Therefore the post-calving aggregation totaled 17,305 caribou with an estimated composition of 2,808 males $\geq$ 1 year, 9,285 females $\geq$ 1 year and 5,212 calves.

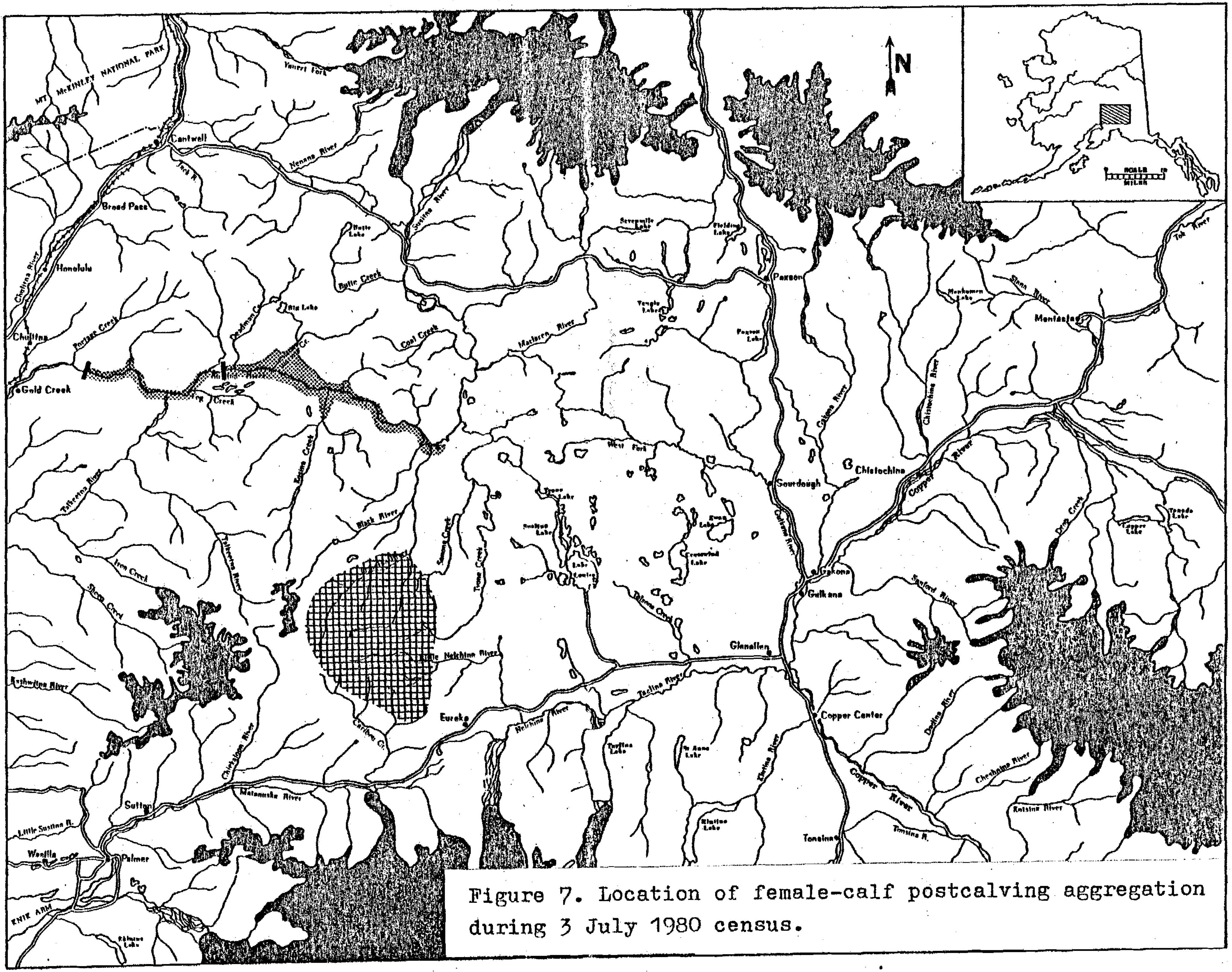

Figure 7. Location of female-calf postcalving aggregation during 3 July 1980 census.

Fall composition data (Table 2) were collected on 14 October 1980 when the main Nelchina herd was distributed on the Lake Louise Flat during the rut (Fig. 4). The ratio of males $\geq$ 1 year to 100 females $\geq$ 1 year was 61.9, the highest ever recorded for the Nelchina herd. While collecting the composition data I felt that sampling was probably biased towards males. Large males were easily identified and tended to catch my eye. Also, concentrations of males usually occurred at the back of groups where sampling began. Often the groups fragmented and animals towards the front were not fully sampled. An indication that the data may have been representative or that observer bias has been consistent over time was the near perfect fit (r^2=0.99) of this years ratio with the linear increase which has occurred since 1976. Indeed an increase in the proportion of males would be expected for a herd which is increasing and previously had a relatively low proportion of males.

The estimated fall population was calculated as follows:

18,558 = 17,305 X 0.537 X 0.978 X (1+1.042) where 17,305 = the number of animals in the post-calving aggregation,
0.537 = proportion of females in the post-calving aggregation,
0.978 = survival of females from the time of post-calving counts until fall and consists of an estimated 2.2 percent hunter harvest, 1.042 = ratio of bulls and calves to females in the fall. The figure 18,558 is the fall population estimate.

In recent times the Nelchina herd has increased from 37,000 in 1956 (Watson and Scott 1956) to 71,000± 11,867 in 1962 (Siniff and Skoog 1964) and then declined to about 8,000 in 1972 (Bos 1973, 1975). Since that time the herd has appeared to increase slowly to the present estimate of 18,558.

Table 1. Nelchina caribou postcalving sex and age compositon data, 5 July 1980.

Area	MM per 100 FF	Calves per 100 FF	Calves N	Calves %	Cows N	Cows %	Bulls N	Bulls %
A	19.8	54.8	222	31.4	405	57.3	80	11.3
B	76.9	37.4	107	17.5	286	46.7	220	35.9
C	33.5	67.6	184	33.6	272	49.7	91	16.6
Weighted*	30.2	56.1		30.1		53.7		16.2

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

Table 2. Nelchina caribou fall sex and age composition data, 14 October 1980.

MM per 100 ♀	Calves per 100 ♀	Calves N	Calves %	Cows N	Cows %	Bulls N	Bulls %
61.9	42.3	170	20.7	402	49.0	249	30.3

Habitat Selection

Analyses of habitat use and selection are dependent on computer programs and habitat mapping not yet available. Bos (1974) and Skoog (1968) remarked on habitat characteristics of the Nelchina calving grounds; 2,600 to 4,600 feet elevation, gently sloped, shrub birch, meadow, dwarf heath, relatively low snow pack and early snow loss. Characteristics of summering habitat include high elevation, wind exposure, scattered patches of snow and ice, grass, sedge, willow, dwarf birch and forbs (Skoog 1968, Hemming 1971). Suitable winter habitat characteristics include snow depths <60 cm, ice crust <3.8-6.4 cm, irregular terrain, forest and/or shrub cover, lichens, sedges and windswept range (Hemming and Pegau 1970, Skoog 1968).

Planned Activities Remainder Phase I

Distribution and movement studies and habitat selection studies will continue through Phase I with routine monitoring of radio-collared caribou. Increased emphasis will be placed on more frequent monitoring when animals are near the proposed impoundment sites, i.e. 15 April - 15 June and 1 August - 1 October. To more precisely evaluate subherd status at least two females will be collared in the Chunilna Hills area and monitored periodically, particularly during the calving period. Radio-collared caribou in the Talkeetna River and upper Susitna-Nenana subgroups will be monitored to better evaluate their subherd status. Population size of the Nelchina herd will again be estimated using the aerial photo-direct count-extrapolation caribou census technique.

During field activities I noted well worn caribou trails in the vicinity of the proposed Watana impoundment. LeResche and Linderman (1975) and Skoog (1968) both remarked on the value of mapping caribou trail systems to document historical movement patterns. I plan to map the trail systems in the vicinity of the proposed impoundments to determine traditional crossing sites.

Potential Impacts of Project Construction

It is apparent that the resulting impoundment from construction of the proposed Watana dam would intersect a major migratory route of the Nelchina caribou herd. During the initial 8 months of this study only moderate use of this migratory corridor has occurred by radio-collared caribou (and presumably by all Nelchina caribou). Four radio-collared animals have crossed the proposed impoundment area a total of seven times. Five of the crossings were north to south while two were south to north. Historical reviews indicated movements of virtually the entire female-calf segment of the herd across the proposed impoundment area in many years. During most years between 1950 and 1973 all or many of the females crossed from the calving grounds to summer in the greater Deadman-Butte Lakes area (Skoog 1968, Hemming 1971, Bos 1974). Varying proportions of the herd have wintered in upper Nenana-Susitna drainages in nearly all years. Between 1957 and 1964 this area was the major wintering area (Hemming 1971). Spring migration routes during those years would have undoubtedly crossed the impoundment area.

Large scale movements of caribou across the proposed impoundment area have not been recorded since about 1976 (Eide pers. comm.). However, based on past movement patterns and the quantity of good habitat available in the upper Nenana-Susitna area [Skoog (1968) considered some of this area the most important habitat for year around use in the Nelchina range] it seems inevitable that caribou will again use the area in large numbers. Movements to and from the calving grounds will again result in many caribou crossing the Susitna River in the area of the proposed Watana impoundment.

The reactions of caribou to the sudden creation of a large impoundment intersecting a major migratory route cannot be predicted with confidence. Movements across the impoundment would largely occur during three periods. Spring migration from the winter range to the calving grounds would occur from late April through May. This would be 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 run off. Post-calving movements from the calving grounds to summer range north of the Susitna would occur in late June or July at which time the impoundment would be ice free and nearing maximum water level. Additional movements throughout August and September could occur but would likely involve smaller, dispersed groups of animals. At this time the impoundment would be at maximum water level and ice free.

A possible reaction to the impoundment by caribou is complete avoidance and refusal to even attempt crossing. Another possible reaction would be avoidance by some components of the herd and attempted crossing by other segments. Cameron et al. (1979) documented avoidance of the trans-Alaska pipeline corridor by females and calves during summer. They also suggested avoidance by large groups, group fragmentation and/or decreased group coalescence near the pipeline corridor. Should animals attempt to cross the impoundment; spring migration would appear to pose the most serious problems. Pregnant females are often in the poorest condition of the annual cycle at this time (Skoog 1968) and migratory barriers which normally could be easily circumvented could become sources of mortality. Klein (1971) suggested that when animals are in poor physical condition seasonal migrations are easily disrupted. The potential for injury or death to migrating caribou appears greater in spring than during other periods. Skoog (1968) mentioned several instances of injuries and death resulting from falls on or through ice. Ice covered shores, ice sheets and steep ice shelves formed by winter drawn-down of the reservoir could present formidable obstacles to movement (Hanscom and Osterkamp 1980). Both Klein (1971) and Vilmo (1975) mention ice shelving as a mortality factor of reindeer on reservoirs in Scandinavia. Spring breakup would probably occur during the migration in many years posing additional hazards such as floating ice floes, overflow and wet ice shelves.

Crossings during summer and fall when the reservoir would be ice free appear to pose considerably less hazard. Caribou are excellent swimmers and are known to cross much larger bodies of water than the proposed impoundment (Skoog 1968). Young calves might have problems with this distance if migrations occurred shortly after calving. Water crossings have been reported as mortality factors but usually involved rivers rather the more placid bodies of water such as a reservoir (Skoog 1968).

It seems likely that the Watana impoundment would tend to isolate the northwestern portion of the Nelchina range (an area of about 4,000 mi^2). Historically this area has been heavily used as both summer and winter range by Nelchina caribou.

Development of access points such as roads, railroads and air fields would probably have negative impacts on Nelchina caribou. An access route through the Deadman, Watana, Butte Creek drainages to the Denali Highway would traverse a major migratory route through prime caribou habitat. Roads and railroads have been implicated in obstructing movements of caribou and reindeer (Klein 1971, Vilmo 1975, Cameron et al. 1979). Nelchina caribou do continue to cross the Richardson Highway, often in large numbers, and have done so during many years since about 1960 (Hemming 1971). Several studies (Miller and Gunn 1979, Calef et al. 1976) have recorded responses of caribou to aircraft disturbance and speculated on deleterious impacts. Cows and calves were most responsive to disturbance

(Miller and Gunn 1979). Caribou showed increased sensitivity during the rut and calving (Calef et al. 1976).

Electrical transmission lines have been reported to disrupt movements of reindeer in Scandinavia (Klein 1971, Vilmo 1975) because of associated noises (hum) and because they are foreign objects in otherwise familiar surroundings. If electrical transmission are downstream from the proposed Watana dam site they should have little impact on caribou as long as they are routed near the river. Few caribou occur in this area.

The proximity of the Nelchina calving grounds to the proposed Watana impoundments (Fig. 1) is of concern. According to Skoog (1968) the calving ground is the "focal point" of a caribou herd. The Nelchina herd has shown nearly complete fidelity to its calving ground since record keeping began in about 1950. The calving grounds are in one of the most remote and inaccessible regions within the Nelchina range. Development of the Susitna hydroelectric project would change this. Expanded human access and activity would likely occur which have been shown to adversely impact caribou use of calving areas. Cameron et al. (1979) documented abandonment of a portion of the calving grounds of the central Arctic herd concurrent with development of the Prudhoe Bay oil fields. Bos (1974) mentioned the importance of a low snow pack and early melt off on the calving grounds. Should the Watana impoundment act as a "cold body" and retard snow melt on the calving grounds in the spring calf survival could be affected.

Bergerud (1978) presents a somewhat different view and suggests that caribou are quite adaptable and will adjust to human construction and development. He states that the impacts of human development and harassment have been overstated and no good evidence is available indicating that development has caused abandonment of ranges. However, he does state that calving areas may be an exception and should be protected from both development and disturbance.

The Watana impoundment appears to have the potential to negatively impact Nelchina caribou although the extent cannot be predicted. The Devil Canyon Impoundment would occur in an area which both presently and historically has received little caribou use and would probably be of minor significance to the Nelchina caribou herd.

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SUSITNA HYDROELECTRIC PROJECT
ANNUAL PROGRESS REPORT

BIG GAME STUDIES

PART V WOLF

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ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the
Alaska Power Authority

March 1, 1981

SUMMARY

During 1980, 23 wolves from five separate wolf packs were radio-collared in an effort to partially identify packs which could be impacted by Susitna hydroelectric development. An additional four or five wolf packs were suspected of occupying parts of the project area, but no wolves from these packs were captured because of both late arrival of telemetry equipment and poor snow conditions. Five hundred and fifty-six radio locations were obtained on the 23 radio-collared wolves during 1980.

History of the five radio-collared wolf packs prior to and during this study were provided in the body of the report. One territorial dispute between the Tyone Creek and Susitna wolf pack was described.

Territory sizes for the five studied wolf packs averaged 452 mi^2 and ranged from 212 mi^2 to 821 mi^2. Known and suspected wolf territories were mapped. Based upon track counts, public sightings and radio telemetry studies, it was determined that at least four and perhaps five wolf packs would be directly affected by the proposed impoundments. An additional five wolf packs could be indirectly affected by the proposed project if it results in lower moose densities or disrupts movement patterns of migratory moose. Two wolf packs located away from the study area were formed as a result of wolf dispersal from the Susitna area to adjacent vacant habitat. Known wolf territories were essentially nonoverlapping during any particular year.

A minimum of 40 wolves were known to inhabit the study area in spring 1980. By fall the packs had increased by 93 percent to an estimated 77 wolves.

Radio-collared wolves were observed on 48 kills during 1980. Moose of all age classes comprised 52 percent of the kills. Calves were the most common moose age class. Caribou of all age classes comprised 38 percent of the observed kills. The occurrence of caribou kills during 1980 was slightly larger than that observed in previous years. This was partially the result of increased availability of caribou during winter.

During 1980 two packs were intensively monitored to determine rates of predation on moose. Predation rates varied from 1 kill/4.0 days for a pack of four wolves to 1 kill/4.9 days for a pack of eight wolves. Moose counts were conducted in each pack territory and the observed numbers were compared with predation rates. It was concluded that these two wolf packs were a significant cause of calf (short yearling) mortality. Age, sex and physical condition of kills examined in situ were listed and have been analyzed in an earlier report (Appendix 1). Wolf scats were collected at den sites for food habits studies but the results were not available for this report.

The general locations of 17 wolf den and rendezvous sites which have been observed in the project area since 1975 were given. Thus far two wolf packs have been discovered which either have den or rendezvous sites in areas which would be directly impacted by the project.

During May and June 1980 activity patterns of the Susitna wolf pack were intensively studied. Two hundred twenty-seven hours of ground observation were made at the den site. Various associations of adult wolves present at the den site were described.

Continuous monitoring of radio signals from mid-May through early June revealed that the pack excluding the adult female was away from the den site during evening and early morning hours. It was recommended that project personnel avoid wolf den sites during May and June but if absolutely necessary, they should conduct activities near the den during hours when most adult wolves are away from the den. Conceivably this could reduce disruptions to pack members. Movement of pups to the first rendezvous site occurred in early June, probably in response to the presence of the observer at the den site. Subsequent observations revealed that no pup mortality had occurred. It is recommended that if work needs to be conducted near a den site, that personnel delay work until after 6 June. Since the Watana wolf pack would definitely be impacted by project activities, it is recommended that an activities study be conducted on those wolves.

The most important potential impact of the Susitna hydroelectric project on wolves would occur indirectly due to reductions in prey density, particularly moose. Disruption of movements or reductions in migratory moose densities may reduce wolf densities for considerable distances away from the areas actually inundated. Temporary increases in wolf density may occur in the project area due to the displacement of moose and caribou from the impoundment areas. Direct inundation of wolf habitat, particularly den and rendezvous sites, may also lower wolf densities. Additional wolf mortality will probably occur due to increased hunting and trapping activities resulting from publicity concerning the area's wildlife and as access becomes developed.

Some additional data needs for evaluating the impacts of the proposed project on wolves were identified.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Development of hydroelectric power facilities along the Susitna River is expected to have detrimental effects on a number of wildlife species occupying habitats in and adjacent to proposed reservoirs (Taylor and Ballard 1979). Of particular importance are the potential effects these developments could have on both moose (*Alces alces*) and caribou (*Rangifer tarandus*) populations. Equally important are the affects of these impacts on predators and scavenging species which depend on ungulates for food. Three large predator species besides man occur in the Susitna Basin. They include gray wolves (*Canis lupus*), brown bear (*Ursus arctos*) and black bear (*Ursus americanus*). This report concerns studies conducted to date for determining the potential impacts of Susitna hydroelectric development on wolves.

Wolves in Game Management Unit (GMU) 13, commonly referred to as the Nelchina Basin, have been the focus of interest and study for over 30 years (Ballard 1981). History of GMU 13 wolves from 1957 through 1968 was summarized by Rausch (1969). From 1948 to 1953 poisoning and aerial shooting by the Federal Government reduced populations of predators to low levels. By 1953 only 12 wolves were estimated to remain in the basin. This small population quickly expanded and by 1965 was thought to have peaked at 400-450 (Rausch 1969). Although no systematic studies were conducted from 1969 through 1974, McIlroy (1976) suggested that a second population peak occurred in 1970.

During the period of wolf population growth, moose populations in GMU 13 declined suggesting a cause-effect relationship. Subsequently in 1975 a series of predator-prey relationships studies involving wolves were initiated. Results of these studies were provided by Stephenson (1978), Ballard and Spraker (1979), Ballard and Taylor 1980, Ballard et al. (1980) and Ballard et al. (1981a and b). Portions of the aforementioned studies involved experimentally manipulating wolf densities in part of the area which could be impacted by Susitna hydroelectric development (Ballard et al. 1980). Wolf control activities were conducted from 1976 through July 1978. By 1980 wolf densities in the reduction area had returned to precontrol levels (Ballard 1980) and thus studies to determine the potential impact of hydroelectric development on wolves would not be influenced by the earlier wolf control activities. Description of the proposed Devil Canyon and Watana Dam projects have been briefly described elsewhere (Taylor and Ballard 1979.

Objectives of Susitna hydroelectric wolf studies during Phase I were as follows:

(1) To identify wolf packs occupying areas that will be impacted by the Susitna Hydroelectric Project.

(2) To delineate the territories of each pack and identify den sites, rendezvous sites and major feeding areas.

(3) To determine the numbers of wolves and rates of turnover for each pack.

(4) To determine the food habits for each pack.

Data collected from earlier and ongoing GMU 13 wolf studies were, in some cases, combined with those collected during this study in an effort to provide a better understanding of wolf ecology in the Susitna Basin.

METHODOLOGY

Wolves were captured for radio telemetry studies with a Cap-Chur gun and dart (Palmer Chemical Co.) fired from a Jet Ranger 206B helicopter using methods similar to those described by Baer et al. (1978).

Wolves were immobilized with either 2 to 2.5 mg of etorphine (M-99, D-M Pharmaceuticals, Inc., Rockville, MD) or a combination of 1cc phencyclidine hydrochloride (100 mg/cc, sernylan, Parke-Davis Co.) and 1cc of promazine hydrochloride (100 mg/cc, Sparine, Wyeth Laboratories). After being processed and radio-collared, each wolf which had been immobilized with etorphine was given an equivalent cc dosage (2 mg/ml) of the antagonist diprenorphine (M 50-50, D-M Pharmaceuticals, Inc., Rockville, MD) which was injected into the radial vein. No antagonist is available for sernylan.

Captured wolves were equipped with an adjustable radio collar made of fiberglass and urethane manufactured by Telonics (Mesa, AZ). Blood samples were taken from each wolf using methods similar to those described for calf and adult moose (Ballard et al. 1979). Blood samples were shipped frozen to Pathologist Central Laboratory in Seattle, Washington for SMAC analysis and protein electrophoresis. When practical, the following body measurements were recorded: Weight, total length, hearth girth, chest height, neck circumference, shoulder height, tail length, and length of canines.

Radio-collared wolves were tracked and, when possible, visually observed from fixed-wing aircraft using the methods described by Mech (1974). Radio signals were received with a programmable scanning receiver (Telonics). Monitoring intensity was variable but an attempt was made to locate each pack once or twice/week.

Approximate ages of captured wolves were determined on the basis of tooth eruption and wear. Estimates of the ages of wild wolves were based upon their relative size and by criteria described by Jordan et al. (cited by Mech 1970). In some cases, age and sex structures of certain packs were not ascertained until the animals had been killed by hunters and trappers. Hunters and trappers were encouraged to provide the Department with wolf carcasses taken in Unit 13 by offering $10.00 per carcass. Ages of harvested wolves were determined by both tooth eruption and wear, and by examining epiphyseal cartilage of the longbone according to methods described by Rausch (1967).

Sex and age of moose and caribou (*Rangifer tarandus*) killed by wolves were often determined from fixed-wing aircraft based on size, pelage and antler growth. Moose kills were categorized as calves, yearlings or adults. Both calves and yearlings were aged to the nearest month using an assumed birthdate of 1 June.

Size of wolf territories was determined by plotting all radio locations for individual packs and then connecting the outermost observations (Mohr 1947). Locations for individual radio-collared wolves which had dispersed were not included. Sizes of wolf territories and study areas were determined with a compensating polar planimeter. All study areas and wolf territories were planimetered at least three times and then averaged to compute mi^2 (km^2). This method was selected to provide estimates comparable to those reported in other published studies. Other territory estimation methods will be explored in the future.

Active wolf dens located through observations of radio-marked wolves or during associated flying were inspected on the ground after they were vacated by wolves. The vicinity of each den was searched and all scats collected and food remains identified. Scats were placed in individual paper bags, then autoclaved and analyzed using previously described techniques (Stephenson and Johnson 1972), except that hair scale impressions (Adorjan and Kolenosky 1969) were used to confirm identification of prey remains. Comparisons of hair scale impressions were made with know samples by imprinting them on a slide containing clear fingernail polish.

When practical, wolf kills were examined on the ground. Cause of death was determined according to methods described by Stephenson and Johnson (1973) and Ballard et al. (1979). A femur or metatarsal and the mandible were collected from each kill to aid in establishing the animals physical condition on the basis of percent marrow fat using methods described by Neiland (1970). Ages of moose killed were determined on the basis of tooth eruption and cementum annuli, using methods described by Sergeant and Pimlott (1959). Caribou were aged on the basis of tooth eruption and wear (Skoog 1968).

During January through April 1980 an attempt was made to locate and examine all kills made by selected radio-collared wolf packs during a 2-3 month period. An attempt was made to radio-locate these packs every other day and to backtrack them to their previous location by following tracks.

In early May 1980 two members of the Susitna wolf pack were equipped with activity transmitters (Telonics) in an effort to determine the daily activity patterns of a denning wolf pack. Each activity transmitter was equipped with a tip switch which altered the pulse rate of the transmitter which was dependent on the position of the animal's head. When the animal's head was down, the pulse of the radio decreased and conversely when the animal was standing, the pulse rate increased. A semi-permanent monopole antennae was erected ¼ mile away from the pack's den site. Both amplitude and period of each radio transmitter was monitored during the denning season with a portable digital data processor (Telonics TDP-1) which was connected to a portable programmable scanning receiver and a rustrak recorder (Gulton Inc., Manchester, N.H.). All three instruments were powered by a 12-volt battery, all of which were housed in a large plastic container for weather protection. While activity patterns were monitored electronically, the den area was observed for a 31 day period by Dr. James Foster. During ground observations the presence or absence of radio-collared animals was determined by manually scanning the den site area with a hand-held antenna (Ballard et al. 1977). Both ground and aerial observations were used to verify activity data which were plotted on the rustrak recorder.

The recorder continuously plotted radio signal information on a paper spool at the rate of 8 inches/hour. A separate bench mark transmitter was used as a control to calibrate the receiver so that a continuous comparison could be made between the known location and activity of the bench mark transmitter to data collected from the wolf transmitters.

Descriptions of the proposed Devil Canyon and Watana Dam projects have been described elsewhere (Taylor and Ballard 1979) Because moose are the principal wolf prey, the boundaries of the wolf study area were the same as those described for upstream moose studies except that some packs were studied outside the boundary area because of wolf dispersal from the primary study area. Boundaries of the primary study area were as follows:

The Denali Highway on the north to its confluence with the Maclaren River on the east, the Maclaren River to its confluence with the first unnamed creek in R4E, T13N (Gulkana Quad) upstream to Monsoon Lake, then a straight line to Tyone Village continuing up Lake Louise to the Lake Louise Road to its intersection with the Glenn Highway, on the south the Glenn Highway to the Little Nelchina, then upstream to the peak of the Talkeetna Mountains, on the west the upper elevations of the Talkeetna Mountains to the confluence of the upper north and south forks of the Talkeetna River, then northwest to the mouth of Portage Creek, then upstream of Portage Creek to its headwaters to the headwaters of Brushkana Creek to its confluence with the Denali Highway (Fig. 1).

Vegetation, topography and general climate of the area has been described by Skoog (1968), Bishop and Rausch (1974), and Ballard (1981) and thus no further descriptions are needed until vegetation studies under Subtask 7.12 are completed.

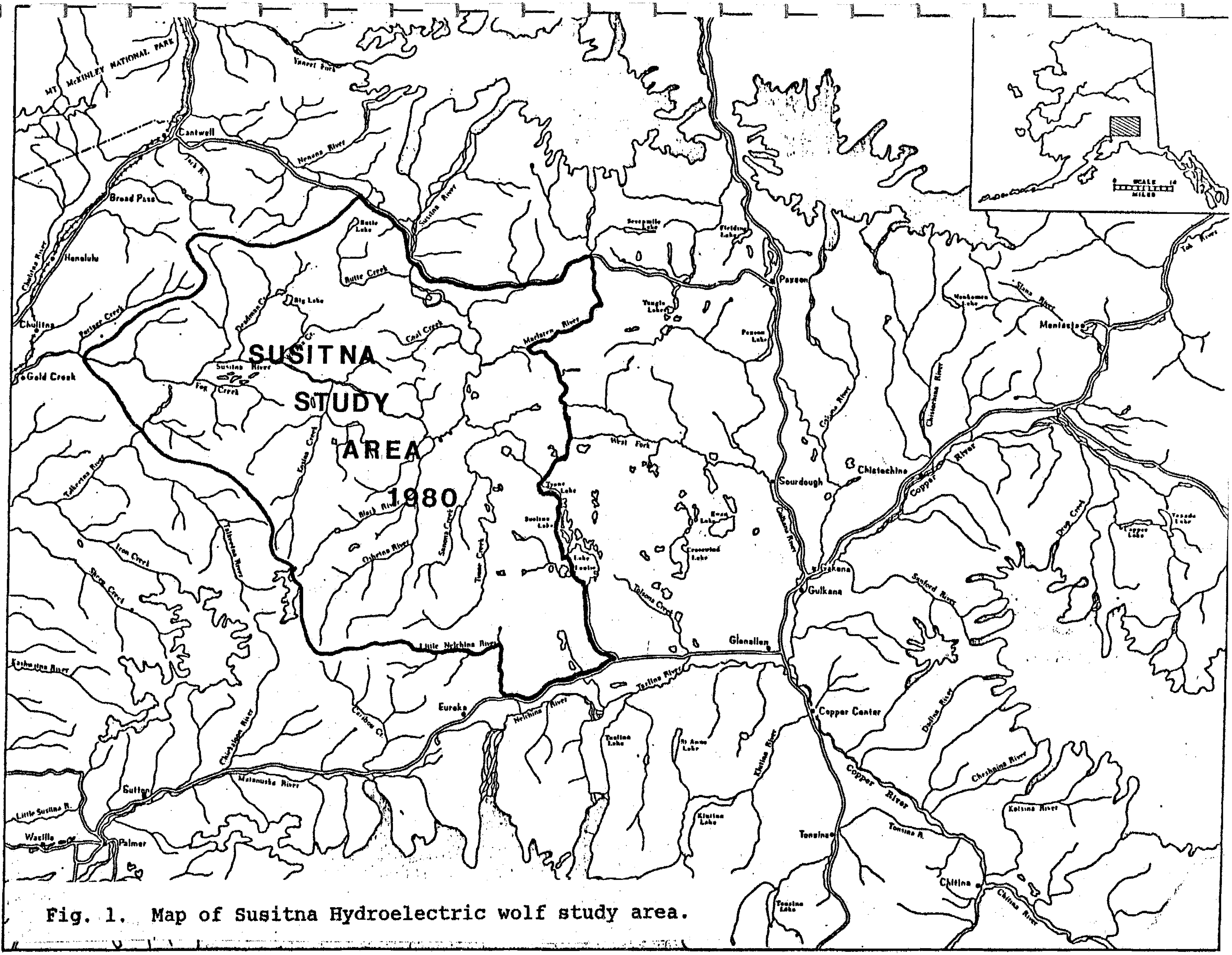

Fig. 1. Map of Susitna Hydroelectric wolf study area.

RESULTS AND DISCUSSION

During 1980, 23 wolves from five individual packs were captured and radio-collared on 27 occasions. Fourteen (61%) of the captured wolves were males and nine (39%) were females (Table 1). Six of the 23, were recaptured from earlier studies. A combination of phyencyclidine hydrochloride (Sernylan) and promazine hydrochloride (Sparine) was used to capture 10 wolves. Although this drug is cheap and effective, it is no longer available commercially and consequently use of etorphine (M-99) was initiated. An average of 2.8 mg (SD=1.02) of M-99 was needed to immobilize 17 wolves. Induction times ranged from 4.0 to 26.0 minutes, averaging 10.2 minutes (SD=8.0). Longer induction times and multiple dosages were usually the result of malfunction of the first dart. The dosage of M-99 was increased from 2.0 to 2.5 mg and this change appeared to provide more rapid immobilization with no apparent adverse effects. Response of individual wolves to the antagonist M-50-50 was usually quite rapid, averaging 1.7 minutes (SD=1.4) and ranged from 45 seconds to 5.3 minutes. Use of M-99 to immobilize free ranging wolves from helicopter has not previously been reported in the literature. Although further refinement of drug dosages appears desirable, the results reported here indicate that M-99 is a suitable alternative to Sernylan for immobilizing wolves.

Morphometric measurements and blood analysis of captured wolves are in the process of being entered in to a computer and therefore, except for weights, packed cell volume, and percent hemoglobin, they will not be presented at this time. Data from this study and earlier wolf studies (Appendix A) will be combined and analyzed jointly to provide sufficient sample size to describe morphometric growth and development in this wolf population.

Table 1. Summary of statistics associated with wolf radio-collaring activities for Susitna Hydroelectric studies in GMU 13 of southcentral Alaska during 1980.

Orig. Pack Affiliation	Accession Number	Date Captured	Est. Age	Color	Sex	Weight (lbs)	Drug Dosage (mg)	Location of Injection	Induction Time (min)	Antagonist Dosage (cc)	Reverse Time (min)	Packed Cell volume	% Hb
Susitna	122229*	04/16/80	Yrl.	Gray	♂	105	M-99 2.5	Left rump	5.5	2.5	1.7	57	20+
	122295*	03/20/80	4 yr.	Gray	♀	-	Sernylan: 1:1 Sparine	?	-	N/A	N/A		
		04/15/80				100est	M-99 2.0	Left leg	7.0	2.0	1.0	49.5	17.9
	122296*	02/20/80	6-7 yr.	White	♂	110est	Sernylan: 1:1 Sparine	?	-	N/A	N/A		
	122302	02/20/80	Pup	Gray	♀	-	Sernylan: 1:1 Sparine	-	-	N/A	N/A		
		10/16/80	Yrl.			75	M-99 2.0	Tail	5.0	2.5	1.5	63	20+
	122303	02/20/80	Yrl.	Gray	♂	80	Sernylan: 2.0 Sparine	Left rump	-	N/A	N/A		
	122305	04/13/80	3 yr.	Gray	♂	100	M-99: 2.0-.25 Rompun	?	8.0	3.0	1.0	55	20+
		10/16/80				106	M-99 2.5	Right rump	5.5	2.5	2.0	68	20+
	122306	04/13/80	Pup	Gray	♂	85est	M-99: 2.0:4 Rompun	?	8.0	3.0	1.0	53	18.9
Susitna-Sinona	122312	10/14/80	Pup	Gray	♂	46	M-99 2.5	Top back	5.0	2.5	.8		
	122313	10/14/80	2-3yr	Gray	♂	106	M-99 2.25	Left leg	-	2.5	1.0	63	20
Tolsona	122220*	07/06/80	2.5yr	Black	♀	68	M-99 2.25	Front leg	20.0	2.5	1.0		
							2nd dart 1.5	?	3.0				
	122315	10/16/80	3-4yr	Black	♀	78	M-99 2.5	Top back	5.0	5.0	5.3	68	20+
							2nd dart 2.5	?					
	122316	10/16/80	Yrl	Gray	♂	82	M-99 2.5	?	6.0	2.5	1.5	62	20+
Tyone	122215*	02/20/80	3-4yr	Gray	♂	111	Sernylan: 1.0:1.0 Sparine	?	?	N/A	N/A		
	122216*	02/20/80	3-4yr	Gray	♀	95	Sernylan: 1.0:1.0 Sparine	?	?	N/A	N/A	51	20

Table 1 (cont.)

	122298	02/20/80	Pup	Gray	♀	84	Sernylan: 1.0:1.0	?	?	N/A	N/A	44	20
							Sparine						
		10/16/80	1.5yr			82	M-99 2.5	?	12.0	2.5	.8	56	19.5
							2.5	?	12.0				
	122299	02/20/80	Pup	Gray	♀	82	Sernylan: 1.0:1.0	?	?	N/A	N/A		
							Sparine						
	122300	02/20/80	Pup	Gray	♂	93	Sernylan: 1.0:1.0	?	?	N/A	N/A	48	20
							Sparine						
	122301	02/20/80	Pup	Gray	♂	100	Sernylan: 1.0:1.0	?	?	N/A	N/A		
							Sparine						
	122317	10/16/80	2-3yr	Black	♂	?	M-99 2.5	Left shoulder	40	2.5	1.0	60	20+
Watana	122308	04/24/80	3-4yr	Gray	♀	91	M-99 2.5	Top back	17.0	8.0	5.0	47	25+
	122309	04/19/80	Pup	Gray	♀	79	M-99 2.0	Chest cavity	4.0	4.0	.8	52	20+
	122310	04/23/80	2yr	Gray	♂	101	M-99 2.0	Left side	26.0	5.0	1.5	52	20+
							2.0	Back					
	122311	04/23/80	2yr	Gray	♂	112	M-99 2.0	?	?	5.0	2.0	50	20

* Recapture

Five hundred and fifty-six individual radio locations were obtained for the 23 radio-collared wolves during 1980 (Table 2), yielding an average of 24 locations per animal. A total of 1,300 wolf sightings were made at the locations which represented 255 pack days (pack day is defined as any day on which a pack was located one or more times).

Radio contact with at least four wolf packs occupying habitats along the Susitna River near the proposed impoundments was not established during this study period. Necessary radio telemetry equipment was not ordered until January 1980 and consequently it arrived in late spring after adequate snow conditions, necessary for detecting and capturing wolves, had deteriorated. Lack of adequate snow cover and clear sunny weather during fall and early winter also prevented capture efforts. With the exception of the Watana wolf pack radio contact with the other four study packs was possible only because a few members of each pack continued to have functioning radio collars from earlier studies and thus we were able to locate the packs for additional collaring.

Pack Histories

Histories of individual radio-collared wolves and their respective packs are described in the following section. Individual wolves are identified in the text by the last three digits of their assigned accession number. Because some of these packs had been under study before the initiation of this project, data from 1 January through 30 June 1980 were included with data collected earlier (Ballard et al. 1981). An abstract of this latter report is provided in Appendix A.

Susitna Pack

Radio contact with this pack was established in February 1979 within the Deep Lake pack territory (Ballard et al.

Table 2. Summary of numbers of location observations of radio-collared wolves by individual and pack affiliation during 1980 in the Susitna Hydroelectric Project area.

Pack Name	Accession Number	No. Radio Locations	No. Wolf Sightings	No. Pack Days
Susitna	122295	80	376	85
	122296	9		
	122302	60		
	122303	9		
	122305	26		
	122306	32		
	Subtotal	216		
Susitna-Sinona	122229	24	76	24
	122312	3		
	122313	4		
	Subtotal	31		
Tolsona	122220	35	367	35
	122315	3		
	122316	5		
	Subtotal	43		
Tyone	122215	31	320	75
	122216	11		
	122298	41		
	122299	36		
	122300	41		
	122301	13		
	122317	4		
	Subtotal	177		
Watana	122308	31	161	36
	122309	12		
	122310	28		
	122311	18		
	Subtotal	89		
Totals	23	556	1,300	255

1981). At that time the Susitna wolves were observed fleeing from the carcass of the Deep Lake female (#009) which they had just killed. Reasons for this conflict and the fate of an uncollared gray which had been accompanying wolf 009 are not known, particularly since this pack never returned to the Deep Lake area.

When collared, the pack was comprised of at least two adults and seven pups. On the basis of size and later capture records, a tenth wolf, an adult male was suspected of having been in the pack. Following initial capture, the pack moved to the area south of the big bend in the Susitna River. Whether these wolves had always occupied the area west of Lake Susitna and Tyone is unknown but seems likely based on the identified gaps between territories of other packs for the period 1975 through 1978 (Ballard et al. 1981). By late spring 1979 the pack numbered six or seven. Pack losses between fall and spring were probably the result of one to two wolves being shot and at least one dispersal.

The pack was first observed at the 1979 den site on 13 April. At least six pups were raised but were not observed until 3 August. Between late summer and October 1979 the pack declined to 10, possibly due to dispersal.

During December and January 1979-80 large concentrations of Nelchina caribou were found within the Susitna pack territory as they began migrating towards the Wrangell Mountains. In late January 1980, wolf 229, a yearling male, and at least two gray associates appeared to follow the caribou migration and dispersed to the east. This group was subsequently referred to as the Susitna-Sinona pack. By early February 1980 the original Susitna pack numbered seven.

In early March 1980 the pack was reduced by two members because of a conflict with the Tyone pack. Details of this conflict follow:

On 8 March while conducting a study of predation rates, wolf 295 (the adult gray female of the Susitna pack) was tracked to a location 2 miles (3.2 km) south of Vermillion Lake. She was alone. By backtracking her in the snow for several miles to the west to the confluence of Sanona and Tyone Creeks seven additional wolves were located in one area. As this was more than had been observed in the Susitna pack during the previous 2 weeks, a check of other wolf radio frequencies revealed that radio-collared members of the Tyone pack, which was comprised of two adults and six pups, were also present. A search was made for other radio-collared members of the Susitna pack and wolf 296, the light adult gray male which on the basis of tail posture and leadership in the pack was assumed to be the alpha male, was found dead 0.5 miles (0.8 km) north of Tyone Creek. A subsequent examination of wolf 296 revealed puncture marks on the neck and shoulders. In addition, at least seven distinct wolf trails radiated from the area, leaving little doubt that wolf 296 had been killed by other wolves. Following blood in the snow wolf 296 was backtracked to the location where the struggle had begun. At this site a fresh adult moose kill was discovered.

At the moose kill there were at least two wolf beds in the snow approximately 20 feet away. A moose fetus, a dead ptarmigan (*Lagopus* sp.) and two wolf beds were also found on the opposite side of the creek from the moose kill. Tracks of a single wolf (possibly wolf 296) indicated that it had fled from the moose kill. Approximately 100 yards separated the carcass of the moose and the carcass of wolf 296.

One of the wolf trails radiating from the moose kill site was spotted with blood. This trail was followed for approximately 0.25 miles upstream where the trails of four wolves came together, suggesting that an apparent pursuit continued. Approximately 0.25 miles (0.4 km) north of the creek, members of the Tyone pack had apparently caught wolf 303 (a gray yearling male). Wolf 303 was still alive, but had lost a considerable amount of blood according to signs in the snow.

Wolf 302 of the Susitna pack was radio-located at 1130 hr. 3.5 miles east of the carcass of wolf 296. When originally located at 1030 hr. she had been within 0.25 miles (0.4 km) of the Tyone wolves. At this time the location of four of seven Susitna wolves and all eight Tyone wolves was known.

While leaving the site an additional fresh calf moose kill was observed close to the adult moose kill. The calf had been killed by punctures in the neck and anal regions but had not been fed upon.

On 9 March 1980 wolves 295 and 302 of the Susitna pack were located. Wolf 295 had moved to the east side of the Tyone River. Wolf 302 was within 5 miles (8 km) of wolf 295 and appeared to be heading directly toward her. The Tyone pack, however, was in the same location observed on 8 March and had revisited the kill site of wolf 296 and the site of injured wolf 303. Wolf 303 had moved approximately 50 feet where members of the Tyone pack finally killed him, apparently with punctures in the neck and around the ears.

Based upon ground and aerial observations, it was concluded that the Susitna pack had come upon a moose kill made by the Tyone wolves. The moose kill was located on the territory boundary of each pack (Fig. 2). Therefore, in addition to competition for possession of the kills, the conflict may have involved a territorial dispute. The Susitna area appeared to have a relatively poor availability of prey in comparison to the Tyone pack territory during this winter. Comparison of prey abundance between the two areas will be discussed in the predation rates section of this report. Although the literature indicates that conflict with and between pack members occasionally results in wolf mortality, all reported incidences have involved only one mortality.

Following the dispersal of wolf 229 and its associates, and the deaths of wolves 296 and 303, the Susitna pack was reduced to four wolves by late spring 1980. They denned at the same site they had used in 1979 and were first observed there on 23 April.

During the 1980 denning season, two of four remaining pack members (#'s 295 and 305) were fitted with activity radio transmitters. In addition, ground observations at the den site were made from 1 May through 6 June 1980. Methods and results from this study period are being prepared for publication by James Foster, Woodland Park Zoo and Warren Ballard, Alaska Department of Fish and Game. Preliminary results of this 1 month study are presented in the summer activities section of this report.

The pack moved the pups to the first rendezvous site, located approximately 0.75 miles west of the den site between 4 and 6 June. A second rendezvous site, located approximately 5 miles to the northwest, was briefly occupied between 1 and 7 August.

No pup mortality was observed in 1980. In addition no trapping or hunting mortality occurred in 1980 due to poor snow conditions, and, thus, the pack was still comprised of 10 wolves by the end of December.

From 1979 through December 1980, the Susitna pack occupied a territory of approximately 462 mi^2 (1,197 km^2).

Tolsona Pack

Prior to mid-June 1978 contact with this pack consisted of public sightings, track counts and harvest records. These data indicated that in early fall 1977 the pack had numbered at least 11. By the end of winter, trappers had reduced the pack to three individuals.

Radio contact with this pack was established in early June 1978. In search of a potential den site, aspen-covered knolls were examined from fixed-wing aircraft until the den site was found and a yearling gray male (#210) was radio-collared. At that time the pack was comprised of wolf 210, an adult gray female, and a small black wolf which may have been a yearling. At least eight pups were raised at the site. Pups were moved to a rendezvous site 3.5 miles (5.6 km) away from the den site between 24 and 26 June 1978. During late summer 1978 wolf 210 began exhibiting a propensity to travel to the western extremes of the old Mendeltna territory which was thought to have been vacant since February 1978. During these forages wolf 210 was always observed alone. In mid-September 1978 radio contact was lost. At that time the pack numbered 10.

There was no radio contact with this pack from September 1978 until late January 1979 at which time a live black yearling pup was purchased from a local trapper. The pup had been caught by the toes and was in good enough condition to be radio-collared. At the time her pack affiliation was uncertain. Within 2 weeks of capture, however, she had rejoined the Tolsona pack which then numbered seven (three blacks and four grays).

By 10 May 1979 the pack began frequenting the den site utilized in 1978. Pups were first observed outside the den on 25 June. An accurate count of the number of pups produced was never obtained. In mid-October, however, the pack numbered 16 (11 grays and 5 blacks). On the basis of size and the scruffy appearance usually exhibited by pups at that time of the year, it is believed at least six and perhaps nine pups were raised (3 blacks and 6 grays).

During summer 1979 members of this pack appeared to continuously expand their range westerly into the old Mendeltna territory. In mid-October, when the largest count of the pack (16) was obtained, they were located close to Moore Lake which had been the northern territory boundary of the Mendeltna pack. Although wolf 210 had not been radio-located since late August of 1978, it was present with the pack at that time.

During winter 1979-80 the pack suffered attrition due to trapping and perhaps from dispersal even though portions of their territory were included in an area closed to hunting and trapping. Radio contact was temporarily lost when wolf 220's radio transmitter failed prematurely. Contact with this pack was not re-established until early June 1980 when they were discovered at the Nickolson Lake den site which had been used by the Mendeltna pack in 1977. Wolf 220 was recaptured in July 1980 and at that time the pack was comprised of a minimum of two black adults, seven gray adults and six pups. In late June the pack moved to the Nicholson Lake rendezvous site which had been used as a den site by the Mendeltna pack in 1977. This movement was the result of an attempt to ground capture and radio collar one wolf. On 6 July wolf 220 was recaptured by helicopter darting.

By late fall 1980, the pack numbered 16 (4 blacks and 12 grays) suggesting that seven pups may have been raised.

Based upon the presence of an adult black wolf in the Tolsona pack from summer 1978 to 1980 and the known expansion of this pack's territory into the Mendeltna area, it is suspected the black wolf may have been a survivor of the Mendeltna pack (Ballard et al. 1981). As mentioned in the Mendeltna pack section, following winter 1977-78 all but two black wolves were accounted for according to wolf sealing documents. Perhaps, following drastic reduction in numbers, these two blacks dispersed and became integrated with the Tolsona pack which in spring 1978 was thought to contain only three wolves.

From June 1978 through December 1980 the Tolsona pack occupied an area of 821 mi^2 (2,126 km^2). Their range extended from Tazlina Lake to Lake Louise, west to Tyone Creek and then east several miles past Tolsona Creek (Fig. 2). At this time no other pack territories were believed to overlap the Tolsona territory.

Tyone Creek Pack

Prior to establishment of radio contact with this pack in November 1977, data consisted of track counts and public sightings. Between spring 1976 and fall 1977 the pack numbered from six to eight individuals. In fall 1977 the pack numbered 12. Apparently the pack denned in 1977 because one pup (#151) was radio-collared.

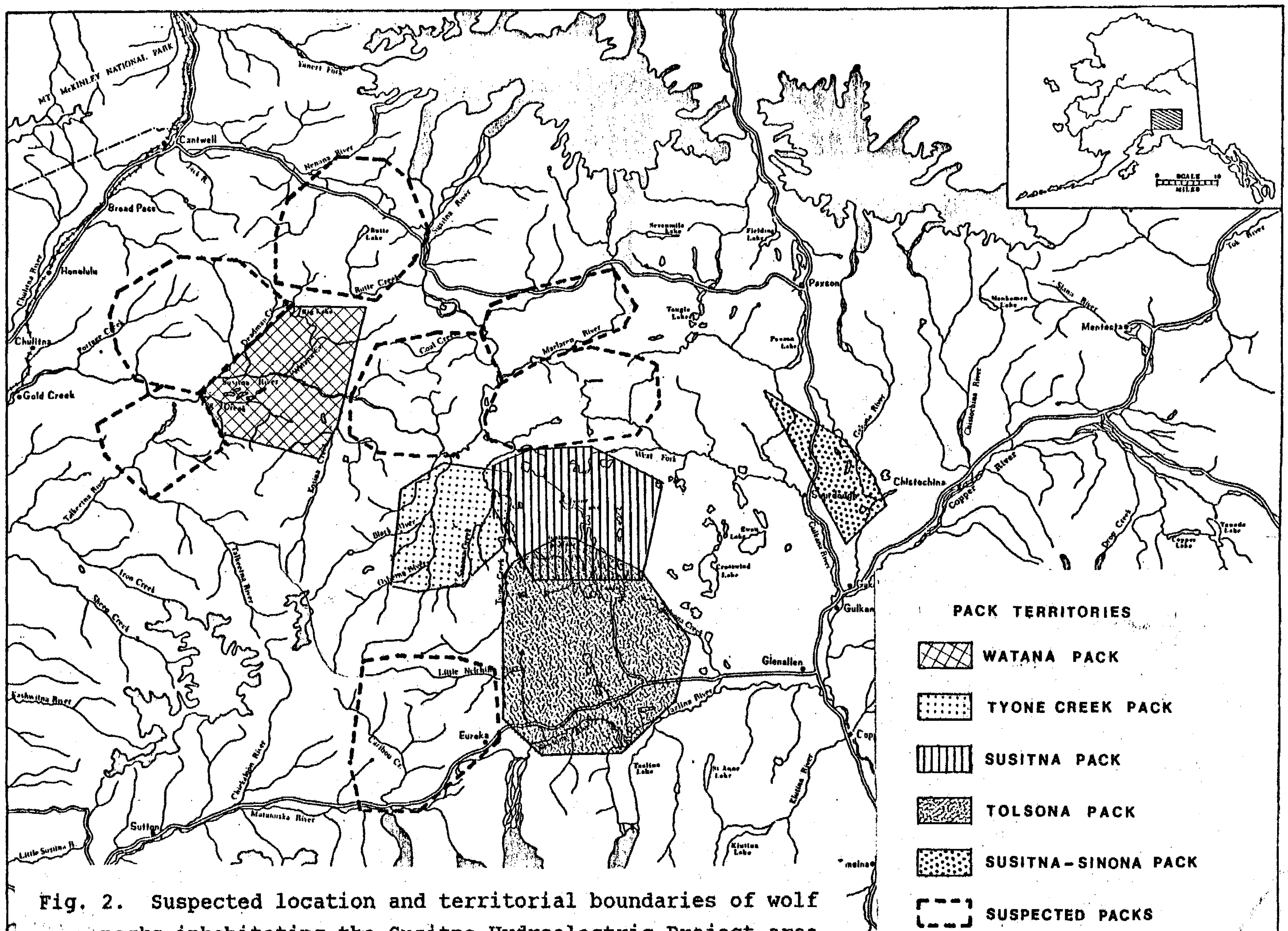

Fig. 2. Suspected location and territorial boundaries of wolf packs inhabitating the Susitna Hydroelectric Project area during 1980.

During the 1977-78 hunting-trapping season 11 of 12 known pack members were harvested in this area, one of which was not retrieved. The remaining wolf (#116) dispersed from the area. By 27 February he was observed accompanied by a black female in the western edge of the Keg Creek territory. During March both wolves emigrated to the Susitna River study area. In late March the black female was removed by Department personnel during experimental wolf control studies. Wolf 116 continued to reside in the Susitna study area and by 20 June was observed with a yearling female which was also removed in mid-July. By late fall wolf 116 was observed alone at Monahan Flats, having dispersed over 60 miles (96 km) from his original capture location. Following this latter observation, radio contact with wolf 116 was lost and it is assumed he dispersed farther to the north or west.

During fall 1977 and early winter 1978 the Tyone Creek pack occupied an area of 253 mi^2 (655 km^2). Public observations and track sightings indicated that the pack also ranged to upper Goose Creek on the west and the Susitna River to the north.

In November 1978 contact with wolves in this area was re-established when two adults (#215 and 216) were radio-collared. Whether these wolves were descendants of the original Tyone Creek pack, which was thought to have been eliminated by ground shooting in 1978, or represented wolves colonizing a new area is not known. They did not, however, occupy the area previously occupied by the Tyone Creek pack.

During winter 1978-79 no other wolves were ever observed with this pair. On 23 April they were first observed at the 1979 den site. Seven pups, which were first observed on 6 July, were reared.

In early March 1980 this pack killed two wolves from the Susitna pack during a conflict near two recently killed moose. Details of this conflict were provided in the description of the Susitna pack.

Wolf hunting and trapping within this pack's territory was closed in both 1978-79 and 1979-80 so that wolf numbers would remain stable for the predation rate studies. However, five wolves, three of which were radio-collared (#215, 216 and 301), were removed from the pack. One of these was legally ground shot when the pack ventured out of the closed area in January 1980. In March 1980, four others were killed illegally by aerial hunters. These mortalities reduced the pack to four pups by late March 1980.

Following the removal of the alpha male and female from the pack, the remaining pups were apparently unable to kill either moose or caribou. From mid-March through December these wolves were never observed on a fresh kill and revisited many of the old kills made prior to the reduction in pack numbers. In mid-April the pack began exhibiting an erratic movement pattern: on 14 April they were observed at Kosina Creek approximately 20 miles (32 km) northwest of the original territory boundary, then on 25 April they were observed on the middle fork of the Susitna River approximately 50 miles (80 km) north of the territory boundary. In both cases, however, the pack returned to the old pack territory within a few days of the observation. Obviously the pack did not den in 1980 but the pups did show a tendency to linger around the old 1979 den site.

By late June 1980 the pack of four was joined by an uncollared black wolf. By mid-July the three radio-collared wolves began exhibiting a propensity to travel independently of one another. Contact with wolf 299 was lost after 24 October 1980 when it was located at Boulder Creek above the Denali Highway.

Wolf 298 continued to frequent the old Tyone Creek territory except on 27 August she was observed approximately 40 miles (64 km) to the south at the head of Chitna Creek accompanied by one gray and one black. Following this observation wolf 298 was always observed with one black in the old territory. This black was captured and radio-collared (#317) on 16 October and was determined to be a young adult male suggesting that a bond had been formed.

Between 26 August and 18 September 1980 wolf 300 dispersed approximately 65 miles (104 km) northeast to the vicinity of Dickey Lake. This young male remained in the vicinity of Dickey Lake through early fall and by 23 October was accompanied by an uncollared black wolf. We suspect this uncollared wolf is a female and that a pair bond had been formed. Perhaps not surprisingly this pair of wolves began occupying the same locales which had been used by the Middle Fork wolf pack in 1977-78. In spring 1978 this territory area was thought to be vacant (Ballard et al. 1981). Insufficient radio locations have been obtained thus far to calculate territory size.

Prior to the removal of the adult wolves from the Tyone Creek pack in March 1980, they had occupied a relatively small territory of 302 mi^2 (782 km^2).

As mentioned earlier following the removal of the adult pair in March 1980, the remaining four pups were never observed on a fresh ungulate kill. They did revisit old kills which had been made prior to March 1980 Since these pups (yearlings) became associated with other adult wolves, we have only observed one pair (#'s 298 and 317) with a fresh kill. These observations suggest that these wolves were either making kills so infrequently that our monitoring schedule was not intense enough to detect them or they were subsisting on small game.

Watana Pack

Contact was temporarily established with this pack in March 1978 when three wolves were removed by Department personnel as part of the experimental wolf removal program and one adult male (#197) was radiocollated. Wolf 197 occupied the area from upper Watana Creek to lower Fog Creek. Contact with this wolf was lost in April for unknown reasons.

From April 1978 to April 1980 data for this pack consisted only of track counts and observations by Department personnel. By fall 1978 the pack numbered three and may have remained at that level through spring 1979, although the presence of only two wolves could be ascertained. The pack apparently denned in 1979 because seven wolves were present by fall.

In late April and early May 1980, three adults (#308, 310 and 311) and one pup (#309) were captured and radio-collared near Watana Creek. They were first observed at a den site on 13 May where at least six pups were raised. Prior to parturition the pack was known to be comprised of at least five and perhaps as many as eight wolves. Between 8 and 14 July pups were moved to a rendezvous sites approximately 1.0 mile WNW of the den site. No other rendezvous sites were observed and the pups began traveling with the adults regularly by late September. During September wolf 311 was shot by a hunter on Watana Creek. Radio contact with wolf 309 was lost after 12 August either due to dispersal or radio failure. By late December, 13 wolves still remained in the pack suggesting that pup survival was high and no further adult mortality had occurred. From April through December the Watana pack occupied an area of 400 mi^2 (1036 km^2).

Wolf Territories and Population Numbers

For the purposes of this report Etkins (1964) definition of territorality was used; "any behavior on the part of an animal which tends to confine...its movements to a particular location." Most definitions of territorality assume that the territory is defended against intruders. Although wolves in the Nelchina Basin apparently do at times defend their area against other wolves, intrusions into a neighboring territory often occur when the home pack is not using that portion of the area.

Table 3 summarizes territory sizes for the five wolf packs which have been intensively investigated for Susitna hydroelectric studies. Territory sizes for the five packs averaged 452 mi^2 (1170 km^2) which was comparable with sizes determined for other wolf packs in GMU 13 (Ballard et al. 1981).

Figure 2 depicts the spatial arrangement of known and suspected wolf territory boundaries in the project area in 1980. Based upon track counts, public sightings, and radio locations of radio-collared packs, at least four and perhaps five wolf packs occupy portions of the Susitna River which would be directly impacted by the Devil Canyon or Watana impoundments. The packs are Tsusena Creek, Watana, Stephan Lake, Jay Creek and Tyone Creek. A minimum of five additional packs could be indirectly affected by reductions in moose density through direct mortality or disruption of known moose of known moose migration patterns. These packs include the following: Butte Lake pack,

Table 3. Summary of territory sizes for wolf packs studied as part of the Susitna Hydroelectric Project studies during 1980.

Area	Territory Size mi^2	(km^2)
Susitna	462	1,197
Susitna-Sinona	212	548
Tolsona	821	2,126
Tyone Creek	364	943
Watana	400	1,036
$\bar{x}$	452	1,170
S.D.	226	584

Maclaren River pack, Keg Creek pack, Susitna pack and the Tolsona pack. Additionally, two packs (Dickey Lake pack and the Susitna-Sinona pack) were the result of dispersal from the aforementioned packs. Had these packs been at reduced densities, these dispersals may not have occurred and these pack areas could have remained vacant. It is interesting to note that even under the intensive harvest pressure exerted by ADF&G personnel from 1976-78, not all wolves were removed from along the Susitna River. At that time it was suggested that wolves occupying the Susitna River bottomlands provided a reserve population for emigration into areas where harvesting either eliminates packs or severely reduces population density (Ballard and Spraker 1979:57).

Wolf territories were essentially nonoverlapping during the course of any particular year (Ballard et al. 1981). What overlap did occur was either seasonal in nature or was the result of the manner territories were plotted.

Numbers of wolves estimated to occur in eleven wolf packs are presented in Table 4. Spring 1980 estimates represent the post-hunting population while those in fall represent gains due to reproduction and dispersal prior to hunting and trapping losses. These data suggest that from spring to fall 1980 these wolf packs increased by 93 percent.

Food Habitats

Tables 5 through 9 list kills at which members of the five radio-collared wolf packs were observed during 1980. A total of 48 kills were observed. Moose of all age classes comprised 52 percent of the total kills with calf moose being the most common age class (56%). Caribou of all age classes comprised 38 percent of the observed kills. The percentage of observed caribou kills may have been slightly larger than that observed in earlier GMU 13 wolf studies (27%) because of the increased

Table 4. Estimate of numbers of wolves by individual pack inhabiting the Susitna Hydroelectric study area in spring and fall 1980.

Pack Area	Spring 1980 (Post Hunt)	Fall 1980 (Prehunt)
Butte Lake	3-4?	3-4+
Dickey Lake	?	2
Jay Creek	6	7-8?
Keg Creek	?	?
Maclaren River	2	4-5
Stephen Lake	2+	11
Susitna	4	10
Susitna-Sinona	4	4-5
Tolsona	9	16
Tyone Creek	4	2
Watana	5	14
Total	40	77

Table 5. Chronological summary of kills at which the Tolsona wolf pack was observed from 6 January through 17 February and July through December 1980 in Game Management Unit 13 of southcentral Alaska.

Date of Observation	Time	Species and Age	Percent Consumed	Estimated Date of Kill or Comments
1/6/80	2:45pm	Caribou - Adult	90%	1/5 4 wolves
1/9/80	10:45am	Caribou - ?	90%	1/8 11 wolves
1/25/80	10:06am	Moose - Calf	75%	1/24 12 wolves
1/27/80	10:54am	Caribou - ?	95%	1/26-27 12 wolves
1/29/80	11:15am	Moose - Calf	100%	1/28-29 12 Wolves
2/7/80	3:36pm	River Otter	-	2/7 12 wolves
2/9/80	11:05pm	Moose - 2 yr.	80%	2/8 12 wolves
2/10/80	10:20am			Still on kill of 2/9 11 wolves
2/14/80	9:35pm	Unk.-poss. beaver	-	2/14 8 wolves
2/16/80	1:20pm	Moose - Calf	75%	2/15-16 11 wolves
2/17/80	12:05am			Still on kill of 2/16 11 wolves
8/27/80	3:30pm	Caribou - Ad ♂	15%	8/26-27 4 wolves
10/16/80	11:00am	Snowshoe hare	-	10/16 15 wolves

Table 6. Chronological summary of kills at which the Watana wolf pack was observed from mid-April through December 1980.

Date of Observation	Time	Species and Age	Percent Consumed	Estimated Date of Kill or Comments
5/13/80	1:16pm	Moose - Adult	-	? Could have been a tagging mort. At least 1 wolf present.
5/14/80	3:35pm			Returned to kill of 5/13.
6/2/80	4:30pm	Caribou - Adult	50%	6/1 4 wolves
6/13/80	12:50pm	Moose - ?	100%	Old kill from past winter.
9/10/80	4:50pm	Moose - Adult? ♀	25%	9/9
9/16/80	2:30pm	Caribou - ?	50%	9/15-16

Table 7. Chronological summary of kills at which the Susitna-Sinona wolf pack was observed from mid-April through December 1980.

Date of Observation	Time	Species and Age	Percent Consumed	Estimated Date of Kill or Comments	
1/9/80	11:40am	Caribou - ?	75%	1/8	2 wolves obs.
1/29/80	10:30am	Moose - Calf	75%	1/28	3 wolves
9/26/80	9:05am	Moose - Adult ♀?	100%	?	3 wolves
10/14/80	9:15am	Prob. Snowshoe hare		10/14	4-5 wolves

Table 8. Chronological summary of kills at which the Susitna wolf pack was observed from January through December 1980 in Game Management Unit 13 of southcentral Alaska[1].

Date of Observation	Time	Kill Made	Species and Age	Percent Consumed	Estimated Date of Kill or Comments	
1/23/80	1:00pm	Yes	Moose - adult	75%	1/22 or 1/23	7 wolves
1/25/80	11:08am	No				
1/27/80	12:23pm	Yes	Caribou - adult ♀	90%	1/26	7 wolves
1/28/80	9:23am	No				
1/29/80	11:05am	Yes	Caribou - adult	100%	1/28	7 wolves
2/01/80	2:32pm	No				
2/03/80	12:03pm	Yes	Caribou - adult	100%	2/2	7 wolves
2/05/80	10:30am	No				
2/07/80	2:48pm	No				
2/10/80	11:50pm	No				
2/12/80	2:00pm	Yes	Caribou - assumed adult	100%	2/11 or 2/12	7 wolves
3/12/80	9:35am	No				4 wolves
3/14/80	12:20pm	Yes	Caribou - adult ♀	90%	3/13	4 wolves
3/16/80	12:30pm	No	-	95%	Still on kill of 3/14	4 wolves
3/18/80	10:45am	No				
3/20/80	10:45am	Yes	Caribou - adult	100%	3/18	4 wolves
3/22/80	3:40pm	Yes	Moose-assumed calf	100%	3/20 or 3/21	4 wolves
3/25/80	11:30am	Yes	Moose - calf	90%	3/23 or 3/24	4 wolves
3/27/80	8:45am	No				
4/15/80	12:30pm	Yes	Caribou - ?	90%	4/13-14	1 wolf
5/18/80	7:45 pm	Yes	Moose - adult or L. yearling	50%	5/17-18	3 wolves
5/25/80	1:00pm	Yes	Caribou - adult ♂	5%	5/25	1 wolf
6/2/80	11:30am	Yes	Beaver	0%	6/2	4 wolves
6/23/80	7:10pm	Yes	Moose - adult?	50-75%	5/22-23	1 wolf[2]
8/7/80	12:15pm	-	Moose - ?	100%	old	2 wolves
8/26/80	9:30am	Yes	Moose - calf	0%	8/26	8 wolves
11/19/80	12:40pm	Yes	Caribou - ?	95%	11/18	7 wolves

1/ From 23 January through 12 February 1980, pack was comprised of 3 adults, 2 yearlings and 2 pups while from 12 March through 27 March, pack was comprised of 2 adults, 1 yearling and 1 pup or yearling.

2/ Possible bear kill.

Table 9. Chronological summary of kills at which the Tyone Creek wolf pack (2 adults, 6 pups) was observed from January through December 1980 in Game Management Unit 13 of southcentral Alaska.

Date of Observation	Time	Kill Made	Species and Age	Percent Consumed	Estimated Date of Kill or Comments
1/23/80	11:30am	No			
1/25/80	10:35am	Yes	Caribou - adult ♂		
1/27/80	11:51am	No			
1/29/80	11:25am	Yes	Moose - calf	95%	1/28
2/01/80	2:06pm	No			
2/03/80	10:56am	No			
2/05/80	10:00am	No			Dug up old kill
2/07/80	3:05pm	No			Visited caribou kill of 1/25/80
2/09/80	10:50am	No			Visited old unidentified kill
2/12/80	2:20pm	Yes	Moose - calf	50-70%	2/11 or 2/12
2/14/80	10:30am	No		100%	still on kill of 2/12
2/16/80	5:22pm	No			
2/17/80	1:00pm	No			
2/18/80	10:10am	No			
2/20/80	8:50am	Yes	Moose - adult ♀	75%	2/19
2/22/80		No			
2/24/80	12:00 m	Yes	Moose - calf	60%	2/23/or 2/24
2/25/80	2:30pm	No		95%	Still on kill of 2/24
2/27/80	9:15am	No		100%	Still on kill of 2/24
2/29/80		No		100%	Still on kill of 2/24
3/02/80		No		100%	Still on kill of 2/24
3/04/80	10:15am	No			
	4:30pm	No			
3/06/80	11:00am	Yes	Moose - calf	5%	3/6
3/08/80	10:30am	Yes	Moose - adult ♀	25%	3/8 killed 2 Susitna pack members and consumed two ptarmigan
			Moose - calf	<5%	3/8
3/09/80	11:45am	No			Still at kill of 3/8
3/10/80	9:45am	No			Still at kill of 3/8
3/12/80	10:00am	No		60%	Still at kill of 3/8
3/14/80	11:00am	Yes	Moose - adult	60%	3/13
3/16/80	1:00pm	Yes	Moose - calf		3/16
1/9/80	12:20pm	Yes	Moose - calf	95%	1/7-8 2/
1/11/80	11:30am	No			Still on kill of 1/9 2/
3/27/80	9:30am	No			Return to kill of 2/24 2/
3/29/80	9:05am	No			Return to old kill 2/
3/31/80	2:27pm	No			Return to killof 3/14 2/
4/4/80	12:55pm	No			Return to killof 3/8 2/
4/6/80	11:13am	No			Return to killof 3/14 2/
4/8/80	10:04am	No			On old moose kill 2/

2/ Pack of four pups.

availability of caribou during winter 1979-80 (Ballard et al. 1981). Earlier studies suggested that wolves were selecting adult moose during most months of the year except during January through July, when short and long yearling moose appeared to comprise a disproportionate percentage of the kill (op. cit.). Kill data collected during 1980 appear to follow this general pattern.

Table 10 lists the sex, age, condition, and cause of mortality of kills which were examined in situ during 1980. These data were combined with those collected in GMU 13 from 1970-72 and 1975 through 1979 in an effort to assess the age and condition of prey taken by wolves. Analysis of this data was provided by Ballard et al. (1981).

During late summer and fall wolf scats were collected to provide more detailed information on the summer food habits of denning wolf packs. Scats were collected at the following sites: Watana den, Susitna den and Tolsona den and rendezvous site. Scats from 1980 have not yet been analyzed and consequently data were not available for this report.

Predation Rates

Potentially the most serious impact of the proposed project on wolves could be reduction in prey numbers. In an effort to evaluate the affects of prey reductions on wolves it is necessary to determine the numbers and types of prey consumed. Winter predation rates were estimated for two packs by intensive radio monitoring and back tracking. A detailed discussion of predation rates for the two packs follow:

Susitna Pack

From 23 January through 27 March 1980 members of the Susitna pack were observed on nine kills (Table 8). These

Table 10. Age, sex, condition (as determined by percent fat) and cause of mortality of moose and caribou kills examined in GMU 13 of southcentral Alaska during 1980.

Accession Number	Age	Sex	Date of Collection	Approximate Location	Percent Fat Longbone	Percent Fat Ramus	Marrow Color	Cause of Death
Species Moose								
120601	2	♀	01/28/80	Kenny Lake	90.4	68.1	Pink	Accident
120602	Calf	?	02/21/80	Susitna Lake	24.0		Pink	Wolf predation
120603	Adult calf	?	02/21/80	Oshetna River	46.5	--	Pink	Wolf predation
120604	Calf	?	01/12/80	Sanona Creek	89.7	--	Pink	Wolf predation
120605	Adult		02/20/80	Black River	84.5	61.6	Pink	Wolf predation
120606	Calf	?	02/21/80	Little Nelchina R.	53.3	41.0	Pink	Wolf predation
120607	2	?	02/21/80	Old Man Lake	84.1	65.2	Pink	Wolf predation
120608	Calf	?	02/21/80	Little Nelchina R.				Wolf predation
120609	10	♀	02/21/80	Grayling Lake	88.1	72.6	Red	Unknown
120610	Adult	♀	02/04/80	Eureka	60.8	--	Pink	Potlach kill
120611	Adult	♀	04/01/80	Kenny Lake	98.1	--	White	Shot
120612	Adult	♀	03/18/80	Tyone Mountains	81.2	--	Pink	Wolf predation
120613	14	♀	03/13/80	Black River	83.7	67.2	White-red	Wolf predation
120614	Calf	?	03/25/80	Squaw Lake	57.1	44.9	Red	Wolf predation
120615	Calf	?	03/26/80	Black River	61.2	60.0	Pink	Wolf predation
120616	12	♀	03/26/80	Oshetna River	87.3	65.8	Pink-red	Wolf predation
120620	Adult	♀	04/22/80	Watana Creek	83.9	54.6	Pink	Tagging
120657	Calf	♀	04/30/80	Glenn Highway	5.9	9.1	Pink	Winter kill
120658	16	♀	03/08/80	Sanona Creek	85.6	77.1	Pink-red	Wolf predation
120659	Calf	♀	03/08/80	Sanona Creek	33.9	--	Pink	Wolf predation
120660	Adult	♀	05/21/80	Glennallen	15.0	--	Pink	Winter kill
Species Caribou								
55121	Adult	♀	01/27/80	Susitna Lake	90.5	--	Pink	Wolf predation
55122	Calf ?	?	02/03/80	Minnesota Lake	75.6	--	Pink	Wolf predation
55123	Adult	♂	02/21/80	Tolsona Creek	29.4	--	Pink	Wolf predation

data were divided into two periods because of changes in pack numbers described in the pack history section. The first period extended from 23 January through 12 February 1980, during which time the pack numbered seven (three adults, two yearlings and two pups). During this interval they preyed upon four caribou and one adult moose for a kill rate of 1/4.2 days. Caribou comprised 80 percent of the kills in 1980 while in 1979, all of the observed prey were moose. Differences appeared to be related to the availability of prey because in 1979 few, if any, caribou had been available to this pack while in 1980 relatively large numbers of caribou overwintered in this pack area.

In 1980 changes in prey availability and abundance and perhaps in pack numbers also appeared to alter the movement patterns of this pack compared to 1979. In 1979 they had frequented the drainages of the Tyone River while in 1980 they occupied the area near Susitna Lake. Based upon kills observed during this time period, this pack of seven wolves had 5.3 kg of available food/wolf/day.

During the second sampling period from 12 March through 27 March 1980 this pack numbered foru wolves, providing an opportunity to compare kill rates for the pack when at a lower number. Kills were comprised of one adult moose, one calf moose, and two adult caribou. The kill rate was 1/4.0 days, which provided 5.7 kgs of available food/wolf/day, this was fairly close to the rate of kill observed when the pack included seven members.

In an effort to determine possible impacts of this wolf pack on moose, a moose survey in the pack area was conducted in late March. Four and one half hours of flight time (0.59 minutes/mi^2) were spent surveying this 462 mi^2 area. A total of 51 moose were counted: 43 adults and eight calves (15.7%). The observer subjectively estimated that he may have observed 25 percent of the moose present. Assuming moose were being taken at the rate indicated (caribou comprised 66.7% of kills), this pack killed eight adults and four calves from December through April. These kills represented 19 percent of the adult moose and 50 percent of the calf moost counted in March after most of the predation had occurred. If the observer had indeed counted only 25 percent of the moose and if we include projected kills as part of the base population the projected predation loss would have been 4 percent of the adult moose and 11 percent of the calf (short yearling) moose in the area. Wolf predation appears to be contributing to high mortality of calf (short yearling) moose in the Susitna pack territory.

Tyone Creek Pack

During early 1980 weather and tracking conditions were excellent, allowing this pack of two adults and six pups to be monitored during a 54 day period (23 January through 16 March 1980). The pack was observed on 11 kills: three adult moose seven calf moose, and one adult caribou (Table 9). The prey species used by this pack were similar to these observed in 1979 when they were comprised of two adults. However, in 1979 when the pack was comprised of two adults, calf moose (short yearlings) comprised only 29 percent of the kills while in 1980 when the pack numbered eight wolves, calves comprised 64 percent of the kill, possibly indicating a change in prey selectivity based on pack composition. This pack was observed on a fresh kill at the rate of 1/4.9 days with an estimated 4.9 kgs of food available/wolf/day.

As with the territory of the Susitna pack, moose in this pack area were counted in early March 1980. Four and one half hours (0.89 minutes/mi^2) were spent surveying the

302 mi^2 pack area. A total of 266 moose were counted: 221 adults and 45 calves (17%). The observer subjectively estimated that he had observed 50 percent of the moose present. The observed moose kill rate was extrapolated for the months of December through April, yielding an estimated kill of eight adult moose and 20 calf moose. These projections comprised 4 percent of the adult moose and 44 percent of the calf moose observed during the survey. Assuming only 50 percent of the moose were observed during the survey and adding the projected kills to the base population, the percentages would have been 2 percent of the adult moose and 18 percent of the calf (short yearling) moose in the area. In either case, it appears that wolf predation on calves (short yearling) in this area was a significant mortality factor.

Den Sites

General location of both den and rendezvous sites located from 1975 through 1980 in the study area are depicted in Fig. 3. Because some misinformed individuals believe wolf pups make desirable pets, more specific descriptions of den and rendezvous site locations will not be provided in these reports. This information will be retained on file in the Glennallen office and will be provided to project personnel upon request.

Many of the sites depicted in Fig. 3 have not been examined on the ground. Specific site descriptions for the following packs will be provided in the final Phase I report: Watana den and rendezvous site--1980, Deadman den--1975, Clearwater den--1976, Susitna den--1979 and 1980, Tolsona den--1979 and 1980, Tolsona rendezvous site 1980, and Mendeltna den and rendezvous site 1976 through 1977.

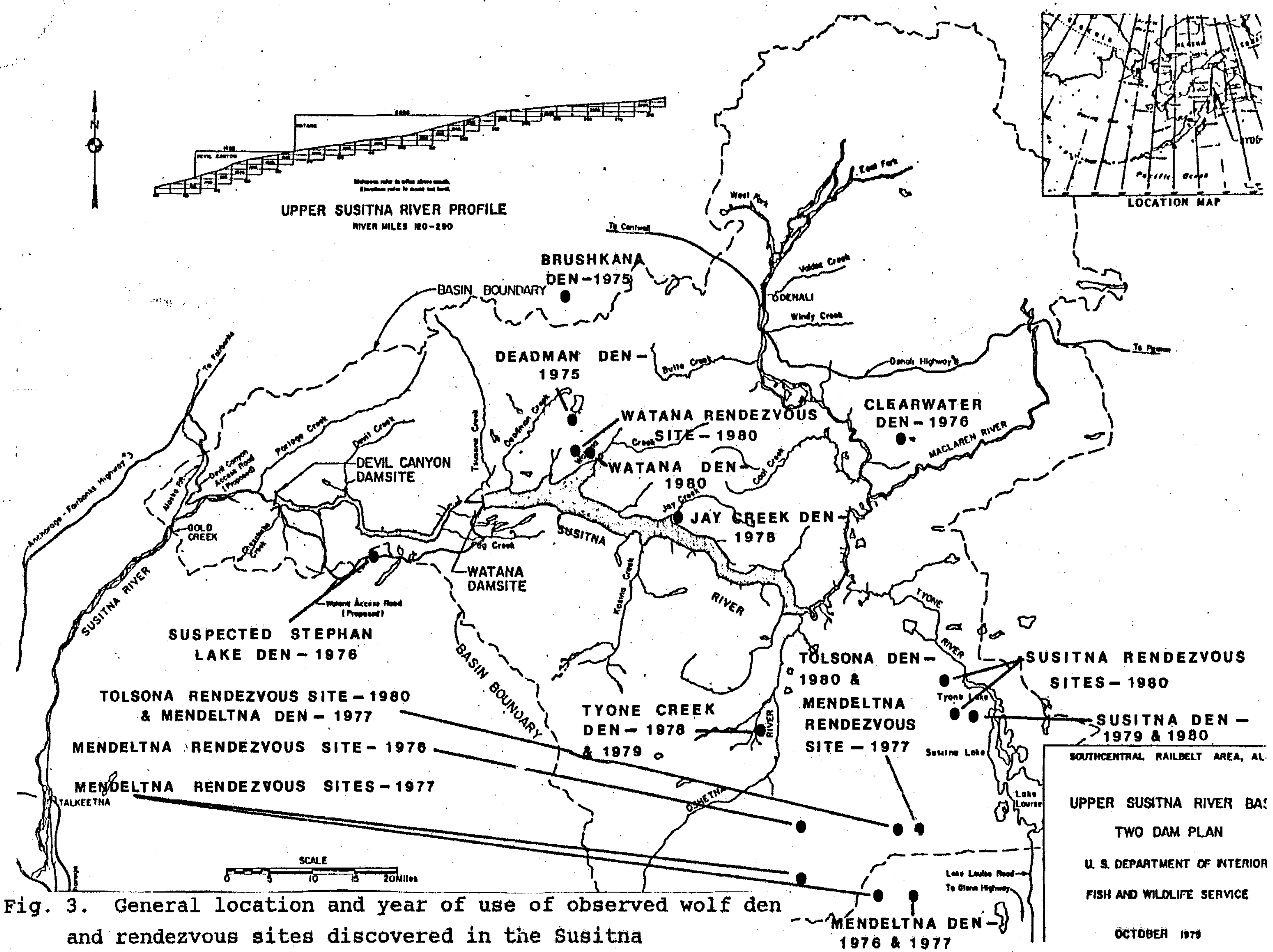

Fig. 3. General location and year of use of observed wolf den and rendezvous sites discovered in the Susitna Hydroelectric Project area from 1975 through 1980.

Most dens discovered in GMU 13 were roughly centered within the observed territory, but several were located near territorial boundaries (Ballard et al. 1981). The average distance between eight natal dens used in 1975 was 22.8 air miles (37 km) and ranged from 16 to 28.5 air miles (25 to 46 km). These figures represent only those cases in which it was ascertained that no dens existed in intervening areas. This average distance is somewhat less than that described in the northcentral Brooks Range (Stephenson and Johnson 1973) where the minimum average distance between dens was about 25 miles (40 km).

Thus far only two packs (Watana and Jay Creek) have been discovered which have had either den or rendezvous sites in areas which could be directly influenced by construction and operation of the proposed hydroelectric projects. Possibly other sites exist in the project area for packs with which radio contact has not yet been established.

Summer Activity Patterns

From 1 May through 6 June activity patterns of the four adult members (two adults and two yearlings) of the Susitna pack were intensively monitored through a combination of ground observations, continuous 24 hour monitoring of radio signals from a permanent ground station, and periodical monitoring from fixed-wing aircraft.

Two hundred twenty-seven hours of ground observations were made from a blind located on a ridge next to the den site. Presence or absence of radio-collared wolves at the den site during observation periods, which usually occurred from 0800 hours to 1600 hours, was determined by both scanning with a hand held antenna (Ballard et al. 1979) from the blind and by direct observation. Figures 4 through 6 visually depict the various family associations which were present at the den site according to hand held antenna locations. Of the three

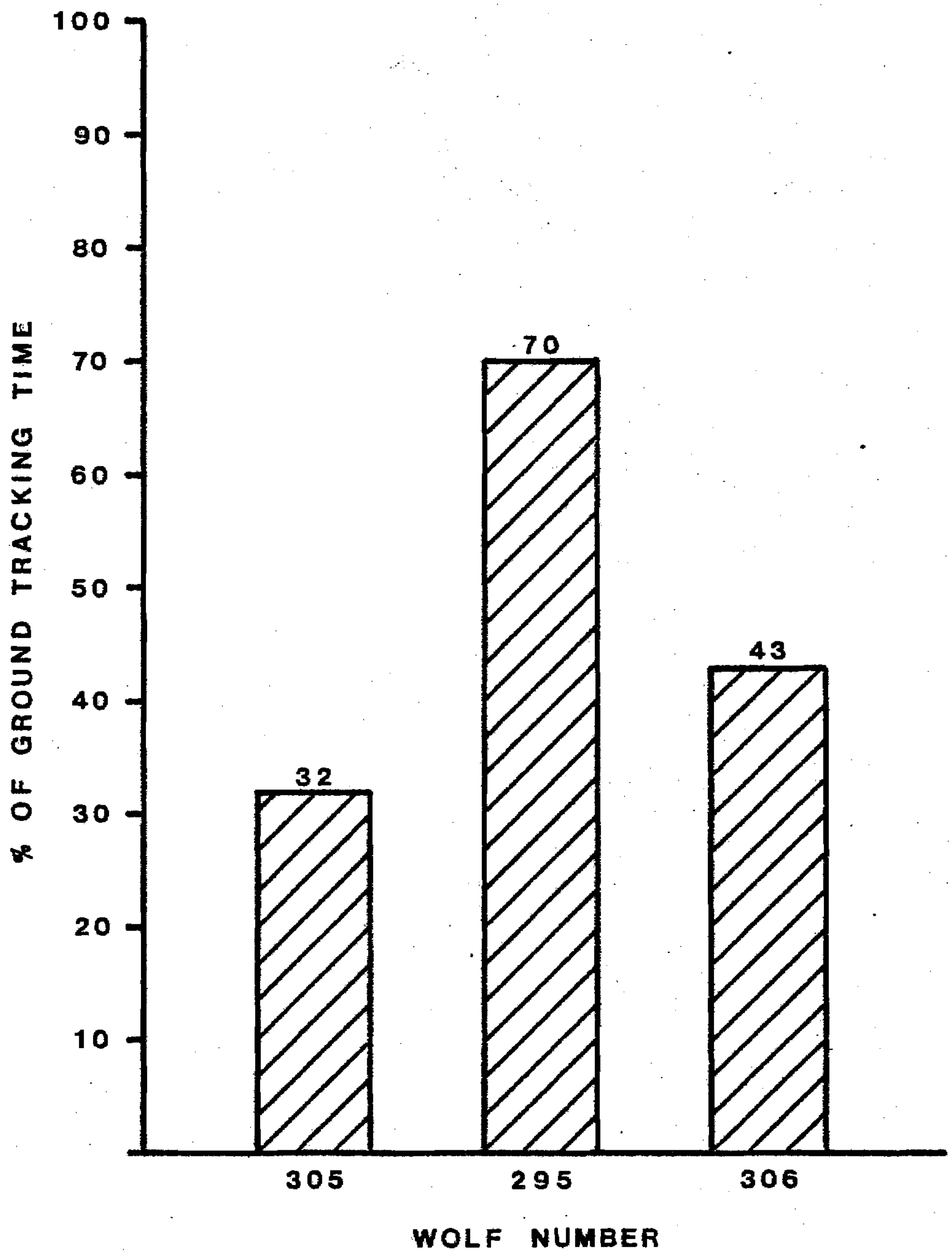

Fig. 4. Occurrence of three radio-collared wolves at the Susitna wolf pack den studied from 1 May through 6 June 1980 in GMU 13 of southcentral Alaska.

Fig. 5. Occurrence of lone adult wolves at the Susitna wolf den from 1 May through 6 June 1980 in GMU 13 of southcentral Alaska.

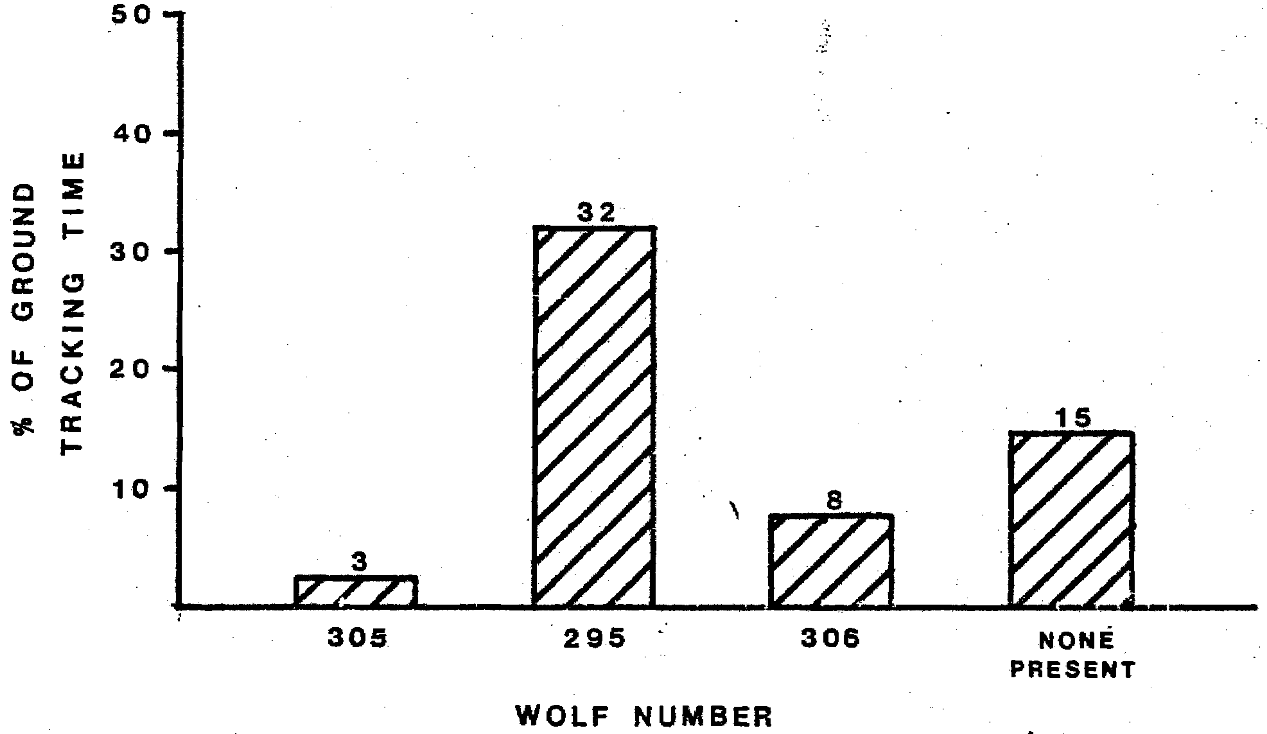

Fig. 6. Frequency of occurrence of adult wolf associations at the Susitna wolf den from 1 May through 6 June 1980 in GMU 13 of southcentral Alaska.

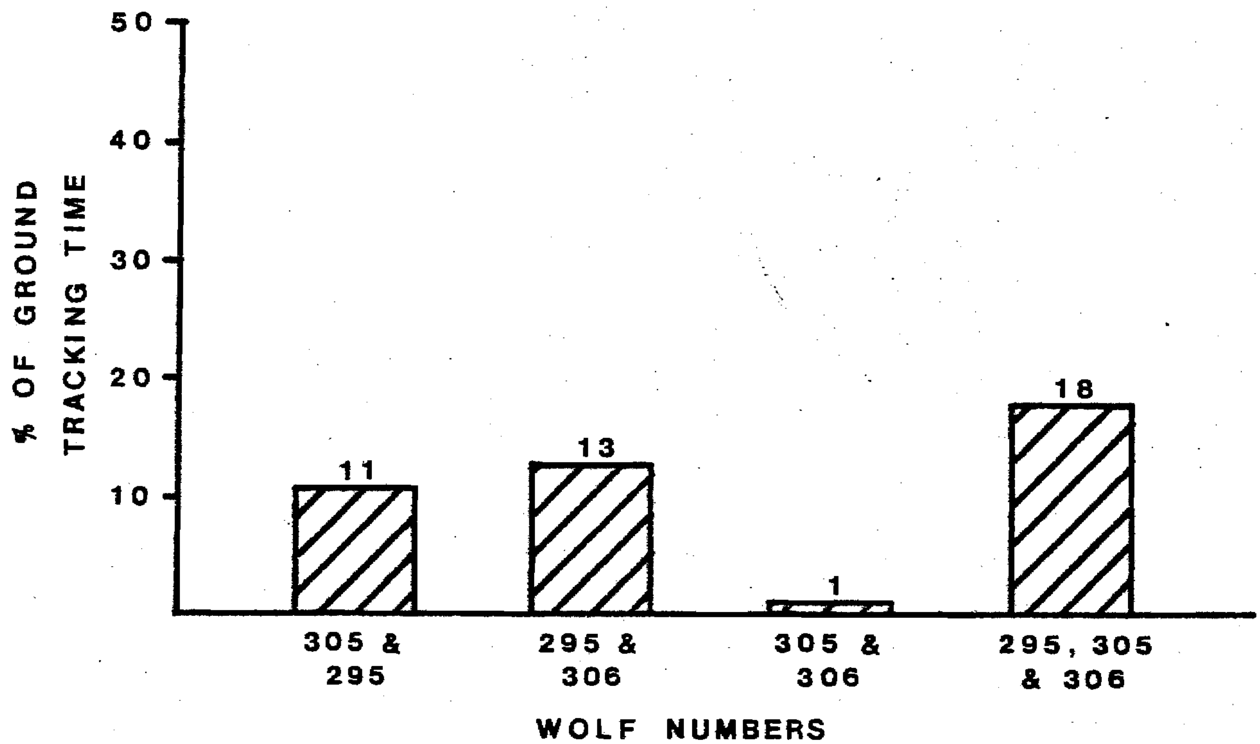

Table 11. Chronological summary of Susitna radio-collared wolf observations conducted from fixed-wing aircraft in late May and June 1980 in conjunction with den site studies in GMU 13 of southcentral Alaska.

Date	Time	(Ob. No.)	I/D	Location	Activity
May 7	---	124	295	In den	Resting
		126	305	¼ mile NW	Resting
		127	302	¼ mile NW	Walking
		127	306	¼ mile NW	Walking
May 12	18:10	129	295	At den	Unobserved
	18:15	130	305	NW of den	Traveling
	18:15	130	302	NW of den	Traveling
	18:15	130	306	NW of den	Traveling
May 13	08:10	132	295	At den	Resting
	08:20	131	305	Approx. 12 mi NW	Resting
		131	302	Approx. 12 mi NW	Resting
		131	306	Approx. 12 mi NW	Resting
May 18	08:10	133	295	At den	Resting
	19:25	135	295	At den	Resting
	19:45	136	305	Approx. 10 mi NE	Resting by moose 50% consumed
		136	302	Approx. 10 mi NE	Resting by moose 50% consumed
		136	306	Approx. 10 mi NE	Resting by moose 50% consumed
May 19	14:45	134	295	At den	Resting
		134	305	200 yd NW of den	Traveling
		134	302	200 yd NW of den	Traveling
		134	306	At den	Resting
May 25	07:57	137	295	At den	Resting
		137	305	At den	Unobserved
		137	302	At den	Resting
		137	306	At den	Unobserved
	13:00	138	305	Approx. 16 mi SW	Just killed adult caribou (2 mi NW of Nelchina den)
May 30	07:02	139	295	At den	Resting
		139	305	At den	Resting
		139	302	At den	Resting
		139	306	At den	Resting
May 31	13:50	129	295	At den (100 yds West)	Resting
	13:55	140	306	Approx. 3 mi NW	Resting by moose kill
June 2	11:30	129	295	At den	Resting
		141	305	12 miles SW	Eating beaver
		142	302	¼ mile from den	Hunting beaver
		142	306		Hunting beaver

Table 11 (Cont). Chronological summary of Susitna radio-collared wolf observations conducted from fixed-wing aircraft in late May and June 1980 in conjunction with den site studies in GMU 13 of southcentral Alaska.

Date	Time	(Ob. No.)	I/D	Location	Activity
June 4	11:50	129	295	At den	Resting
		129	305	At den	Resting
		129	302	At den	Resting
		129	306	At den	One unidentified gray observed trotting away 600 yd west
June 6	10:21	143	295	At new den	Resting
		143	305	At new den	Resting
		143	302	At new den	Resting
		143	306	At new den	Resting
June 7	12:15	144	305	Approx. 8 mi SW	Beaver hunting area
June 10	12:15	143	295	At new den	Resting
		143	302	At new den	Resting
		143	306	No signal	
June 12	08:46	145	306	Approx. 5 mi SW	Traveling

radio-collared wolves which were radio tracked from the blind, the adult female (#295) was present at the den site more often than either the adult male (#305) or the yearling female (#306) (Fig. 6). The most likely explanation for wolf 295's disproportionate presence at the den is due to nursing responsibilities. Ground observation suggested that parturition had occurred on 1 or 2 May and thus the pups were relying on female #295 for nourishment.

Figure 5 provides additional support that the alpha female (#295) occupied the den site more often than other pack members. These data suggest that although the alpha female spends more time at the den all adults share in spending time alone at the den with pups. Figure 5 suggests that on some occasions no wolves were present at the den. However, the radio signal from wolf 302 could not be received and thus this wolf's presence alone at the den may have accounted for the time gaps. The pattern for wolf 302 is expected to be similar to that of the other yearling (#306).

These data also suggest that the adult male (#305) spent the least amount of time at the den. Ballard et al. (1981) demonstrated that during the denning period adult males (or in this case the alpha males) were usually present when large ungulate kills were made. It can be inferred since wolf 305 spent the least time at the den, that much of his activity was associated with providing food for the pups. This was supported by aerial observations (Table 10).

The den site is the focal point of wolf activity during the period of pup rearing. Fig. 6 depicts the association of various pack members while at the den. When more than one adult wolf was present at the den site, most often all three and probably all four adult wolves were present. Wolves 305 and 306 were most often absent from the den site. These data and those presented in Table 11 suggest that young adults were accompanying the adult male on hunting forays. The time of day at which these activities occur is pertinent to potential development activities which must occur close to den sites.

Continuous monitoring of signals from the permanent tracking station was not initiated until 19 May 1980 and was continued through 10 June. Comparison of ground observations with data collected on the recorder suggests that behavior of individual wolves was accurately displayed on the tape. However, ground observations were too infrequent to accurately truth all wolf activities. Also the design of the tapes does not lend itself to transfer onto computer. Thus each data point would have to be individually transferred onto computer, requiring hundreds of man-hours. Development of a tape which would allow easy transfer of data onto computer, would provide an enormous amount of data concerning wolf activity and could easily be related to energy budgets. Regardless, the techniques did allow the determination of the presence or absence of wolves at the den for 24 hour periods.

The presence or absence of the alpha female (#295) and male (#306) at the den site from 19 May through 10 June is depicted in Fig. 7. As expected, the female spent more time at the den site than did the male. These observations were also supported by ground and aerial observations (Table 11). Male 305 exhibited a pattern of remaining at the den site during mid-day hours but away from the den during evening and early morning hours. Ground observations suggested that wolf 306 exhibited a similar pattern of den occupancy. Aerial observations indicated that when away from the den, the pack was hunting. Similar to the pattern described by Ballard et al. (1981), whenever a large ungulate kill had been made wolf 305 was usually present.

Wolf 295 remained at or close to the den site during most of the study. By late May it appeared she began making short

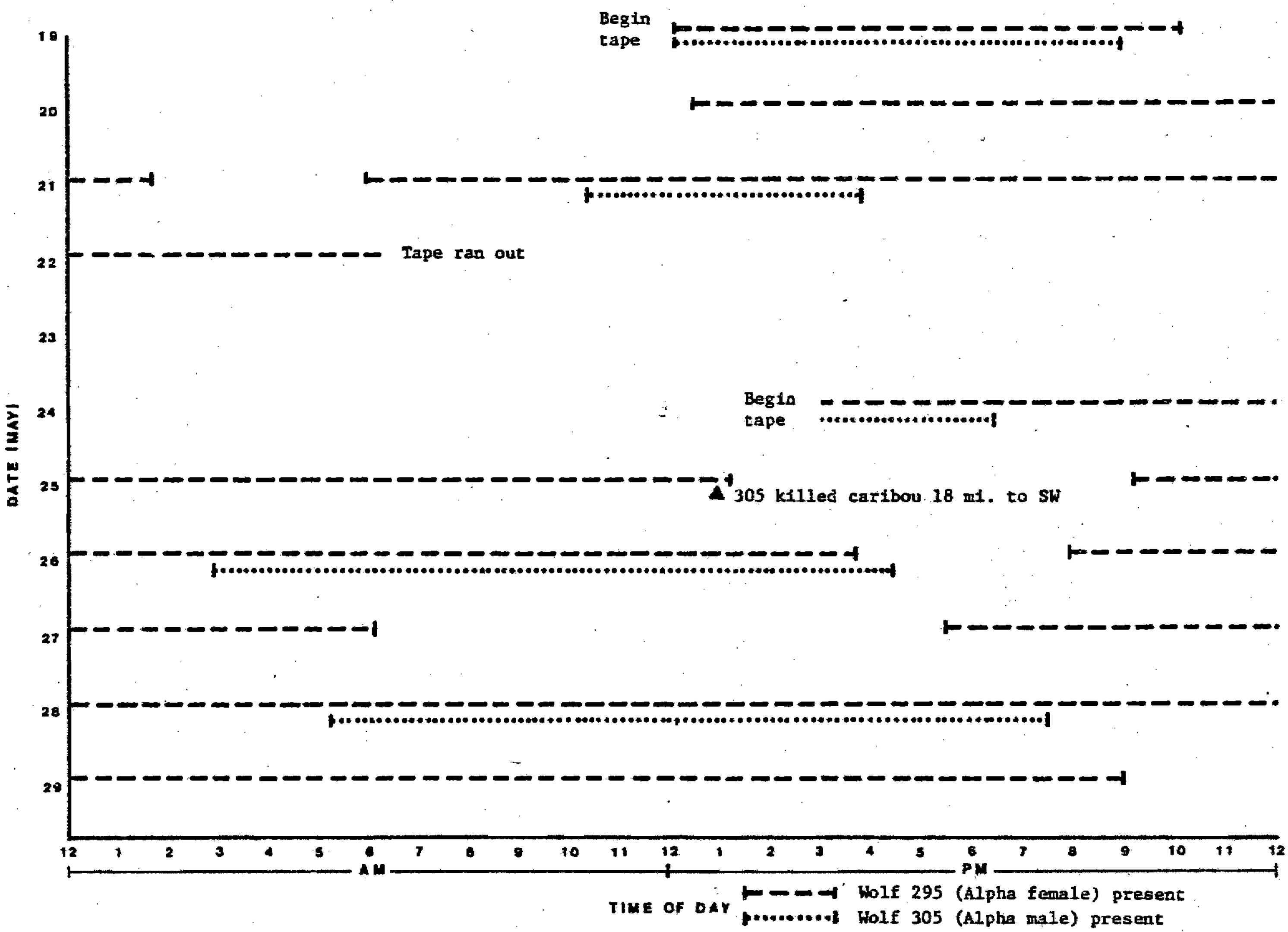

Fig. 7. Presence or absence of the two adult members of the Susitna wolf pack at a den site located in in GMU 13 of southcentral Alaska from 19 May through 10 June 1980.

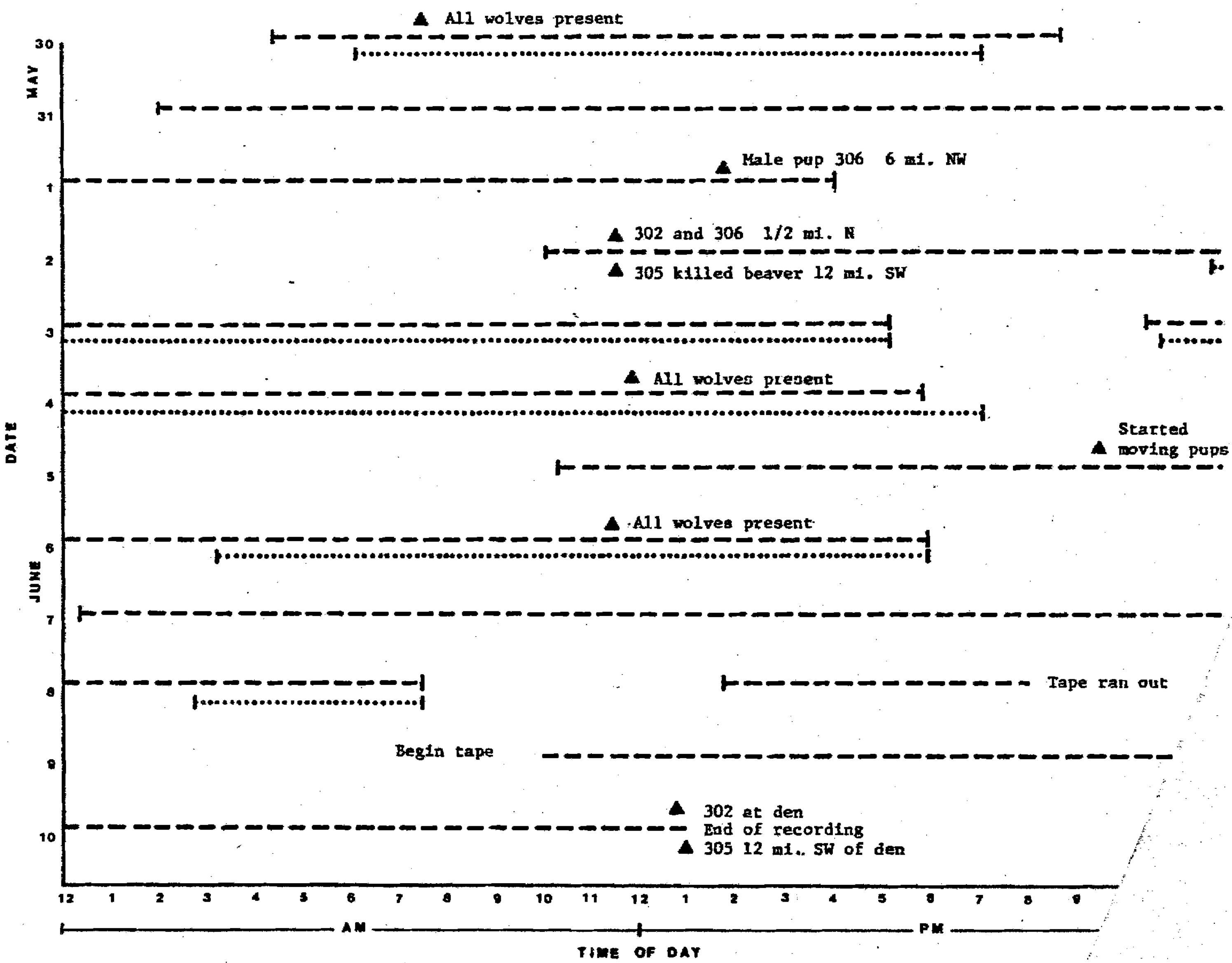

Fig. 7. Continued.

forays away from the site, leaving yearlings to "babysit" the pups.

Den site observations provide a basis for recommending time periods when Susitna project personnel could work near a den site area and yet possibly disrupt as few wolves as possible. It is well recognized that human disturbance causes wolves to abandon den sites. Project personnel, particularly helicopter activities, should avoid den sites during May and June. However, if work near a den site is absolutely essential for the project, it is recommended that this work occur during evening and early morning hours because most adult pack members would probably be away from the den site and the adult female would probably be inside the den with the pups. Although any human intrusion near a den site would be disruptive, intrusions during the recommended hours may be less disruptive and might avoid wolf abandonment of the site.

During this study it became apparent that the placement of the blind and the presence of the observer were perhaps a source of annoyance to the pack. Between 4 and 6 June the Susitna pack moved to their first rendezvous site. At approximately the same time at the Tolsona den, an attempt at ground capturing a wolf caused the pack to move to a rendezvous site. Of 22 observed instances of wolves moving to the first rendezvous site (Ballard et al. 1981) these two observations resulting from human disturbance were the earliest. Subsequent observations, however, indicated that all pups survived and therefore the disruption did not increase pup mortality. From these observations it is inferred that if project personnel had to conduct activities close to a den site, they could probably do so as early as 4 June without increasing pup mortality even though the den site could be prematurely abandoned.

These recommendations assume that most GMU 13 wolf packs exhibit the same activity patterns as the Susitna pack.

Obviously further study is desirable. Since the Watana pack will obviously be impacted by project activities, it is recommended that the denning activities study be repeated on this pack in either 1981 or 1982.

Potential Impacts of Susitna Hydroelectric Project on Wolves

The most important impact of the proposed project on wolves would occur indirectly due to reductions or changes in the density, distribution, sex-age composition, and/or physical condition of prey. Reductions in moose density in the immediate vicinity of the impoundments would probably cause reductions in wolf densities for at least four to five resident wolf packs which currently occupy the area. Also any disruption of moose migrations and/or reductions in migratory moose densities may also reduce wolf densities in areas where migratory moose reside.

Immediately following construction of the impoundments we anticipate temporary increases in wolf densities next to impoundment areas due to the increased availability of moose and caribou which would be displaced from the reservoirs. In turn, this may amplify the effects of wolf predation on moose and caribou and ultimately result in lower densities for all species. Increased competition between bear and wolf could be expected which would probably result in additional mortality to each species.

Aside from the indirect affects resulting from reductions in prey density the proposed impoundments would directly eliminate wolf habitat due to inundation of den sites, rendezvous sites, travel corridors, and feeding areas. Loss of habitat will force wolf packs to readjust territory boundaries with neighboring packs which probably will result in an undetermined amount of mortality due to social strife. Lower wolf dentsities in the vicinity of the impoundments may also result in lower densities elsewhere if populations reach low enough levels that wolves no longer disperse from the area to vacant habitats caused by hunting, trapping and natural mortality.

Increases in human activity in the project area will probably disrupt and in some cases cause wolves to abandon den and feeding sites. Early den site abandonment could increase pup mortality. Increased human activities may result in increased hunting and trapping activities as the occurrence of different packs become common knowledge to larger numbers of hunters and trappers and as access into the project area becomes more developed.

Study Plan for Continuation of Phase I Studies

Wolf studies conducted thus far have identified continuing and additional data requirements for properly determing the impacts of Susitna hydroelectric development on wolves. Parts of these needs may be accomplished during the remainder of Phase I studies, however, others may be better suited for Phase II. Some identified data needs are listed as follows:

1. Establish radio contact with other suspected wolf packs depicted in Figure 2 in order to gather quantitative data on movements, foods habits, population dynamics, and to locate den and rendezvous sites.

2. Intensively monitor radio-collared wolves during late winter, spring and summer to further quantify predation rates in an effort to assess prey needs for study area wolves.

3. Periodically conduct moose and caribou censuses in individual wolf pack territories to determine availability and distribution of prey and to determine impacts of wolf predation on prey.

4. Intensify efforts to visit wolf kills to quantify sex, age and physical status of prey taken.

5. Periodically conduct wolf censuses in areas where wolf radio telemetry studies are not being conducted to monitor population status so that numbers of wolves depending on migratory prey can be estimated.

6. Continue to conduct ground examinations of den and rendezvous sites to describe site characteristics and to gather wolf scats to further quantify summer food habits.

7. Initiate summer activity pattern studies of the Watana wolf pack in an effort to refine recommendations to avoid disturbance.

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Appendix A. Abstract of report summarizing wolf research activities in Game Management Unit 13 from 1975 through June 1980.

ALASKA DEPARTMENT OF FISH AND GAME
JUNEAU, ALASKA

STATE OF ALASKA
Jay S. Hammond, Governor

DEPARTMENT OF FISH AND GAME
Ronald O. Skoog, Commissioner

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

NELCHINA BASIN WOLF STUDIES

By

Warren B. Ballard
Robert O. Stephenson
and
Ted H. Spraker

Volume III

Final Project Report
Federal Aid in Wildlife Restoration
Project, W-17-9 and W-17-10, Jobs 14.8R, 14.9R and 14.10R
with Additional Support from the Alaska Power Authority

JOB PROGRESS REPORT (RESEARCH)

State:	Alaska		
Cooperators:	Warren Ballard, Robert Stephenson, Ted Spraker, Sterling Eide, James Foster, Albert Franzmann, Art Flynn, Dan Holleman, SuzAnne Miller and John Schlotthauer		
Project Nos.:	W-17-9, W-17-10 and W-21-2	Project Title:	Big Game Investigations
Job No.:	14.8R	Job Title:	Wolf Populations and Movements in Relation to Those of Prey Species
Job No.:	14.9R	Job Title:	Wolf Food Habits
Job No.:	14.10R	Job Title:	Impact of Wolf Predation Upon Ungulate Populations

Period Covered: July 1, 1975 to June 30, 1980

SUMMARY

Between 1 April 1975 and 30 June 1980, 103 individual timber wolves representing up to 22 different wolf packs were captured and radio-collared in Game Management Unit 13 (Nelchina Basin) of southcentral Alaska. Cost and problems associated with helicopter darting were discussed.

The 103 radio-collared wolves were individually located on 3,525 separate occasions resulting in 6,927 wolf sightings. Pack and individual wolf histories were presented and discussed.

Wolf territories were for the most part non-overlapping. Overlaps which did occur were seasonal in nature or due to the method territories were plotted. There appeared to be changes in territory boundaries from year to year. Territory sizes for

14 intensively studied packs ranged from 268 to 864 mi^2, averaging 537 mi^2. Territory size appeared to increase for larger packs and for those packs in areas of low moose density.

Wolf den and rendezvous site usage was described. The earliest that radio-collared wolves were observed at a natal den was 13 April. Wolves began visiting den sites in late April and early May. Parturition appeared to occur throughout the month of May. Natal dens were abandoned between 4 June and 1 August. Pups were observed traveling with adults between late August to mid-September of each year.

Radio-collared wolf packs were observed on 360 individual prey kills, 38 (10.6%) of which were also occupied by one or more brown bear. Moose of varying ages comprised 72 percent of the observed kills. Calf and short yearling moose comprised 20 percent of the total kill. Wolves were preying upon short and long yearling age classes from January through July disproportionately to their presence in the moose population. Moose calves 0-6 months of age comprised only 6 percent of the kills observed.

Four thousand two hundred and ninety food items were identified in 3,624 wolf scats collected at den and rendezvous sites during a 5 year period. Overall, calf moose was the most frequent identified food item (44%). Percent occurrence of various prey items in wolf scats were generally related to prey abundance. Occurrence of calf moose in scats was correlated with subsequent fall calf-cow ratios, suggesting that wolves were preying upon calf moose in proportion to their abundance. Scat data were converted to numbers of individual prey eaten which was then extrapolated to GMU 13 spring wolf population estimates. This analysis suggested that wolves in GMU 13 were preying upon from 434 to 1,013 moose calves annually from mid-May through mid-July.

One hundred twenty five moose and 25 caribou kills were examined *in situ* to determine both cause of death and age and physical condition of prey taken by wolves. One instance of surplus killing of caribou by wolves was reported. Percent fat of calf and short yearling moose killed by wolves was significantly higher than those of calves dying from both accidental causes and winter kill. We concluded that wolves were preying upon relatively healthy calf and short yearling moose.

Age and condition of wolf-killed adult moose examined from 1970-1972 were combined with data collected during this study. Overall, ages of adult moose killed by wolves were significantly ($P<0.05$) different from tagged moose, winter killed moose, and moose dying from accidental causes and winter kill.

Age and condition of wolf-killed adult moose were compared with those of moose tagged during the same year predation occurred. We concluded that during severe winters wolves preyed upon adult moose in proportion to their ratios in the moose population while during average or mild winters older adult moose were being preyed upon.

Marrow fat percent of wolf-killed adults was significantly ($P<0.05$) higher than moose dying from winter kill but not significantly ($P>0.05$) different from those dying of accidental causes. We concluded that wolves were preying upon relatively healthy adult moose during winter.

Overall, 17 wolf packs averaged a kill every 4.9 days with a range of 3.1 to 12.7 days per kill. Differences between packs and problems associated with methods of calculating predation rates were discussed.

During the winters of 1978-79 and 1979-80 five wolf packs were intensively monitored to determine rates of kill according to pack size. Ungulate kill rates varied from one kill/8.3 days for a pack of two to one kill/3.6 days for a pack of nine wolves. Large wolf packs generally appeared to have a higher kill rate than smaller wolf packs.

During the summers of 1977 and 1978 activity patterns of two denning wolf packs were studied and are discussed. It was determined that adult males (presumed to be alpha males) were nearly always present when ungulate kills were made.

Wolf densities in GMU 13, excluding the wolf removal area, varied from 1 wolf/37.6 mi^2 in fall 1975 to 1 wolf/121.7 mi^2 in spring 1978. Wolf numbers in GMU 13 have declined since 1975. Hunting, trapping and dispersal were identified as the main reasons for the decline. GMU 13 wolf densities were compared with those reported elsewhere in North America.

Annual GMU 13 wolf harvests were presented and discussed. Rates of harvests from individual radio-collared wolf packs were examined in relation to productivity and ability of packs to replace losses. Losses in excess of 41 percent of the fall population resulted in pack population declines the following fall. It was recommended that a hunting and trapping bag limit of seven wolves be established in GMU 13. It was also suggested that a post hunting-trapping wolf density of 1 wolf/100 mi^2 might be suitable to keep wolf predation on moose to a minimum but yet maintain a reasonable wolf population.

Of 103 wolves radio-collared during this study, 14 (14%) were known to be alive on 30 June 1980. Twenty-five percent were also known to have dispersed during the 5 years of study. The largest source of wolf mortality was human induced (77%). Ground shooting and suspected illegal aerial hunting, accounted for 76 and 11 percent, respectively, of the man caused mortality. Natural forms of mortality accounted for 23 percent of the mortalities.

During this study at least 26 radio-collared wolves were known to have dispersed from their original pack area. Sixty-eight percent of the dispersals were males. Approximate average ages of dispersed males was 35 months, while females averaged 37 months. Dispersal was most prevalent during months of April through June. Average distance dispersed was at least 67.7 miles. The longest documented movement was 460 miles, constituting a record movement for this species.

The effects of wolf predation on moose calf survival was studied in two areas of GMU 13. In one area, referred to as the Susitna River Study Area, wolf densities were lowered by Department personnel. In the other area of GMU 13, (remainder of the Unit generally east of Talkeetna Mountains) wolves were intensively studied to enumerate population densities and food habits.

From January 1976 through July 1978 a total of 60 wolves were killed by Department personnel in an effort to test the hypothesis that lowered wolf densities would improve moose calf survival. Wolf Densities in the Susitna River study area were estimated at 1 wolf/98 mi^2 of habitat in spring 1975 to 1 wolf/232 mi of habitat in spring 1978. By spring 1980 wolf densities had increased to within at least 89 percent of the spring 1975 estimate due to reproduction and immigration.

Fall moose sex and age composition count data and annual harvests were compared between the wolf removal area and other comparative count areas in GMU 13 where Department wolf control had not been conducted. Statistical analyses revealed no significant (P>0.05) differences in either calf-cow ratios, moose observed per hour of survey, nor in ratios of harvested moose. Had wolf control increased moose calf survival we would have anticipated some significant differences in these ratios. Results of wolf food habits, moose calf mortality, and bear food habits studies indicated that the rates of predation on moose calves by wolves were far less than by brown bears. This tended to explain the lack of response by the moose population to reductions in wolf densities. Results of the bear transplant on moose survival were compared and discussed with this study.

SUSITNA HYDROELECTRIC PROJECT
ANNUAL PROGRESS REPORT

BIG GAME STUDIES

PART VI WOLVERINE

Craig L. Gardner,
Warren B. Ballard
and
Donald A. Cornelius

ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the
Alaska Power Authority

March 1, 1981

SUMMARY

During April and May 1980, five adult wolverine were captured and four (3 males, 1 female) were radio-collared. Eighty-six radio locations were obtained during 1980.

Yearly home range sizes for male wolverines 040 and 043 were 154 mi^2 (399 km^2) and 105 mi^2 (272 km^2), respectively. The summer home range for lactating female 042 was 33 mi^2 (86 km^2). Summer movement patterns of the three male wolverine seemed to be influenced by the Susitna River. Only three occurrences of river crossings were documented during the study period. Within their home ranges, all radio-collared wolverine showed a fidelity toward upland shrub (willow-birch) habitats and toward southerly and westerly slopes.

All three male wolverine displayed a gradual change in their home range usage. Seasonal preferred areas are suspected to be related to the breeding period and timing of ground squirrel emergence and caribou calving.

Ground tracking during May and December, 1980 indicated wolverine dependence on small mammals.

Potential impacts on wolverine by the Susitna hydroelectric project include the following: loss of habitat due to inundation, and road and transmission line construction; a probable reduction in prey densities; increased competition with other scavengers and predators; and a readjustment of home range size and seasonal movements.

There is evidence that wolverine are intolerant of human disturbance. Impacts from disturbance might be influenced by timing and placement of construction activities. For example activities on southerly and westerly slopes are more likely to affect wolverines than are those on northerly or easterly slopes.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The only information available on wolverine (*Gulo gulo*) in the Susitna River Basin comes from work conducted by Rausch and Pearson (1972) and ADF&G harvest records. Both sources provide a gross indication of such population characteristics as sex and age ratios and population status. These studies do not, however, provide the types of information needed to determine the probable impacts of the proposed Susitna hydroelectric projects on wolverine populations. The current study was initiated in April 1980 to:

1. Determine distribution and abundance of wolverine utilizing the study area.

2. Determine wolverine seasonal habitat requirements and movement patterns.

3. Obtain an estimate of the wolverine population's age structure and sex ratio to determine population trend.

4. Determine wolverine dependency on the areas which could be inundated by the proposed dam system or altered through road or transmission line construction.

This report addresses preliminary findings of wolverine movements and home range size, habitat use, and distribution within the project area. The report period only extends from 10 April through December 1980 due to the late arrival of radio telemetry equipment.

METHODOLOGY

Capture efforts were conducted during April and May 1980, using helicopter capture techniques (Ballard and Spraker 1979). A combination of 0.25 cc Sernylan (Bioceutic Lab., Inc.) and 0.20 cc Rompun (Barrett Division of Cutter Laboratories, Inc.) was used for immobilizing two wolverine. Because Sernylan is no longer commercially available, a combination of 0.4 cc etorphine (1-mg/cc M-99, D-M Pharmaceuticals, Inc.) and 0.5 cc Rompun was used to capture the last three wolverine. Each captured wolverine was aged, sexed, weighed, measured, ear tagged and radio-collared. Data from each wolverine were recorded on a tagging form (Fig. 1). After processing, wolverine immobilized with M-99 were injected with an equivalent cc dosage of the antagonist dipremorphine (2 mg/ml M 50-50, D-M Pharmaceuticals, Inc.). Each captured or necropsied wolverine is referred to by the last three digits of its assigned accession number.

Radio collars (Telonics, Mesa, AZ) were constructed of butyl rubber and had an inner circumference ranging from 29 to 39 cm. Each collar was equipped with a whip antenna which extended 26 cm from the collar. The entire unit weighed 232 g.

Radio loactions were made approximately twice per week during April and once per week thereafter, similar to methods described by Mech (1974). Radio locations were recorded on 1:63,260 U.S.G.S. map and activity, number of associates, and general habitat were described on a standard field form (Fig. 2).

Aerial habitat classification (Table 1) followed a system described by Ballard and Taylor (1980). This system was specially designed to describe habitat types from fixed-wing aircraft. For this reason and because we were more familiar with it, it was used in lieu of Viereck's and Dyrness's

Wolverine Tagging Form - Susitna Hydro Project

Accession # ___________ Date ___________ Time Spotted ___________

Sex ___________ Recapture (?) ___________

Location spotted: ___________

Habitat Description ___________

Description of Associates: ___________

Location where collaring took place : ___________

____

Drug utilized: 1. Sernylan 2. Rompun 3. M-99

4. Ketamine 5. Bicillin 6. Sparine

7. Other ___________

Concentration: ___________ Leader/Shooter: ___________/___________

	Drug	Dosage	Time Hit	Time Down	Dart Location	Comments
1st Hit						
2nd Hit						
3rd Hit						
Total Hits						
Misses						

Incomplete Injection? Yes______ No ______

Antagonist Utilized? No ______ Yes______ Drug ________ Dosage __________

Recovery Time ___________

Fig. 1. Wolverine tagging form used for the Susitna wolverine study, 1980.

Wolverine Tagging Form - Susitna Hydro Project

Collaring Team ______________________, ______________________

Radio # and Frequency ______________________________________

Description of Animal (scars, coloring, missing claws) ____________________

____

____

Measurements: Est. Age __________ Weight ______________

Total Length __________ Tail Length ____________ Hind Ft. Length ________

Testes Length ________ Vulva turgid? Yes ___ No ___ Neck Circum ________

Heart Girth __________ Body Temp. __________

Upper Canine: Left ________ Rt. ________ Ant.-Post ______ Lig.-Lab. ________

Lower Canine: Left ________ Rt. ________ Ant.-Post ______ Lig.-Lab. ________

Marking Data: L. ear tag __________ Rt. ear tag __________

Specimens Collected: Tooth? (which one) ____________________

Hair __________ Feces ________ Blood (hep) __________ (Non-hep) __________

Fig. 1 (continued).

Fig. 2. Aerial monitoring form for wolverine in the Susitna River Basin, 1980.

WOLVERINE OBSERVATION FORM

Wolverine Accession # ________

Date	Map #	Time	Visual Yes/No	Habitat	Aspect & Slope	Activity	Direction Of Travel	Association	Comments & Observations

Table 1. Habitat classification utilized to classify wolverine habitat usage from fixed-wing aircraft from April through December 1980 in the Susitna River Basin of southcentral Alaska.

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

1/ Modified from Ballard and Taylor 1980.

2 Spruce densities also classified as high/medium or low.

classification system (1980). We believe that most of our classifications can be transformed to Viereck's and Dyrness's level 3 classification, which is probably as accurate as can be obtained from the air.

Wolverine tracks were followed on the ground during May and December 1980 in an effort to gather information pertaining to food habits and activity patterns. Tracks were initially found by aircraft.

Wolverine carcasses were purchased from hunters and trappers in Game Management Unit (GMU) 13 by offering $10.00 per carcass. Each carcass was necropsied in an effort to quantify age structure of the harvest, reproductive status, and morphometric measurements.

Wolverine observation forms (Fig. 3) were distributed to pilots, biologists and other investigators in the study area in an attempt to gather more data on wolverine distribution. Sightings of both wolverine and wolverine tracks, general description of habitat and activity were solicited.

Harvest records from sealing forms and bounty records from 1962 to present were examined.

Study Area

Based upon radio telemetry data, track observations and proposed road construction, the area depicted in Fig. 4 is considered the project impact area for wolverine. The study area boundary follows the basin boundary in the west to its confluence with the Denali Highway on the north, the Denali Highway to its confluence with the Susitna River on the east, down the Susitna River to its intersection with the Tyone River, up the Tyone River to Tyone Lake, then a southwest line to the intersection of the Little Oshetna River with the

DATA FORM FOR MISCELLANEOUS BIG GAME AND FURBEARER OBSERVATIONS-SUSITNA RIVER PROJECT

Use for observations of wolf, fox, coyote, lynx, wolverine, river otter, mink, bear marked moose, marked caribou, beaver dam and den site. Please try to pick up a skull, jaw, long bone, and hair sample of any dead animals of these species encountered, including unmarked individuals.

DATE________ TIME________ a.m. p.m. OBSERVER________ PROJECT________

SPECIES (Check one):

__ brown bear
__ black bear
__wolf
__coyote
__fox
__wolverine
__river otter
__mink
__collared moose
__collared caribou
__beaver dam or pond

IDENTIFYING MARKS (if any): Collar color________.

Numeral color and number (if any):________. Ear Flag Color ________ right left

Other marks (describe):________

LOCATION:________ (map name, 1:250,000), ________ (Quad. number, 1:63,360), ________ (other map-specify)

Specific Location Description:________

____

Type of Vegetation________

COMPANION ANIMALS PRESENT:________ (number), ________ (sex/age/size?), ________ (identifying marks?)

ACTIVITY

__1. Dead
__2. Resting or bedded
__3. Feeding
__4. Walking
__5. Running
__6. Fishing
__7. Digging
__8. Swimming
__9. Standing
__10. Obviously hunting or attacking (species).

Other activity________. Direction moving________.

DEN SITE ______ OR BEAVER DAM ______OBSERVATIONS: Animals observed at den site or beaver dam? yes ____ no ____

Description of den site or beaver dam and animals observed:________

____

Please specify the specific location of den sites or beaver dam and attach a map if possible.
Map attached? ___ yes ___ no

PREY SPECIES (for predator specify if on a dead animal, species of prey, freshness of kill)

____

Specimens collected: ___Jaw ___Skull ___Long bone ___Hair

How are specimens labeled and stored? ________

GENERAL COMMENTS:

Return to: Susitna Project, ADF&G, Game Division, 333 Raspberry Rd., Anchorage 99502.
THANKS!!

Fig. 3. Observation form distributed among investigators and pilots in the Susitna River Basin, 1980.

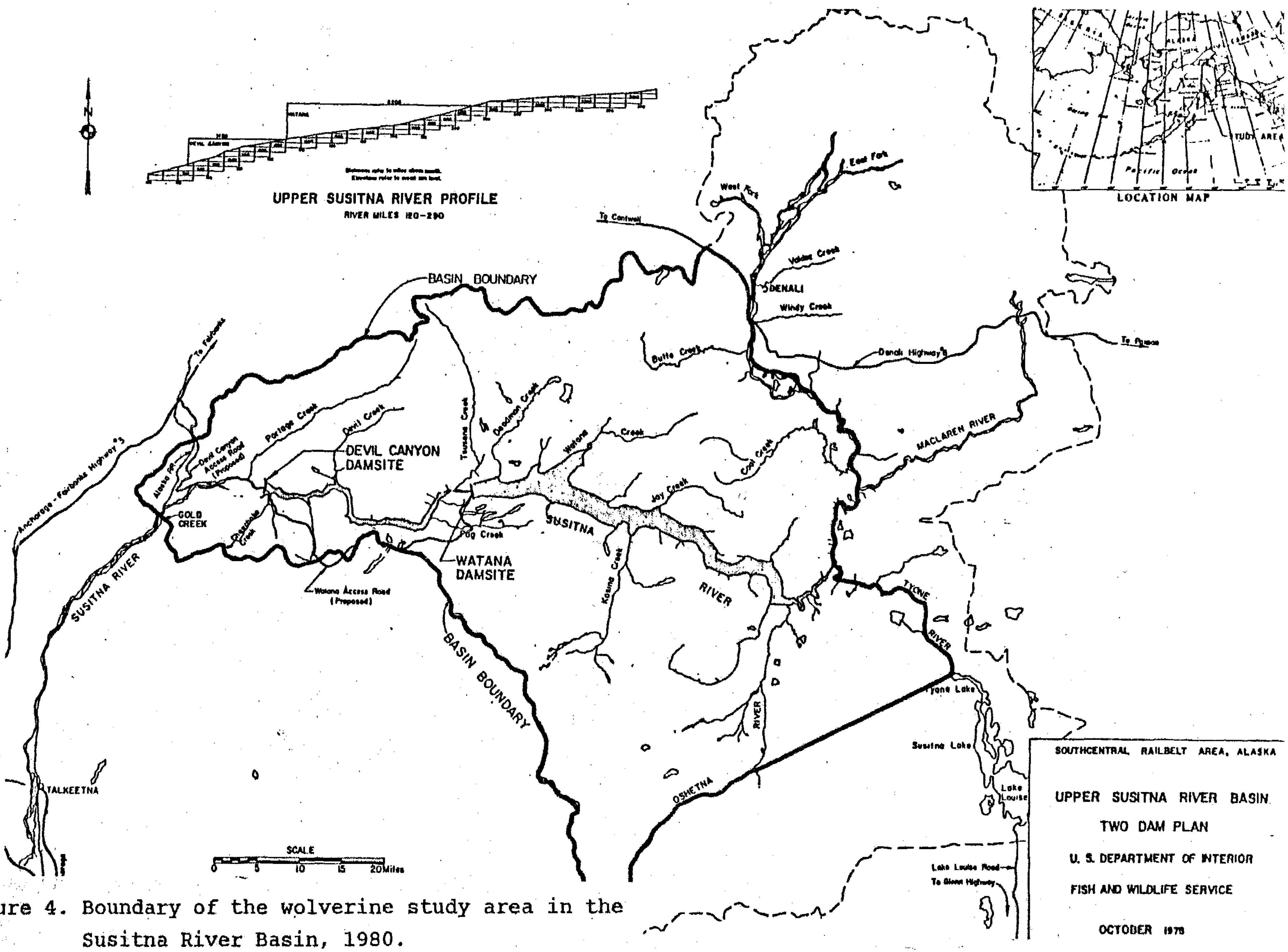


Figure 4. Boundary of the wolverine study area in the Susitna River Basin, 1980.

Oshetna River, along the Oshetna River to its confluence with the basin boundary on the south.

Vegetation, topography and climatic descriptions have been described by Skoog (1968), Bishop and Rausch (1974) and Ballard and Taylor (1980). A more detailed description of vegetation will await completion of vegetative studies under Subtask 7.12.

RESULTS AND DISCUSSION

From 10 April to 7 May 1980, five adult wolverine (4 males, 1 female) were captured and outfitted with radio collars. Capture of additional wolverine was precluded by poor tracking conditions caused by an early spring breakup and by lack of adequate snow cover during fall and early winter. One male (041) died 2 days after capture due to severe hemorrhage caused by the dart. Contact was lost with both 042 (fate unknown) and 044 (expected dropped collar) after 16 August and 9 October, respectively. Tagging locations and physical measurements of captured wolverine are presented in Table 2.

Induction time for the two male wolverine (043 and 044) immobilized with the combination of M-99 and Rompun was 12 and 14 minutes (Table 3). Recovery time after M 50-50 was injected was 2 and 7 minutes. Since the Sernylan was outdated, induction times of wolverine immobilized with this drug may not be indicative of normal induction times. The two successful M-99 immobilizations suggest that M-99 may be an adequate substitute for Sernylan (which is no longer commercially available).

Movements and Habitat Selection

From 10 April through December 1980, radio-collared wolverine were located on 86 occasions. Wolverines were visually sighted on 33 (38%) of the 86 locations. Home ranges were determined for all four wolverine; however, the areas depicted for wolverines 042 and 044 are only summer ranges (Fig. 5 and Table 4). Home range for males 040 and 043 was 154 mi^2 (399 km^2) and 105 mi^2 (272 km^2), respectively.

These limited data suggest that Susitna wolverine have smaller home ranges than those reported elsewhere. In the Brooks Range, Alaska, Magoun, (1979) reported that male's had an

Table 2. Tagging location and physical measurements of wolverine captured in the Susitna River Basin, 1980.

Accession Number	Date	Location	Sex	Est. Age	Weight	Body Length	Tail Length	Girth	Neck Circum.	Head Width	Head Length	Anterior Posterior Width Canine (mm)	Lingual Labial Width Canine (mm)	Comments
116040	4/10/80	4.8km NW of Clarence Lk.	M	7-12	14.5kg	87.6	--	47.9	33.0	11.6	19.4	18.0	10.1	Right eye had microopthelmia
116041	4/19/80	5.6km upstream of mouth of Fog Creek	M	2-3	15.5kg	87.0	--	49.8	34.3	11.4	16.5	23.8	9.3	Teeth badly worn
116042	4/19/80	Watana Creek	F	2-3	9.5kg	80.0	--	38.1	27.0	9.8	14.6	21.3	7.6	Lactating slightly
116043	5/06/80	4.0km SE of of Standing Bear Lake	M	1-2	17.7kg	81.9	--	44.9	11.5	15.9	--	--	--	
116044	5/07/80	Across Susitna River from Stephan Lake	M	--	--	--	--	--	--	--	--	--	--	

Table 3. Drug type, dosage, shot placement and subsequent induction time for wolverine captured in the Susitna River Basin, 1980.

Accession Number	Date	Sex	Wt. (kg)	Age	Drug	Dosage (cc)	Shot Placement	Induction Time (min.)	Recovery Time (min.)
116040	4/10/80	M	14.5	7-12	Sernylan	0.25[1]	Top of neck	36	--
116041	4/19/80	M	15.5	2-3	M-99	1.0	Left front shoulder	4	--
						1.0	Right rear hip		
116042	4/19/80	F	9.5	2-3	Sernylan	0.25	Left shoulder	11	90
					Rompun				
116043	5/06/80	M	17.7	1-2	M-99	0.4	Above left hip	14	7
					Rompun	0.5			
116044	5/07/80	M	--	--	M-99	0.4	--	12	2
					Rompun	0.5			

1 Additional dose was administered.

Table 4. Summary of home range sizes for four radio-collared wolverine in the Susitna River Basin, 1980.

Accession Number	Sex	Est. Age	Home Range (km^2)	Greatest Length Across Home Range (km)
040	M	Adult	399	35.5
042	F	Adult	86	15.2
043	M	Adult	272	19.4
044	M	Adult	378	49.8

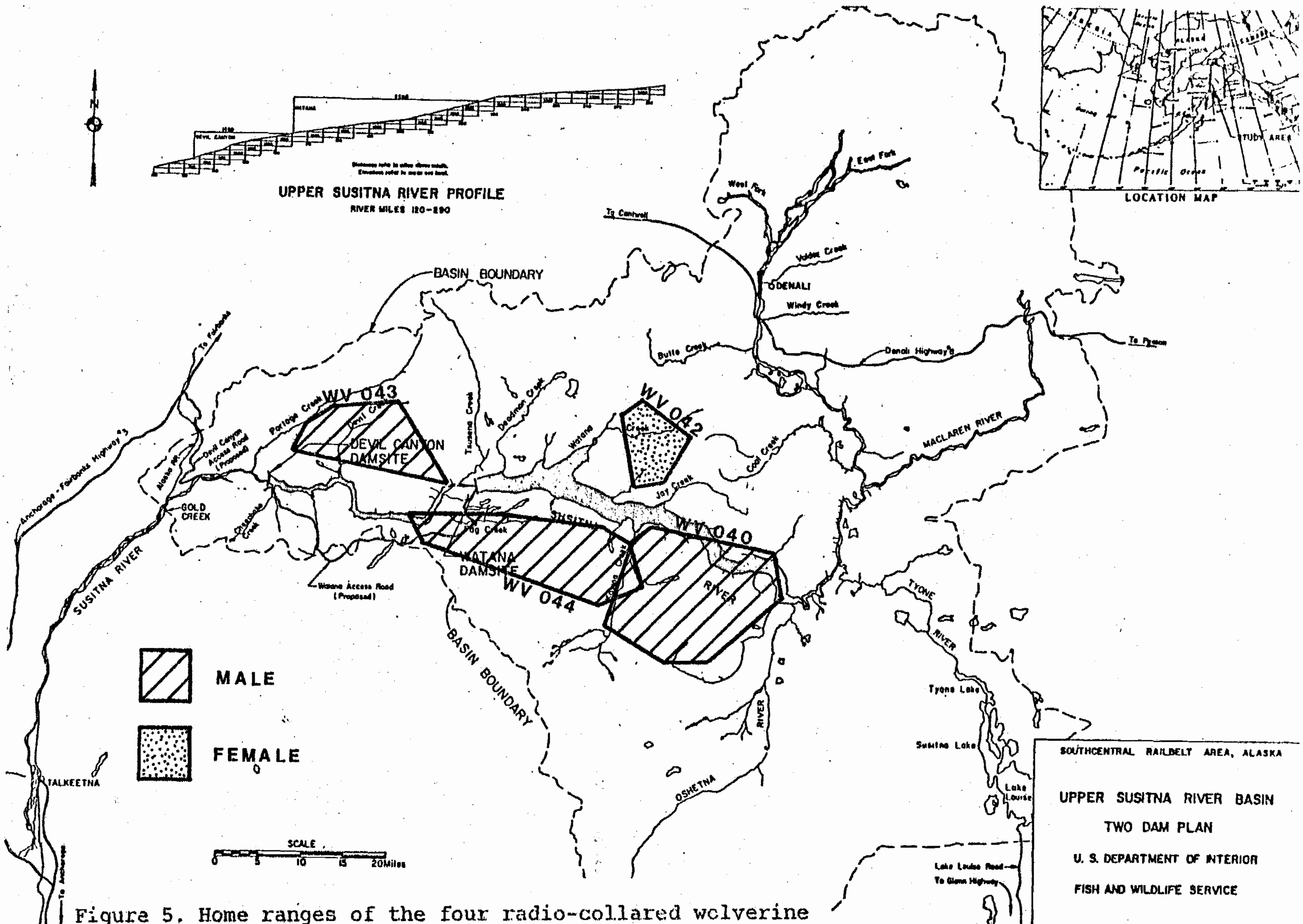


Figure 5. Home ranges of the four radio-collared wolverine in the Susitna River Basin, 1980.

average home range of 127 mi^2 (615 km^2), while in northwestern Montana, Hornocker (In Press) reported an average home range of 150 mi^2 (388 km^2). Krott (1959) believed a male wolverine could have a territory as large as 386 to 772 mi^2 (1,000 to 2,000 km^2) depending on food supply and competition from other species. Hornocker monitored two lactating females and calculated their average home range to be 39 mi^2 (100 km^2). Bjarvall (In Prep.) determined home ranges for three lactating females (during different years) in Sweden ranged from 42 to 85 mi^2 (mean = 66 mi^2). These reported ranges were somewhat larger than the home range of the lactating female 042 in this study, which was 33 mi^2 (86 km^2). Differences in observed home range size between Brooks Range and Susitna Basin wolverine, could have resulted from differences in sampling intensity. However, we would expect the greater diversity and abundance of food items in the Susitna Basin to permit smaller home ranges.

All four collared wolverine exhibited a fidelity toward shrub (shrub willow and dwarf birch) dominated habitats as it accounted for 54 percent (44 of 81) of the relocations. As vegetation maps become available, the percent occurrence of each habitat type in the wolverine's home range will be calculated and inferences about wolverine habitat selection may be possible. Also, it will be beneficial to characterize wolverine habitat by available prey species. Coordination between investigators of the small mammal, the ungulate and the predator studies will be necessary to determine prey distribution.

In relation to topography, the four radio-collared wolverine appeared to favor southerly and westerly slopes.

There was some evidence that the Susitna River formed a partial barrier to wolverine movements during the ice free period. No wolverine tracks were observed on the main Susitna River (Fig. 6) during the study, however, we did not purposely search

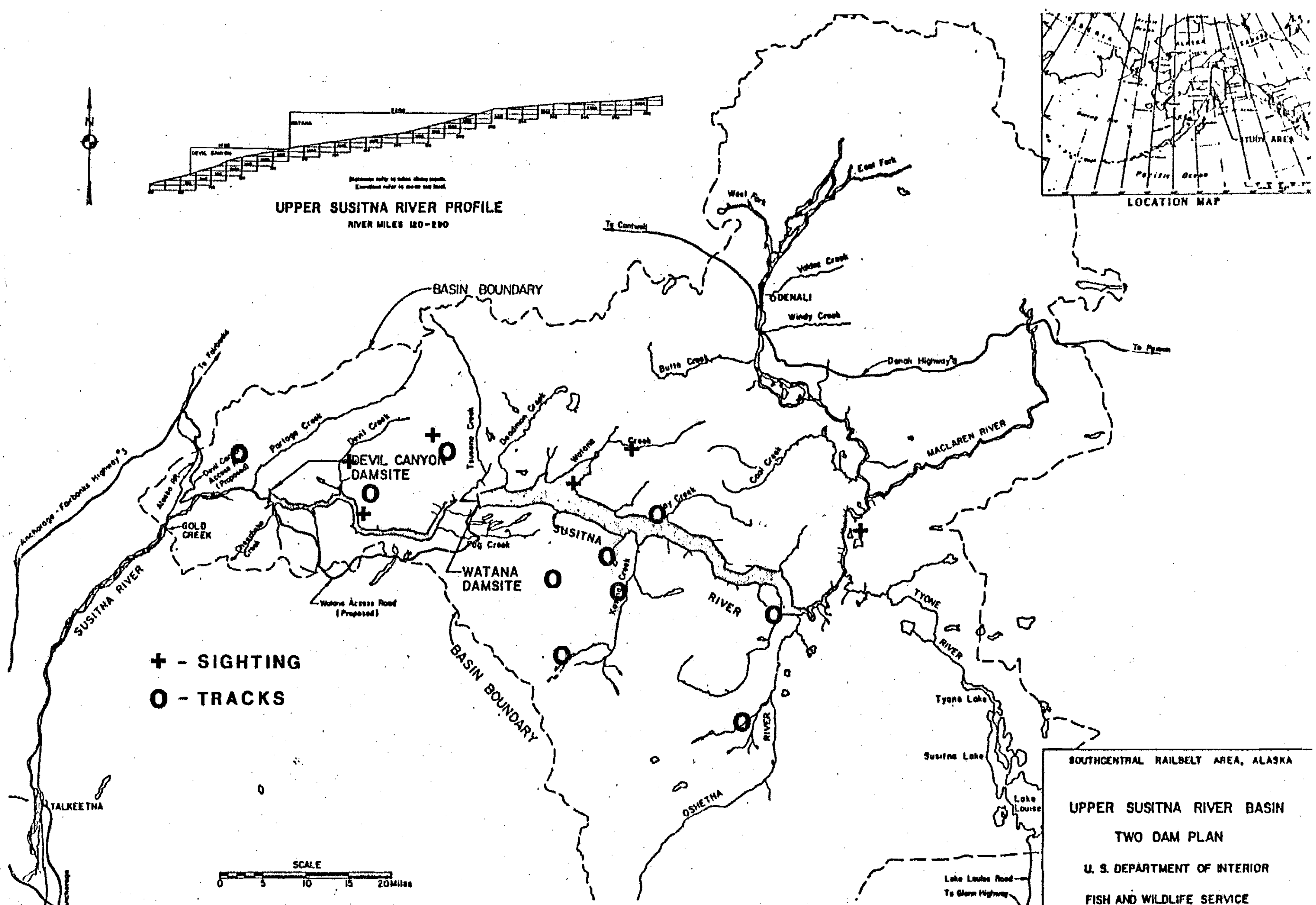


Figure 6. Locations of observed uncollared wolverine and wolverine tracks in the Susitna River Basin, 1980.

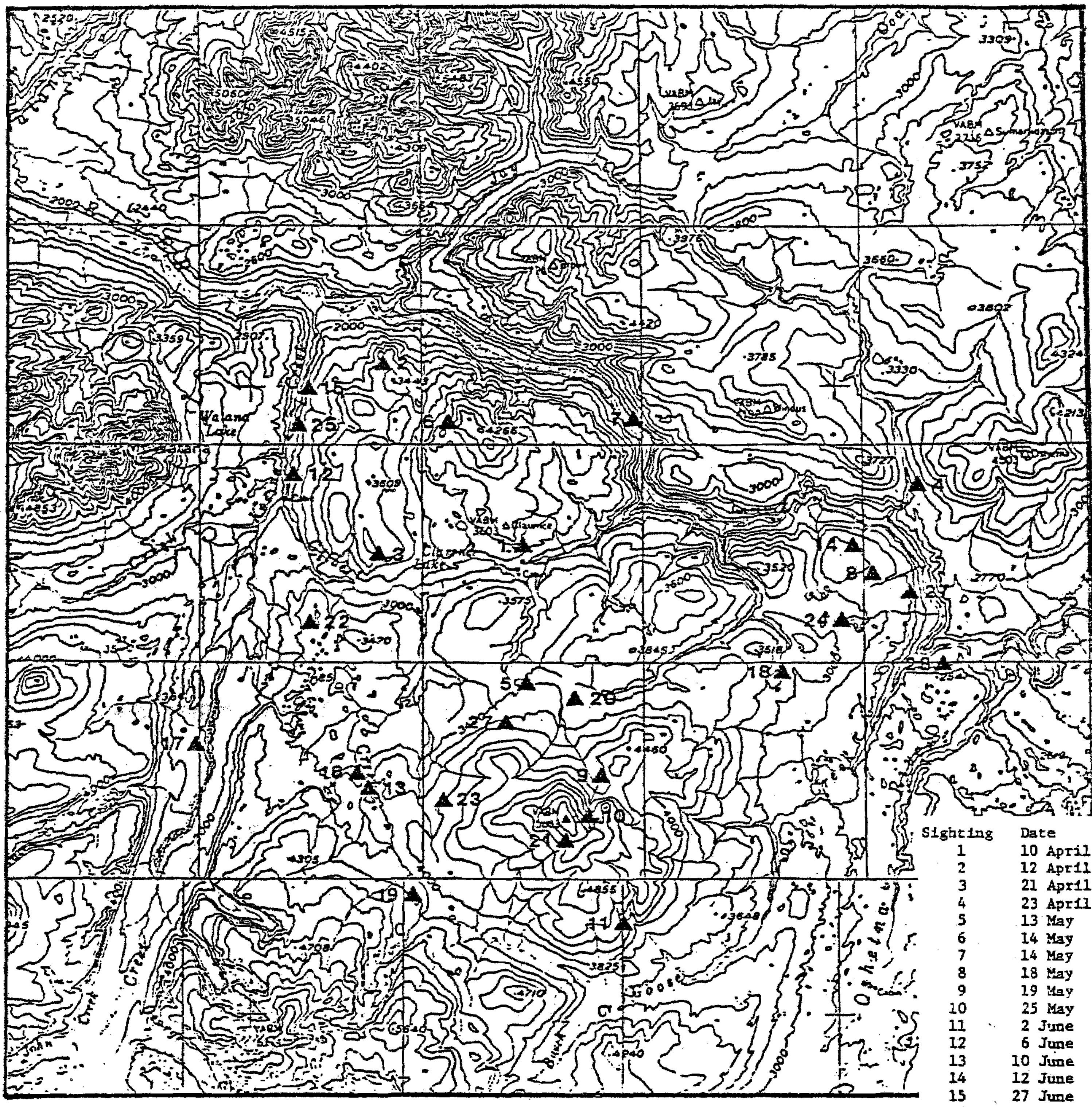
for them. There were only three occurrences of river crossing by radio-collared wolverine during the entire study period. All crossings (two by 040, one by 044) occurred during early spring, when the river was open but at reduced flow. Home ranges of the three male wolverine appeared to parallel the river as the greatest distance across their home ranges ran from east to west. Also, only 9 percent (6 of 66) of their locations were within 0.5 km of the river. Both Magoun (1979) and Hornocker (ob. cit.) indicated that rivers were not barriers to wolverine movements but that they could act as natural boundaries separating individual wolverine. However, in both studies, rivers were much smaller than the Susitna which can reach flows of 90,000 cfs during the summer (Army Corps of Engineers 1975). The low number of locations during the winter do not allow any inferences about usage of the river when it is frozen. It is known, however, that wolf packs in the study area use it as a travel corridor (Ballard et al. 1981).

There were no wolverine or wolverine tracks sightings within 10 km of Watana Camp. Although we have no prior knowledge of wolverine distribution near the camp prior to this study both Bjärvall (In Prep.) and Hornocker (In Press) believed that human disturbance affects wolverine movements and distribution. If true, as construction increases, wolverine population distribution and status may be altered. Special efforts will be taken to radio collar wolverine adjacent to Watana camp to determine if the camp may be a deterrent to wolverine usage and movements. If human disturbance adversely affects wolverine movements and denning activity, then placement of future camps, construction sites and access roads could impact this species. For example, since radio-collared wolverine tended to favor southerly and westerly slopes, placement of access roads along northerly or easterly slopes might reduce these impacts.

There seemed to be a seasonal trend of home range utilization for the three male wolverine. Between 18 May and 10 June 1980, wolverine 040 was located on 5 of 6 occasions within the Kosina Creek caribou calving grounds. During 1980, caribou calving extended from 15 May to 10 June (Pitcher pers. comm.). After which, during the period of 10 June and 26 August 1980, 040 increased its movement and utilized its entire home range (Fig. 7). This increase in travel corresponds with the breeding season which extends between late May and August (Rausch and Pearson 1972 and Magoun (pers. comm.).

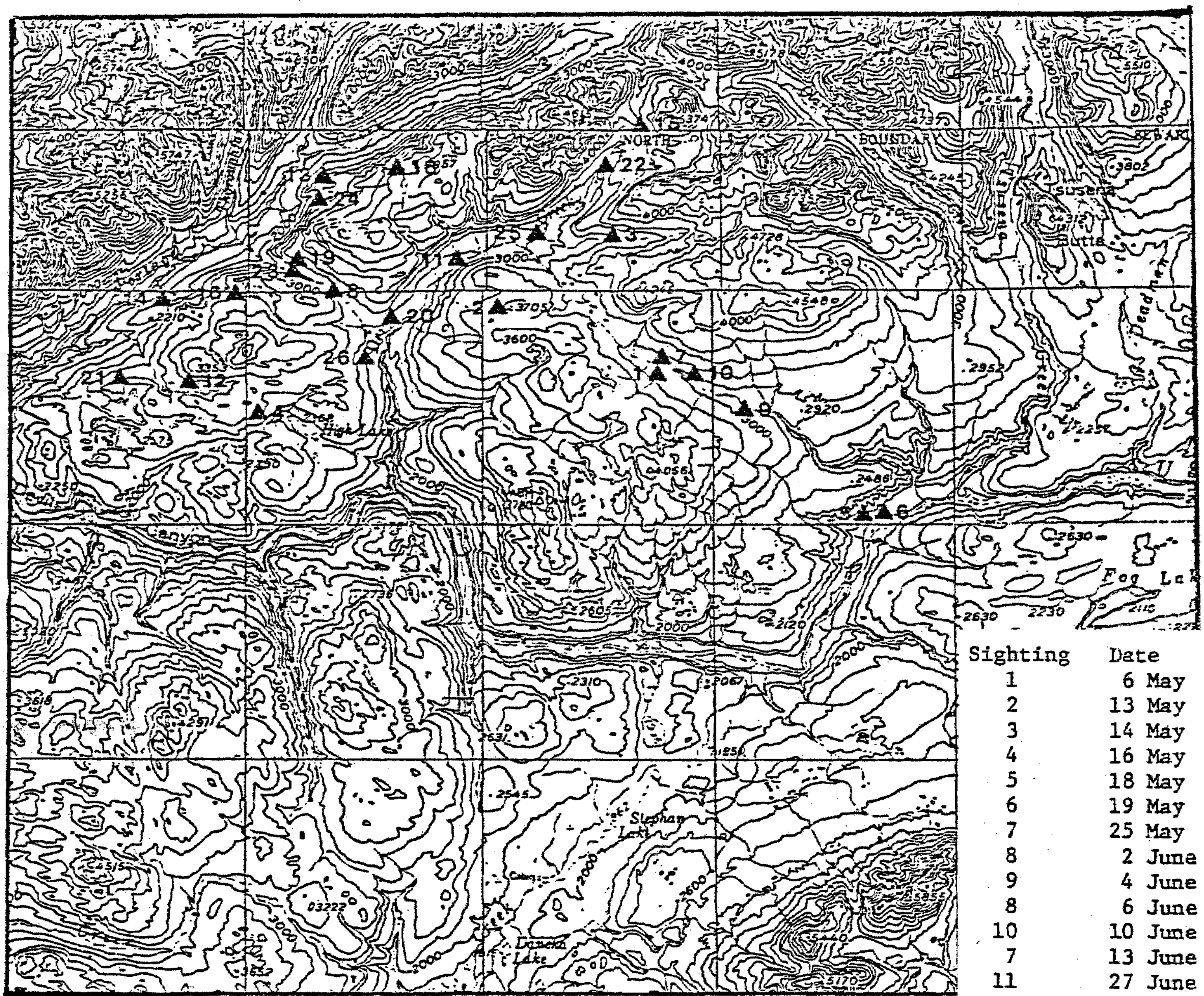
Wolverine 043 also exhibited a gradual change in home range usage. Between 6 May and 27 June 1980, 11 of 14 observations were east of Devil Creek. However, from 27 June to 4 December, all observations were west of Devil Creek and east of Portage Creek (Fig. 8). Without any knowledge of prey availability or distribution of females, it is impossible to make any inferences on the shift of home range preference by 043. Increased monitoring during the next spring and summer may give an indication how these different areas fulfill 043's seasonal requirements.

Wolverine 044 was collared on the Susitna River across from Stephan Lake on 7 May 1980 (Fig. 9). By 13 June 1980 044 had moved approximately 70 km to the vicinity of Kosina and Tsisi Creek drainages. It remained there until 26 August when it began moving back toward Stephan Lake. On 7 October, 044 was located 6 km east of Stephan Lake. Contact was lost after 9 October due to a probable slipped collar. This extensive movement after collaring went from a heavily timbered habitat to an upland shrub and tundra habitat. We suspect that timing of movement may be correlated with peak emergence of Arctic ground squirrels and marmots, which are more abundant in these higher, more open habitats. Ground squirrels and marmots are an important food species for wolverine in the Brooks Range (Magoun op. cit.) and northwestern Montana (Hornocker op. cit.).



Sighting	Date
1	10 April
2	12 April
3	21 April
4	23 April
5	13 May
6	14 May
7	14 May
8	18 May
9	19 May
10	25 May
11	2 June
12	6 June
13	10 June
14	12 June
15	27 June
16	8 July
17	1 August
18	12 August
19	26 August
20	10 Sept.
21	16 Sept.
22	1 Oct.
23	7 Oct.
24	15 Oct.
25	22 Oct.
26	13 Nov.
27	19 Nov.
28	15 Dec.

Figure 7. Locations of wolverine 040 from 10 April to 15 December 1980.



Sighting	Date
1	6 May
2	13 May
3	14 May
4	16 May
5	18 May
6	19 May
7	25 May
8	2 June
9	4 June
8	6 June
10	10 June
7	13 June
11	27 June
12	8 July
13	14 July
14	1 Aug.
15	12 Aug.
16	26 Aug.
17	10 Sept.
18	16 Sept.
19	26 Sept.
20	1 Oct.
21	7 Oct.
22	22 Oct.
23	30 Oct.
24	13 Nov.
26	4 Dec.

Figure 8. Locations of wolverine 043 from 6 May to 4 December 1980.

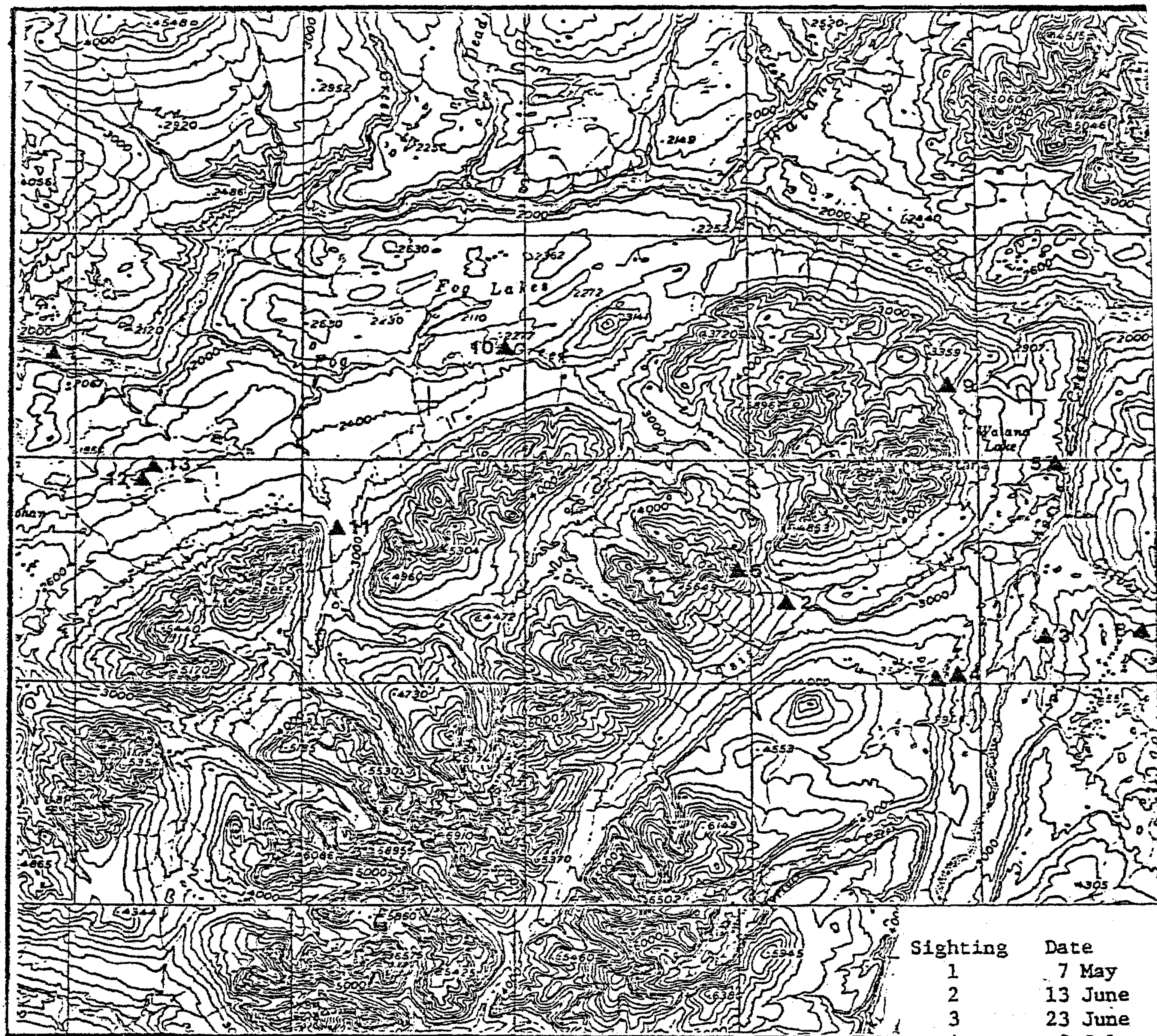


Figure 9. Locations of wolverine 044 from 7 May to 9 October 1980.

Sighting	Date
1	7 May
2	13 June
3	23 June
4	8 July
5	14 July
6	28 July
7	12 Aug.
8	26 Aug.
9	16 Sept.
10	26 Sept.
11	1 Oct.
12	7 Oct.
13	9 Oct.

On several occasions during the summer we observed wolverine with ground squirrel kills.

Ground Tracking

Ground tracking trips conducted in mid-May and early December 1980 indicated that wolverine were preying on small mammals. On 15 May, a fresh set of tracks of an uncollared wolverine within 043's home range was followed for approximately 5 km. Along this route many ground squirrels were observed and four squirrel tunnels had been excavated by the wolverine. There was no sign of capture. The wolverine was followed predominately through alpine tundra and upland willow habitats.

On 1 December, wolverine tracks were followed along the north side of Watana Creek through a white spruce-salix habitat which was interspersed with alder thickets which paralleled small drainages. The tracks were followed for approximately 5 km. The wolverine appeared to be hunting red squirrels. While in white spruce (*Picea glauca*) habitat, the wolverine appeared to investigate trees where squirrels had been present. He had excavated two red squirrel middens. As the wolverine came to an alder thicket, it crossed the thicket with no deviations, suggesting lack of preference for this habitat type. No evidence of a kill was observed.

Carcass Collection and Analyses

Thirty-three carcasses were purchased from local trappers. Morphometric measurements are summarized in Table 5. Age, sex and reproductive condition of the carcasses will be presented in the final report.

Harvest Data

A summary of harvest data collected since 1962 is presented in Table 6. Further analysis of the harvest data will be presented in the final report.

Table 5. Capture location and physical measurements of wolverine carcasses collected in GMU 13 from November 1979 through March 1980.

Accession Number	Kill Date	Location	Sex	Est. Age	Weight (kg) (Skinned)	Comments
116001	2/04/80	Gakona R.	F		6.1	Trapped
116002	2/14/80	Chistochina R.	M		-	Trapped; no head turned in
116003	1/21/80	4.8km W mouth Tyone R.	F		6.4	Trapped; had no teeth, uterus very small
116004	2/11/80	8km N mouth of Tyone R.	F		7.3	Trapped; 4 fetuses
116005	1/15/80	West fork Gulkana R.	M		9.8	Ground shot
116006	2/20/80	Chistochina R.	F		5.9	Trapped; uterus very small
116007	1/11/80	Island Lake	F		7.5	Trapped; all teeth broken
116008	11/24/79	Tolsona Creek	F		4.1	Trapped
116009	1/05/80	Tolsona Creek	F		4.8	Trapped; uterus very small
116010	2/24/80	Kelly Lake	M		12.7	Trapped
116011	2/26/80	Susitna River	F		7.5	Trapped; had ulcer
116012	12/7/79	4.8km S of Cantwell	M		9.8	Trapped
116013	3/02/80	N of Mt. Brag	M		9.5	Trapped
116014	2/08/80	West fork of Gulkana River	M		8.4	Trapped
116015	3/23/80	Between Sanona Ck. and Tyone Ck.	F		4.1	Trapped; uterus very small
116016	3/11/80	Gakona River	F		5.9	Ground shot, post partum

Table 5 (cont.). Capture location and physical measurements of wolverine carcasses collected in GMU 13 from November 1979 through March 1980.

Accession Number	Kill Date	Location	Sex	Est. Age	Weight (kg) (Skinned)	Comments
116017	3/06/80	Minnesota Lake	M		9.3	Trapped
116018	3/21/80	Landmark Camp Lake	F		6.1	Trapped; 1 fetus
116019	3/06/80	Kelly Lake	M		9.5	Trapped
116020	2/15/80	Indian River	M		11.8	Trapped
116021	1/15/80	Indian River	M		11.1	Trapped
116022	10/23/79	Indian River	M		8.6	Trapped
116023	2/05/80	Indian River	F		10.5	Trapped; uterus small
116024	2/15-3/15/80	Tiekel River	M		11.4	Trapped
116025	2/15-3/15/80	Tiekel River	F		7.3	Trapped; post partum
116026	2/15-3/15/80	Tiekel River	M		11.1	Trapped
116027	3/29/80	Mouth Black R.	M		7.8	Trapped
116028	2/15-3/15/80	Tiekel River	F		7.0	Trapped
116029	--	--	M		9.5	--
116030	2/15-3/15/80	Tiekel River	F		6.4	Ground shot
116031	--	8km N of Crosswind Lake	M		9.1	Trapped
116032	--	--	F		7.0	Trapped; post partum
116033	--	--	F		7.5	Trapped

Table 5 (cont.)

Accession Number	Total Body Length	Tail Length	Body Length	Heart Girth	Rack Circum.	Depth of Fat Rump	Depth of Fat Flank	Depth of Fat Sternum
116001	95.8	18.8	77	34	26.2	N O	B O D Y	F A T
116002	--	20.9	--	38.6	--	N O	B O D Y	F A T
116003	95.0	22.0	73	32.4	26.4	N O	B O D Y	F A T
116004	97.0	20.5	76.5	33.9	32.1	--	--	--
116005	100.2	18.4	81.8	39.7	33.5	N O	B O D Y	F A T
116006	92.8	19.8	73	35.7	27.9	N O	B O D Y	F A T
116007	96.3	19.8	76.5	35.8	28.3	0.2	0.3	0.2
116008	95.2	19.4	75.8	25.7	21.8	N O	B O D Y	F A T
116009	93.4	18.4	75.0	28.1	23.6	N O	B O D Y	F A T
116010	110.0	24.0	86.0	46.7	34.7	Trace		
116011	94.2	19.9	74.3	35.9	26.8	None	0.3	None
116012	104.8	19.0	85.8	39.7	31.7			
116013	102.0	19.4	82.6	36.8	29.5	--	0.2	--
116014	101.6	17.5	84.1	38.3	31.5			
116015	91.0	20.0	71.0	30.9	20.4	--	--	--
116016	89.7	17.7	72.0	--	24.7	0.2	0.2	0.2
116017	103.6	20.6	83.0	41.1	28.7	0.3	0.3	0.3
116018	86.1	19.1	67.0	39.0	24.1	0.2	0.3	0.2
116019	104.9	20.5	84.4	38.9	29.9	--	--	--
116020	104.5	20.5	84.0	37.9	30.9	0.2	0.2	0.2
116021	101.6	17.8	83.8	35.7	28.9	0.2	0.3	0.2
116022	93.5	18.1	75.4	34.0	26.2	0.3	0.3	0.2
116023	101.7	20.7	81.0	34.7	27.9	0.2	0.2	0.2
116024	103.0	19.0	84.0	40.2	31.2	0.3	0.3	0.3
116025	93.0	17.2	75.8	35.7	28.5	0.2	0.6	0.3
116026	105.9	22.9	83.0	40.6	30.1	N O	B O D Y	F A T
116027	105.6	23.9	81.7	39.7	33.3	N O	B O D Y	F A T
116028	89.7	21.2	? .5	?33.9	?34.1	N O	B O D Y	F A T
116029	99.7	19.2	80.5	38.5	29.6	0.2	0.6	--
116030	86.6	16.7	69.9	33.8	25.6	0.6	0.6	0.?
116031	102.6	22.6	80.0	36.7	31.1	--	--	--
116032	95.3	21.0	74.3	28.9	24.9	0.2	0.2	None

Table 6. Comparison of annual wolverine harvests from 1962-63 through 1979-80 in Game Management Unit 13.

Year	Harvest	Year	Harvest
1962-63	37*	1972-73	140***
1963-64	32*	1973-74	121***
1964-65	65*	1974-75	96***
1965-66	102*	1975-76	105***
1966-67	132*	1976-77	85***
1967-68	86*	1977-78	58***
1968-69	No Data**	1978-79	69***
1969-70	No Data**	1979-80	57***
1970-71	No Data**		
1971-72	75***		

* Harvest figures are from bounty records.

** The bounty was discontinued on wolverines during this period, and no information on the harvest is available.

*** Harvest figures are from sealing records.

Impacts of the Susitna Hydroelectric Project on Wolverine

The most obvious potential mechanism of impact on wolverine is loss of 51,000 acres of habitat. However, this may not be a major impact. If in fact, wolverine do not use the river bottom extensively throughout the year, then the actual flooding would not be a serious problem. There can be, however, an important indirect impact if the wolverine's main winter food species (moose and small rodents) were detrimentally affected. A decrease in the food base would probably increase competition between scavengers and predators. These changes could alter home range size and seaonal movements and result in lower wolverine densities.

A major impact on wolverine may result from human activities prior to the actual inundation. Disturbances associated with road and camp construction may alter movements and influence reproduction. Further study is required to evaluate the effects of disturbance and to determine if impacts can be moderated through timing and placement of human activities.

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SUSITNA HYDROELECTRIC PROJECT
ANNUAL PROGRESS REPORT

BIG GAME STUDIES

PART VII BLACK BEAR AND BROWN BEAR

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and
Dennis C. McAllister

ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the
Alaska Power Authority

March 1, 1981

SUMMARY

Both black bear (*Ursus americanus*) and brown bear (*U. arctos*) populations in the vicinity of proposed Susitna hydroelecrric dams appear to be healthy and productive. Brown bears are ubiquitous throughout the study area while black bears appear largely confined to a finger of forested habitat along the Susitna River. This finger becomes progressively narrower proceeding upstream. In 1980, 27 brown bears and 27 black bears were captured and marked utilizing helicopter darting techniques. Adults were radio-collared and periodically relocated. A total of 143 point locations were obtained for brown bears in 1980, 120 of these from 15 radio-collared individuals. A total of 229 point locations were obtained for black bears in 1980, 181 of these from 23 radio-collared individuals. Only preliminary and general comments are offered from these data, more detailed analyses await completion of computer digitization procedures, collection of more point-location records, and integrated analyses with vegetation data.

Brown bear use of areas directly impacted by proposed impoundments appeared greatest in the early spring following emergence from dens. We speculate that brown bears may have been attracted to these areas in the spring by the early availability of both vegetable and animal foods. Important vegetable foods may include berries from the previous year, tubers, fresh grasses and sedges which may be available earlier in these areas because of earlier snow melt. Animal foods utilized in these areas may be winter-killed or weakened moose and, somewhat later, moose calves. It is suggested that the proposed impoundments may reduce the extent and utility of these habitats occupied by many brown bears in the study area.

Denning sites of nine radio-collared brown bears in the winter of 1980-81 suggest that the proposed impoundments will have little impact on availability of adequate brown bear den sites.

The most interior run of salmon in the study area occurs at Prairie Creek, a feeder stream running from Stephan Lake to the Talkeetna River. Four of 11 radio-collared brown bears moved to Prairie Creek during the salmon run in July and August, we estimate no fewer than 30 brown bears fished here in 1980. Brown bear movements to or from Prairie Creek may be inhibited by impoundments or impoundment access routes, thereby reducing the availability of this salmon resource to some study area bears.

Studies in the headwaters of the Susitna River conducted in 1979 (Miller and Ballard 1980) estimated a brown bear density of 1 bear/41-62 km^2. We suspect that brown bear density in the impoundment area is roughly comparable to that in the area of the 1979 study. If so, the impoundment study area of 3,500 mi^2 contains approximately 70 brown bears.

Capture and relocation records for black bears suggested that black bear distribution in 1980 was largely confined to or near the spruce forests found in the vicinity of the Susitna River and its major tributaries. These are the habitats which will be maximally impacted by the proposed impoundments; the restricted nature of black bear distribution in the study area suggests that these populations may be highly vulnerable to habitat losses by inundataion as well as by disturbances associated with construction and improved access.

Within the spruce habitats inhabited by black bears, utilization appears most prevalent in the early spring. In late summer 1980 many black bears moved to the more open shrublands adjacent to the spruce forests. This movement appeared motivated by the greater prevalence of berries (*Vaccinium*) in these areas relative to the spruce forests.

Black bears crossed the Susitna River more frequently than brown bears. This result probably reflects the relative proximity of black bear home ranges to the river. The motivation or importance of these river crossings for black bears is not known, neither is it known whether the proposed impoundments would represent a significant barrier to such crossings.

All five of the radio-collared black bears with 1980 dens in the vicinity of the Watana impoundment denned below 2,200 feet elevation, the proposed high water mark of the Watana impoundment. Two of nine black bears denning in the vicinity of the Devil Canyon impoundment denned below the proposed high water mark (1,450 feet); the average elevation of nine of these dens was 1,935 feet (1,300-2,750 feet). Nine of 14 black bear den sites were in spruce habitats and five were in shrubland habitats adjacent to spruce habitats. Based on these data it appeared clear that many current den sites utilized by black bear in 1980 would be inundated by the proposed impoundments. The impact of this den inundation on black bear populations is unclear, clarification will be obtained in 1981 when these den sites will be visited and their characteristics described.

Black bear density appeared variable throughout the study area. A very rough estimate of 1 bear/4.1 km^2 was offered for one area of relatively high density.

Bear studies in the remainder of Phase I will concentrate on collection of additional evidence on bear distribution and movements in the study area. Efforts will be made to increase the proportion of marked animals in the population throughout Phase I and Phase II. Among other things this will ultimately permit a more accurate estimate of bear populations in the impact area.

Phase II efforts should be expanded to include studies of what bears are doing in the impact area, especially during seasons when use of the impoundment area is most intensive. These studies should include food habits analyses and analyses of the degree to which habitat components which will be influenced by the impoundments are available elsewhere. Downstream bear studies are also recommended for Phase II, these studies should concentrate on impacts of altered flooding patterns on downstream black bear populations.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Black bear (*Ursus americanus*) and brown bear (*U. arctos*) are widely distributed and abundant in Alaska. Black bear distribution in Alaska coincides closely with the distribution of forests, with the most abundant populations occurring in "open" forests rather than heavy timber; extensive open areas are usually avoided. Brown bears seem best adapted to open areas of tundra or grasslands although, like black bears, they inhabit a variety of different habitats in Alaska.

Taxonomically there is only one species of brown-grizzly bear. In common usage the term brown bear is utilized to refer to southern and coastal populations of this species and grizzly bear refers to northern and interior populations. Typically "brown" bears are larger and darker than "grizzly" bears. The brown-grizzly bears along the Susitna River described in this report are, most appropriately, referred to as brown bears.

Black bears in Alaska tend to be smaller than in many areas of the contiguous United States, most commonly they weigh 100-200 lbs. Several color phases of black bears are known, the Susitna populations includes individuals that are black, cinnamon, and dark brown.

In Alaska, both species of bears spend the winter in dens. Black bears use a variety of den sites and structures ranging from substantial excavations on hillsides or under logs and trees to, less commonly, simple and relatively shelterless sites. Brown bears most commonly den in well excavated holes on high mountain slopes. The denning period for both species typically runs from October through April or May but annual, geographic, and individual variations are common. In the Susitna area a limited number of observations suggest that black bears enter dens earlier and emerge later than brown bears (Miller unpublished data).

Brown bears are more aggressive and dangerous to man than black bears, this may be the result of evolution in a more open environment without trees to serve as escape habitat and the corresponding need for more agressive behavior to protect themselves and their offspring (Herrero 1972). The corresponding danger to man combined with the increased vulnerability to hunting associated with more open habitats, has lead to great reductions in brown bear distribution and abundance in the contiguous United States. Except in Alaska and parts of Canada, the species is currently classified as endangered. Black bears, on the other hand, are still abundant throughout most of their original range.

Both species have evolved generalist and opportunist strategies and are, correspondingly, biologically compatable with many kinds of man-caused disturbances of their habitat. However, experience has amply demonstrated that brown bear abundance is usually incompatible with increasing human presence except in a few parks where bears are given a legal priority over human developmental activities.

Both species of bears are omnivorous, eating a wide variety of grasses, sedges, other herbaceous plants, roots and berries as well as animal protein when available. Populations with access to salmon may heavily utilize this resource during portions of the year. Brown bears have recently been shown to be significant predators on moose calves in the upper Susitna-Nelchina Basin area (Ballard et al. 1980).

Brown bear research has been undertaken since 1978 in the Nelchina and Susitna River Basins . This research has concentrated on the magnitude and effects of brown bear predation on moose but considerable life history data were also collected (Ballard et al. 1980, Spraker et al. 1981). In this region federal predator control programs conducted from 1948 to 1953 are suspected to have reduced bear populations to low levels.

In the last 20 years brown bear populations have increased and the current population appears to be abundant, young and productive. Fall harvests in the period 1970-1979 averaged 61 bears/year (30-84 bears/year) in Alaska's Game Management Unit (GMU) 13. This level of harvest is suspected to be less than the maximum sustainable yield of this population. In 1980 a May 10-25 bear season was held, the same season will be held in 1981.

Black bear research has not been conducted in the Susitna or Nelchina River Basins. The abundance of black bears and relatively light hunting pressure in these areas permits a year-long open hunting season and an annual bag limit of three bears. An annual average of 63 black bears have been taken in GMU 13 from 1973-1979 (58-70 bears/year). Relative to brown bears, black bears are highly productive and numerous and this population could sustain higher levels of harvest.

The overall objectives of black bear and brown bear studies mandated by proposed hydroelectric development on the Susitna River are:

> "To determine the distribution and abundance of black and brown bears in the vicinity of proposed impoundment area; seasonal ranges, including denning areas, and movement patterns of bears; and seasonal habitat use of black and brown bears."

In Phase I of these studies, emphasis has been placed on determination of relative abundance and seasonal distribution of the two species, in the vicinity of proposed impoundments, and on collection of baseline information on basic biology of impact-area bears in order to compare Susitna-area populations with populations elsewhere. With these kinds of data available by completion of Phase I, Phase II efforts can concentrate on quantification of the levels of potential impacts and on the reasons for them.

The objectives of the first year of effort were primarily procedural rather than analytical: To radio collar a sample of both black and brown bears, to periodically locate these bears and pinpoint their locations, to locate den sites of radio-collared bears, to begin development of techniques which would permit an analysis of habitat selectivity by bears, and to begin the collection of baseline biological data by which to characterize impact-area bear populations.

METHODOLOGY

Brown and black bears were captured by procedures described in Spraker et al. 1981 and Ballard et al. 1980. In brief, fixed-wing aircraft (PA-18) were used to search for bears and bears were immobilized by darts fired from a helicopter (Bell 206B). Drugs utilized included Phencyclidine hydrochloride (Sernalyn), etorphine (M99) and its antagonist Diprenorphine (M50-50), Ketamine hydrochloride (Vetelar), and xylazine (Rompun).

Standard morphological measurements were taken of immobilized bears. When terrain conditions permitted, weights were obtained by means of a scale suspended from the helicopter or a hand-held scale. Specimens of blood and hair were collected to assess physiological condition. Identifying marks applied to all bears included: Lip tattoos, ear tags, and ear flags. Individual bear number referred to in this report represent tattoo numbers with a "G" for brown bear and a "B" for black bears. Bears judged to have completed 80 percent or more of their growth were fitted with radio-collars which transmit in the range of 148.0-153.9 MHz. Ten bears were fitted with double transmitter collars designed so that one transmitter transmitted data on ambient temperature.

Because of the late arrival of new bear collars, some individuals were fitted with radio-collars designed for other species or used bear radios from other projects. Except for the double-transmitter bear radios, all new bear radios were designed with mortality sensors which halve the pulse rate when the collar is stationary for 2 hours, this permits recognition of when a collar has been shed or the bear is dead and also prolongs battery life by reduced electrical draw when bears are in dens.

Bears were captured on 10-22 April, 1-7 May and 18-19 August, 1980. In the first effort only brown bears were seen. Beginning on 1 May black bears were abundant having emerged , apparently, from their dens between 22 April and 1 May. The August tagging effort was designed to capture black bears on mid-summer habitats, away from their 1979-80 dens. These summer captures avoided den-site selectivity biases which may have resulted had only spring-captured bears been followed to their 1980-81 dens.

Attempts to locate radio-collared animals were made on approximate 10 day intervals in 1980. Actual flights varied from this schedule depending on weather conditions and aircraft availability. Most radio location flights were made in a Cessna 180 based in Anchorage and refueled at Susitna Lodge or Talkeetna. Flights were made on 14, 22 and 29 May, 4, 12 and 23 June, 2, 10, 18 and 22 July, 4, 14, 22 and 27 August, 9 and 29 September and 9, 13, and 27 October. Additional radio-locations were made in conjunction with flights to locate other species in the Susitna study area. Reasonable efforts were made to visually observe all radio-located bears. The locations of all non-marked bears spotted during radio-location flights were also recorded. Locations were plotted on US Geological Survey maps (scale 1:63,360) and information on habitat type, behavior, associations, topography, etc. were recorded.

Data collected on monitoring flights were transferred to individual-specific data forms and maps which will be the basis for keypunching and digitizing (see Big Game Biometrics and Data Processing report).

Habitat-type information recorded during monitoring flights was restricted to the following broad categories identifiable from the air:

1. Sparse tall spruce
2. Mod. tall spruce
3. Dense tall spruce (riparian)
4. Sparse med. spruce
5. Mod. med. spruce
6. Dense med. spruce
7. Sparse low spruce
8. Mod. low spruce
9. Dense low spruce
10. Riparian willow
11. Upland willow
12. Willow birch
13. Aspen
14. Riparian hardwood
15. Marsh
16. Alder
17. Rock/ice

The nine habitat types which include spruce were broken down into categories reflecting relative densities and heights of the spruce component. Procedures to determine habitat selectivity from these data and/or data from vegetational mapping subtasks are under development (see Big Game Biometrics and Data Processing report).

Blood samples were analyzed for condition indices by Pathologists Central Laboratories, Seattle. Hair samples are stored for potential trace element analyses. Teeth were collected for aging according to procedures described by Stoneburg and Jonkel (1966) and Johnson and Lucier (1975). Feces collected during capture are stored for food habits studies (anticipated for Phase II), and thin layer chromatographic techniques are being tested on these specimens for potential utility in separating field-collected feces of brown bears from those of black bear (Appendix A). This is an essential element of any food habits study based on fecal analyses in areas where both species are sympatric. Captured bears were photographed.

THE STUDY AREA

Captured bears were located along the Susitna River and its tributaries between Devil Creek (T32N/R8W, Talkeetna Mts. Quad) and the Vee site or gaging station (T30N/R10E, Talkeetna Mts. Quad). The most distant bear captured south of the Susitna River was G293 (upper Tsisi Creek), 25 km south of the Susitna River. The most distant bear captured north of the Susitna River was G312 (T21S/R4W, Healy Quad), about 30 km north of the Susitna River. All black bears and half of the brown bears were captured within 5 km of the Susitna River.

Based on movements of radio-collared bears, the study area was expanded to include upper Chulitna Creek, the whole of Prairie Creek, the height of land separating upper Susitna drainages from Talkeetna River drainages, Kosina Creek, and drainages of the Susitna as far east as the Oshetna River, and upper Jay, Watana, Deadman and Tsusena Creeks. The total area encompassed by movements of radio-collared brown bears included approximately 3,500 km^2 (Figure 1). Because of the difficulty of radio-monitoring this large area, most monitoring efforts were concentrated on a core area within 15 km either side of the main Susitna River, encompassing an area of only 800 km^2. Bears ranging outside of this core area were radio-located less frequently than bears with a greater portion of their home ranges within the core area.

Within this study area black bears were much less ubiquitous than brown bears. The main black bear study area was southeast and east of Devil Mountain to Tsusena Creek (T31-32N/R5-7W), an area which would be impacted by construction of the Devil Canyon dam. A secondary black bear study site, which would be impacted by the Watana dam, was centered around Deadman Creek or (T32N/R4-5W). The most upstream radio-collared black bear was in the vicinity of the gaging station (T30N/R1-2E). The 1980 black bear study area is indicated in Figure 1.

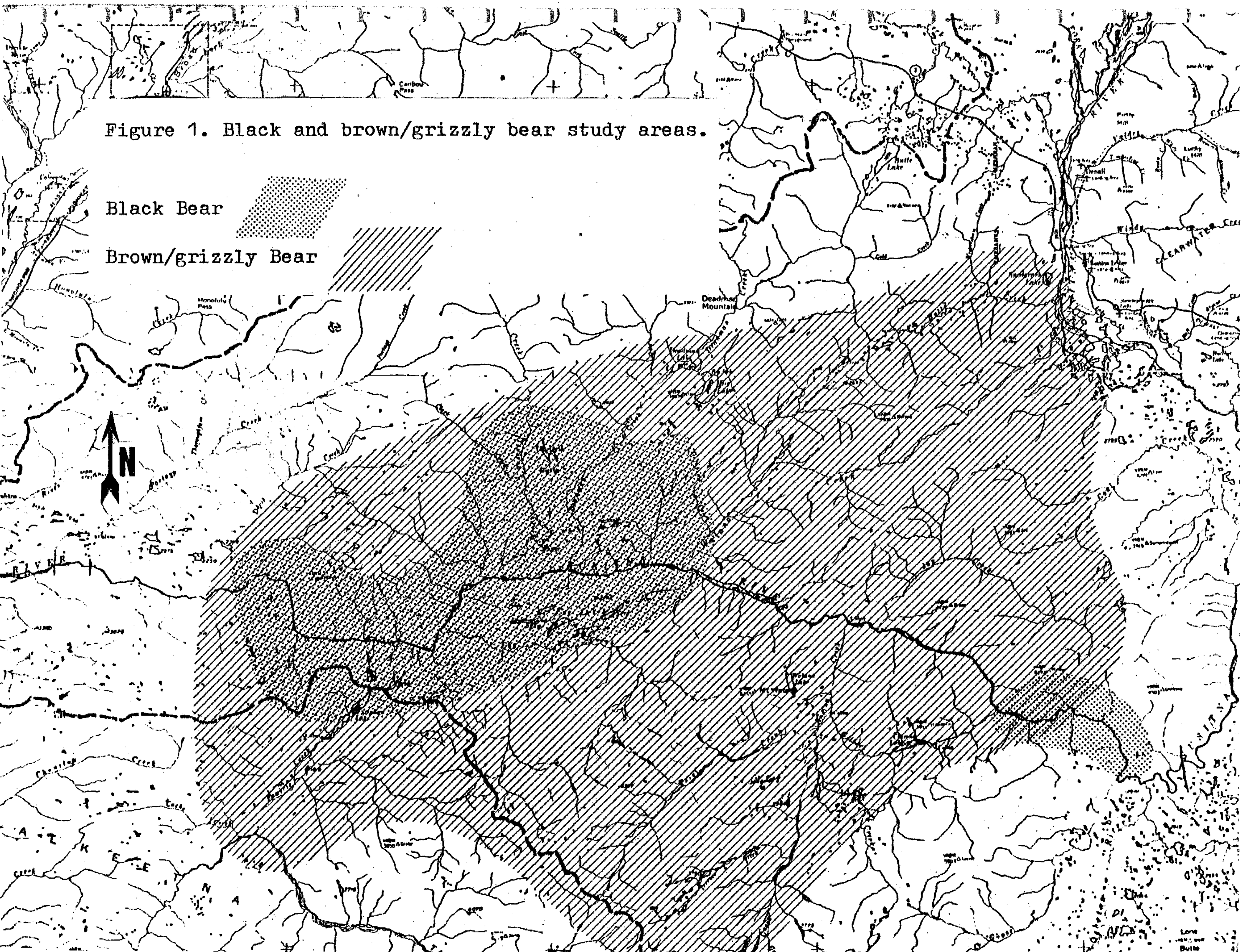


Figure 1. Black and brown/grizzly bear study areas.

RESULTS AND DISCUSSION

Sex and age Composition of Study Animals

Fifty-four bears were captured and marked in 1980, 27 brown bears (Table 1) and 27 black bears (Table 2). One black bear (B303) was captured twice bringing total number of black bear captures to 28. One bear of each species died during capture operations (B296 and G278).

Radio collars were placed on 15 brown bears and 11 of these remain active. Four brown bears shed their collars (G279, G214, G295, G309), all of these were large males (average age = 9.2 years, range 4-12). One nonradioed bear (G311) was shot by a hunter. The total number of marked and radio-collared brown bears remaining in the Susitna study area (October 1980) by sex and age categories is shown in Table 3.

Radio collars were placed on 24 black bears and 16 of these are now potentially active as of October 1980 (Table 4). Two black bears shed their collars (B288 and B302), two died of unknown causes (B291 and B300) and four were shot by hunters (B305, B316, B320, and B326). Based on absence of radio-locations (subsequent to 9 September), radio failures may have occurred for two (B303 and B304) of the remaining 16 radio-collared black bears leaving only 14 active radio-collars at time of denning. The total number of marked and radio-collared black bears remaining in the Susitna study area as of October 1980 by sex and age categories is shown in Table 4.

The sex and age composition of current radio-collared bears is shown in Tables 3 and 4. The sex ratio of adult brown bears captured for Susitna hydro studies is comparable to that in an earlier study nearby and in the 10 year harvest statistics for Unit 13 (Table 5). The age structure of hydro-project bears was younger than in these other subpopulations (Table 5), most

Table 1 Brown bears captured in the spring of 1980, Susitna Dam Study.

# Tattoo	Sex	Age	Wt.	Capture Date	Frequency	Ear flags	Comments
277	F	10.5	225*	4/10	148.004	orange	w/ 2 ylgs, not marked
(278)	M	9.5	375*	4/19	--	--	Capture mortality
(279)	M	9.5	400*	4/20	(150.368)	orange	Collar shed by 6/12
280	M	5.5	300*	4/20	149.508	orange	Recollar next spring
(214)	M	4.5	300*	4/22	(151.512)	blue	Recaptured '78 bear-collar shed 9/9
281	F	3.5	250*	4/22	152.840	orange	Not turgid
282	M	4.5	325*	4/22	--	orange	
283	F	12.5	280*	4/22	148.950	orange	w/ 2 @ 2.5: 284 & 285
284	M	2.5	180*	4/22	--	white	w/ 283
285	M	2.5	180*	4/22	--	green	w/ 283
286	M	3.5	264	5/1	--	orange	
292	F	3.5	174	5/2	--	green	Turgid
293	M	4.5	277	5/2	150.041/.103	white	
294	M	10.5	607	5/2	150.142/.092	white	
(295)	M	12.5	589	5/3	(150.061/.102)	green	Collar shed by 5/4
299	F	13.5	285	5/4	150.041/.112	green	w/ 2 ylgs, turgid
297	M	1.5	65	5/4	--	orange	w/ 299
298	M	1.5	65	5/4	--	orange	w/ 299
306	F	3.5	163	5/4	--	white	Turgid
308A	M	6.5	480	5/6	152.830	white	--
308B	F	5.5	240	5/6	153.810	white	Turgid(?)
(309)	M	12.5	600	5/6	(150.650)	orange	Collar shed by 5/14
312	F	10.5	319	5/7	152.860	orange	w/ 311
(311)	M	(2.5)	227	5/7	--	orange	w/ 312, killed by hunter 9/16
313	F	9.5	286	5/7	152.820	orange	w/ 314 @ 2.5
314	F	2.5	154	5/7	--	orange	w/ 313
315	F	1.5	90*	5/7	--	green	alone

* Weight estimated   () Indicates shed collar or dead bear

Table 2. Black bears captured in the spring & summer 1980, Susitna Dam Study.

Tattoo	Sex	Age	Wt.	Capture Date	Frequency	Ear flags	Comments
287	M	10.5	225*	5/1	150.111/.082	white	
(288)	F	10.5	125*	5/1	(150.032/.122)	white	w/ 2 ylgs, turgid, collar shed by 8/27/80
289	F	9.5	130*	5/2	150.092/.062	white	w/ 2 ylgs, turgid
290	F	8.5	103	5/2	150.022/.142	blue	w/ 2 ylgs, turgid
(291)	M	(3.5)	73	5/2	(150.030)	orange	Post-capture mortality
(296)	M	(10.5)	227	5/3	(--)	--	Capture mortality
(300)	M	(7.5)	274	5/4	(150.023/.121)	orange	Post-capture mortality
301	F	7.5	115	5/4	153.850	green	w/ 1 ylg, turgid
(302)	M	8.5	287	5/4	(150.189)	blue	collar shed by 8/4/80
303	M	7.5	217	5/4	153.870	green	--
304	M	10.5	235	5/4	150.031/.080	orange	--
(305)	M	(9.5)	217	5/5	(151.350)	green	Shot by hunter 8/30/80
307	M	2.5	105	5/5	--	orange	--
310	M	2.5	85	5/6	--	blue/green	--
(316)	F	(12.5)	150*	5/7	(148.912)	blue	w/ 1 newborn, 1 ylg. shot by hunter 8/28/80
317	F	7.8	133	8/18	152.703	white	
318	F	5.8	126	8/18	152.690	white	w/ 1 cub
319	M	3.8	174	8/18	152.682	orange	
(320)	M	(4.8)	200*	8/18	(152.663)	orange	Shot by hunter 9/9/80
321	F	10.8	175*	8/18	152.673	white	
322	M	4.8	154	8/19	152.643	orange	w/ 324
323	M	2.8	122	8/18	152.612	orange	
324	M	5.8	190	8/19	152.624	orange	w/ 322
325	F	11.8	164	8/18	152.632	white	
(326)	F	(5.8)	125	8/19	(152.560)	white	w/ 2 cubs, shot by hunter on 8/28/80
327	F	5.8	118	8/19	152.653	white	w/ 2 cubs
328	F	6.8	150	8/19	152.573	white	w/ 303
303	M	7.8	260	8/19	152.870	orange	recapture

* Weight estimated ( ) Shed collar or dead bear

Table 3. Sex and age composition of marked brown bears remaining in the Susitna hydro-study area, October 1980. Number with radio-collars is given in parenthesis.

1980 Age	Males	Females
0-1	0	0
1-2	2	1
2-3	2**	1
3-4	1	3 (1)
4-5	3 (1)	0
5-6	1 (1)	1 (1)
6-7	1 (1)	0
7-8	0	0
8-9	0	0
9-10	1	1 (1)
10-11	1 (1)*	2 (2)
11-12	0	0
12-13	2	1 (1)
13-14	0	1 (1)
Totals	14 (4)	11 (7)

* One capture-related mortality not included (G214).
** One bear shot by hunter not included (G311).

Table 4. Sex and age composition of marked black bears remaining in the Susitna study area, October 1980. Number with radio-collars is given in parenthesis.

1980 Age	Males	Females
0-1	0	0
1-2	0	0
2-3	3 (1)	0
3-4	1 (1)*	0
4-5	1 (1)**	0
5-6	1 (1)	2 (2)**
6-7	0	1 (1)
7-8	1 (1)*	2 (2)
8-9	1	1 (1)
9-10	0 **	1 (1)
10-11	2 (2)***	2 (1)
11-12	0	1 (1)
12-13	0	0 **
Totals	10 (7)	10 (9)

* One post-capture mortality not included (B291, B300).
** One bear shot by hunter not included (B305, B320, B326, B316).
***One capture-related mortality not included (B296).

Table 5. Average spring ages of Susitna area brown bear subpopulations. (Includes only bears of known sex and age that are 3.0 or older, spring age calculated as xx.5).

Subpopulation	Males			Females			Avg. Both Sexes (Years)	% Males
	Average Spring Age (Years)	(Range)	n	Average Spring Age (Years)	(Range)	n		
GMU 13 fall harvests, 1970-1980	8.0	(3.5-23.5)	208	7.7	(3.5-28.5)	191	7.9	52
1979 Upper Susitna studies (Miller & Ballard 1980)	7.4	(3.5-21.5)	17	7.4	(3.5-16.5)	15	7.4	53
1980 Susitna Hydro studies	6.0	(3.5-12.5)	11	6.6	(3.5-13.5)	9	6.3	55

likely the result of small sample size for hydro-project bears but possibly indicating locally heavy harvest levels.

Larger numbers of radio-collared individuals would be helpful for both species. This is especially the case for brown bears which will be subject to heavy hunting pressures in spring 1981 if weather conditions are good during the season. Given equivalent hunting losses of radio-collared black bears in 1981, by the end of Phase I studies active black bear radios will have been reduced to minimally acceptable numbers.

Brown Bear Seasonal Distribution and Movements

Relocations in 1980 for 15 radio-collared brown bears (excluding offspring and sequential relocations at the same den site) total 120 points (Table 6). For the 11 bears with active radios in winter 1980/81, 107 relocations were obtained (3-14 per individual) (Table 6). Dens were tentatively located for 10 of these 11 bears. Sightings of unmarked brown bears totaled 23, yielding a total of 143 point-locations for brown bears in 1980.

These point-locations are in the process of being digitized (see Big Game and Data Processing report). The digitization process is designed to facilitate mapping and analysis of the point-location data; detailed analysis of these data will be delayed until digitization is complete and until sufficient data to draw preliminary conclusions are available. Only general hypotheses, based on the preliminary point-location data will be presented here.

Brown bear use of the area in the immediate vicinity of the Susitna River and proposed impoundments appeared to be greatest in the early spring, 4-6 weeks following emergence from dens. Eleven of the 21 bears (offspring excluded) captured in the spring of 1980 were within about 5 km of the Susitna River and most of these were on south-facing slopes from which the snow had melted. Inspection of feces collected from these bears suggests that many were feeding on berries (*Vaccinium* spp.) remaining from the previous year's crop. At least two of these bears were feeding on a moose carcass found on the bank of the Susitna River, this moose probably was a winter kill rather than a bear kill. It is a reasonable speculation that bear scavenging early in the spring would be concentrated in the moose winter range along the river, the area where most carcuses would be found. The steep south-facing slopes along the Susitna River are also the first areas to become clear of

Table 6. Number of Brown bear relocation records in 1980 - Susitna Hydro Project (indented bears are offspring of previously listed adult).

Brown Bear #	Sex	1980 age at capture	Capture Date-Last Location	Number of Relocations	No. River Crossings	80/81 Den Located	Status
277	F	10.5	4/10/80 - 8/27/80	5	0	yes	Probably transmitting, outside core area
(278)	M	9.5	4/19/80 -	-	0	-	Capture mortality
(279)	M	9.5	4/20/80 - <6/12/80	1	0	-	Collar shed
280	M	5.5	4/20/80 - 10/13/80	9	2	yes	Active transmitter
214	M	4.5	4/22/80 - <9/980	10	0	-	Collar shed
281	F	3.5	4/22/80 - 10/13/80	13	1	yes	Active transmitter, may have cubs in 1981
282	M	4.5	4/22/80 -	-	-	-	Not radioed
283	F	12.5	4/22/80 - 10/9/80	10	0	yes	Active transmitter
284	M	2.5	4/22/80 -	-	-	-	w/283, not radioed
285	M	2.5	4/22/80 -	-	-	-	w/283, not radioed
286	M	3.5	5/1/80 -	-	-	-	Not radioed
292	F	3.5	5//280 -	-	-	-	Not radioed, turgid
293	M	4.5	5/2/80 - 10/13/80	6	2	no	Bear exceptionally wide-ranging, active transmitter
294	M	10.5	5/2/80 - 10/13/80	13	1	yes?	Active transmitter
(295)	M	12.5	5/3/80 - <5/4/80	1	1	-	Collar shed
299	F	13.5	5/4/80 - 10/13/80	10	2	yes	Active transmitter
297	M	1.5	5/4/80 -	-	-	-	w/299, not radioed
298	M	1.5	5/4/80 -	-	-	-	w/299, not radioed
306	F	3.5	5/4/80 -	-	0	-	Not radioed, turgid
308A	M	6.5	5/6/80 - 7/2/80	3	0	-	Possible radio failure
308B	F	5.5	5/6/80 - 10/13/80	14	5	yes?	Active transmitter, den site not precisely located, should have cubs in 1981
(309)	M	12.5	5/6/80 - <5/14/80	1	0	-	Collar shed
312	M	10.5	5/7/80 - 9/29/80	11	0	yes	Probably transmitting, outside core area
(311)	M	2.5	5/7/80 -	-	-	-	Shot by hunter, w/312
313	F	9.5	5/7/80 - 10/13/80	13	0	yes	Active transmitter, probably have cubs in 1981
314	F	1.5	5/7/80 -	-	-	-	Not radioed
315	F	1.5	5/7/80 -	-	-	-	Not radioed

( ) Indicates shed color or dead bear.

snow and may offer the earliest opportunity to forage for vegetable material (previous years berries, spring sedges and other new growth, tubers, etc.).

Preliminary data suggest that many brown bears move to lowland areas soon after emergence from dens. The 1980 capture locations for seven of the nine bears followed to 1980/81 dens was lower than the elevations of the 1980/81 dens. The average elevation difference for these seven bears was 1,266 ft (275-2,370 ft) (Table 7).

The importance of these spring foraging areas will be documented early in the spring of 1981 by following bears as they emerge from their dens. If the same bears that were captured along the river in spring 1980 return to these sites in spring 1981, the hypothesis that the impoundment area is selectively (preferentially) utilized by brown bears early in the spring will be supported. Such results were found in a Montana study (Singer 1978) where grizzly bears were observed to concentrate during spring and fall on the flood plain of the north fork of the Flathead River where they fed on rhizomatous grasses, several key forbs, root and tubers. Singer found this use to be especially marked in years of heavy snowfall.

If such selectivity for Susitna area bears exists, possible effects of the Susitna impoundments, would include:

1. Direct flooding of seasonally important habitats along the river utilized for collection of vegetable foods following emergence from dens.

2. Indirect effects resulting from decline of moose populations and decreased number of winter-killed moose carcasses available for scavenging, or winter-weakened moose available as prey (assumes negative impact of impoundment on moose populations on their winter ranges).

Table 7. Capture and den site locations for brown bears captured in 1980.

Bear Number	USGS Quadrangle	Coordinates			Elevation (feet)
		Township	Range	Meridan	
Capture Sites					
309	Talkeetna Mts.	31N	3E	Seward	2350
308B	Talkeetna Mts.	32N	3E	Seward	3350
315	Talkeetna Mts.	31N	3E	Seward	3250
286	Talkeetna Mts.	31N	4E	Seward	1450
294	Talkeetna Mts.	31N	4E	Seward	1395
283	Talkeetna Mts.	33N	4E	Seward	3875
313	Talkeetna Mts.	33N	4E	Seward	3650
308A	Talkeetna Mts.	30N	5E	Seward	3300
281	Talkeetna Mts.	32N	5E	Seward	2150
282	Talkeetna Mts.	32N	5E	Seward	2100
279	Talkeetna Mts.	32N	5E	Seward	1900
312	Healy	21S	5W	Fairbanks	3350
293	Talkeetna Mts.	29N	6E	Seward	3550
292	Talkeetna Mts.	30N	6E	Seward	3600
299	Talkeetna Mts.	31N	6E	Seward	3040
295	Talkeetna Mts.	32N	6E	Seward	1575
278	Talkeetna Mts.	28N	7E	Seward	3575
277	Talkeetna Mts.	30N	7E	Seward	3050
280	Talkeetna Mts.	30N	8E	Seward	2775
306	Talkeetna Mts.	32N	9E	Seward	2750
214	Talkeetna Mts.	30N	10E	Seward	1950
Den Sites*					
	Talkeetna Mts.	27N	2E	Seward	2700
	Talkeetna Mts.	31N	2E	Seward	2250
	Talkeetna Mts.	33N	4E	Seward	4150
	Talkeetna Mts.	22S	6W	Fairbanks	4750
	Talkeetna Mts.	22S	5W	Fairbanks	4500
	Talkeetna Mts.	22S	4W	Fairbanks	3350
	Talkeetna Mts.	29N	6E	Seward	4000
	Talkeetna Mts.	31N	7E	Seward	3850
	Talkeetna Mts.	30N	7E	Seward	4850

* Bear numbers for den site locations are not included to avoid utilization of this information by hunters in spring 1981.

3. Retardation of plant phenology in the impoundment vicinity. This would result if the impoundment had a cold-body effect on local climate which, in turn, might decrease spring food availability for bears utilizing the impoundment vicinity for spring vegetable foods.

4. Increased snow depths in riparian habitats utilized in the spring might result from any impoundment cold-body effect and cause increased energy expenditures for mobility as well as decreased spring food supplies.

It is possible that any, or all, of the above possibilities might become limiting to bears only in years of heavy snowfall and corresponding later breakup and delayed phenology.

We are aware of little evidence in the literature for a cold-body effect around bodies of water. In brief, it is possible that a large body of water in the fall would act as a heat source delaying the buildup of the snowpack in the vicinity of the impoundment. Similarily, in the spring this same body of water might lower local temperatures enough to delay snowmelt or cause some spring precipitation to fall as snow rather than as rain. Either effect could retard plant phenology to the point where emergence of, potentially critical, early spring vegetation would be delayed. If a cold-body effect of this type eventuates, it would likely be more severe in the vicinity of lakes or impoundments which are completely frozen over in the spring relative to either running water or lakes covered with ice flows.

Preliminary observations of brown bear denning sites in the study area suggest that the proposed impoundments would have little direct impact on the availability of brown bear denning sites. Most brown bear den sites found were well away from the river and at high elevations in the foothills or mountains surrounding the Susitna River (Fig. 2, Table 7). The lowest

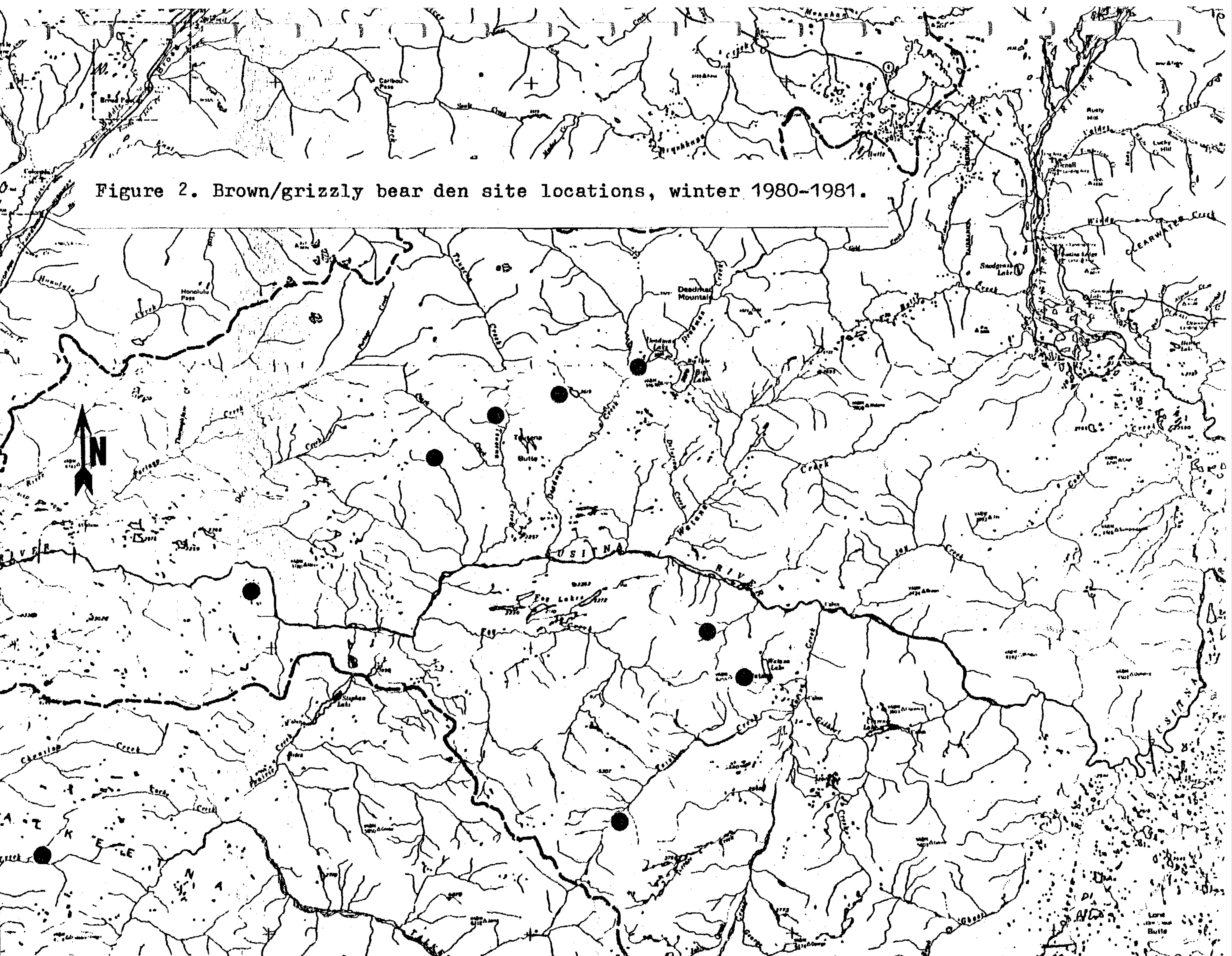


Figure 2. Brown/grizzly bear den site locations, winter 1980-1981.

den and that nearest to the river found was at about 2200 feet elevation about 3 km from the Susitna River, above the height of the Devil Canyon impoundment. Doubtless some brown bears den in areas which would be directly flooded by the impoundments, but this has not yet been documented.

Prairie Creek which flows from Stephan Lake to the Talkeetna River is well known as an area where brown bears concentrate in July and August to feed on salmon, especially king salmon (Fig. 3). Alaska Department of Fish and Game sport fisheries biologists characterize Prairie Creek as having one of the highest concentrations of spawning king salmon in the Cook Inlet region (Larry Engle, pers. comm.). In July, four radio-collared brown bears (of 11 with active collars) moved to Prairie Creek to fish for salmon. The first of the radio-collared bears that moved to Prairie Creek was G294, a large male. He was in the Fog Creek area on June 23 but had moved to Prairie Creek by July 2 and remained there until August 22; he was next seen near Chunilna Creek in October. Other radio-collared bears that moved to Prairie Creek in July and August were G308B, G293, and G283 (Fig. 3). On August 10, past the King Salmon peak, a minimum of 13 brown bears were verified as using Prairie Creek (4 marked adults, 7 unmarked adults and 2 cubs); local residents have reported seeing 20 bears at one time on Prairie Creek. Our guess is that 30-40 individual brown bears fished in this area in the summer of 1980.

The importance of the Prairie Creek salmon run to study area brown bears will be difficult to evaluate. Other studies (Miller and Ballard 1980) indicate that moderately dense brown bear populations exist in the Nelchina Basin without access to salmon. However, it is possible that the availability of this interior run of salmon might provide nutritional benefits that result in local bear populations that are more dense or less nutritionally stressed (larger individuals) than adjacent

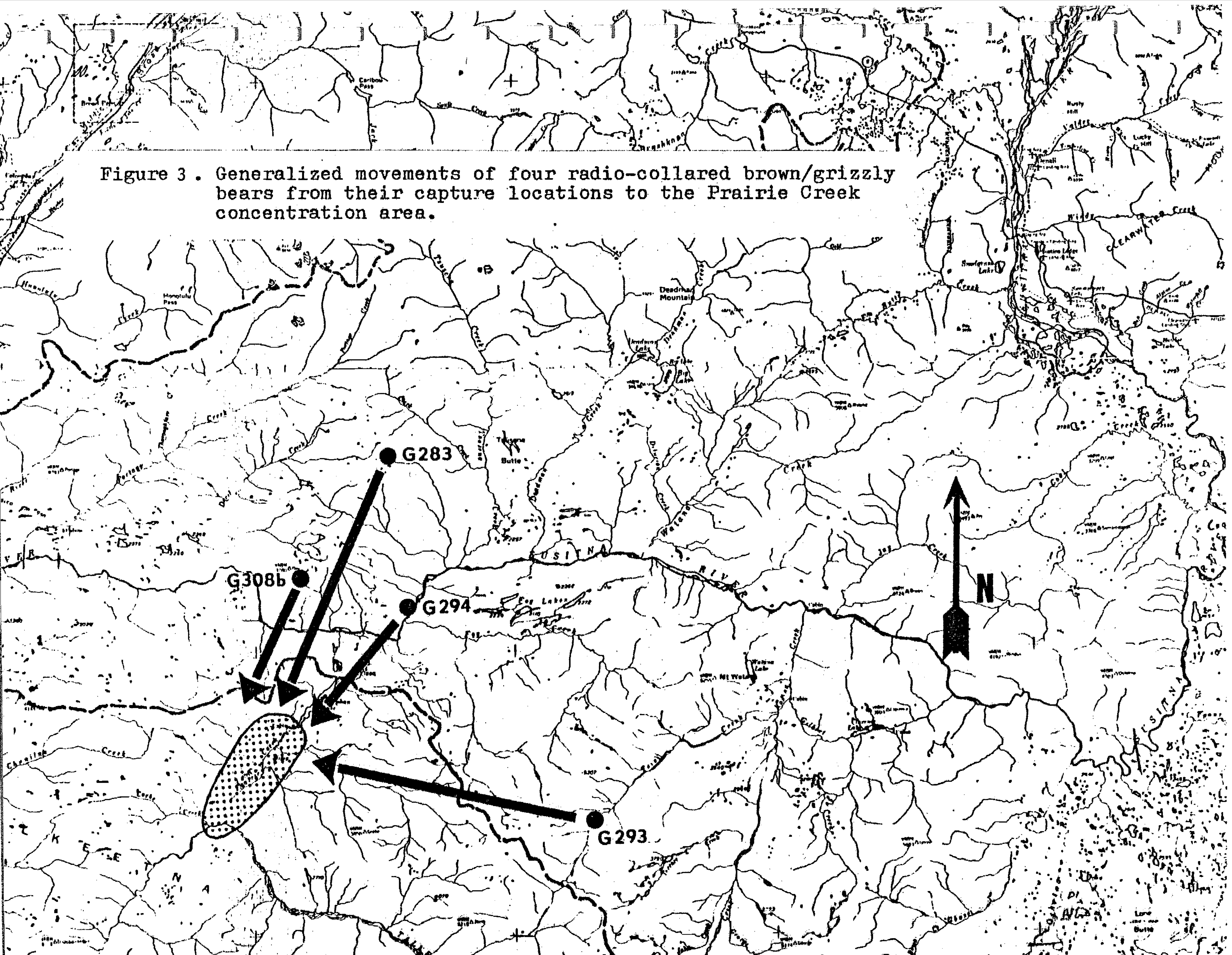


Figure 3 . Generalized movements of four radio-collared brown/grizzly bears from their capture locations to the Prairie Creek concentration area.

populations without access to a salmon run. Preliminary conversations with sport fish biologists (ADF&G) suggest that Prairie Creek salmon runs are unlikely to be negatively affected by the proposed impoundments, however specific salmon studies will not be completed for 5 years. Assuming the proposed dams have no impact on the strength of the salmon run in Prairie Creek, the main impact the proposed construction might have on bear movements is a physical blocking of seasonal movements to Prairie Creek.

All of the radio-collared bears seen at Prairie Creek had portions of their home ranges north of the Susitna River and therefore had to cross the river enroute to or from Prairie Creek. The maximum number of times an individual brown bear was known to have crossed the Susitna River in 1980 was five (Table 6). It is unknown whether the body of water in the proposed impoundments would, in themselves, represent a significant barrier to bear movements, however this possibility cannot be discounted. In addition, the strangeness of mud banks created by fluctuating water levels (if such occurs in mid summer) might represent an equal or greater barrier, perceived or real, to bear movements across the impoundment. Heavily traveled access roads to the impoundments might also inhibit or block bear movements across these roads; any access road built from the Parks Highway to the Watana damsite would have to be crossed by some bears moving to or from the Susitna River and Prairie Creek. Observations of homing brown bears being deflected, both permanently and temporarily, by large strange river beds and highways have been reported in Alaska (Miller and Ballard 1981). On the Alaska Peninsula, Lee Glenn (ADF&G pers. comm.) has observed movements of up to 50 km by bears enroute to McNeil River to fish for salmon. In our 1980 studies, the farthest a Prairie Creek bear (G293) was seen from Prairie Creek was approximately 100 km northeast of Prairie Creek.

The history of brown bear populations in areas of increasing human activity and impact suggests that declines of brown bear populations may be an inevitable result of such changes (Cowan 1972, Herrero 1977). This is the result of a combination of factors including: Direct declines resulting from hunting and defensive kills which may be augmented by improved access and concentrated sources of unnatural foods, behavioral changes to avoid areas of increased human activity, direct destruction of habitat, and man-made barriers which inhibit seasonally important movements.

Brown Bear Density

Determination of the number of bears in the Susitna study area was defined as a major object of the impact assessment study. Bear population estimates are exceptionally difficult and expensive to obtain and it is unlikely that an accurate estimate will be achieved with the funds available for Phase I bear studies. An imprecise estimate may be obtainable from radio-tracking determinations of home range size coupled with an estimate of the proportion of the population which is radio-collared. The precision of such estimates increases as the proportion of the population which is radio-collared increases. Because of the apparent abundance of brown bears in the Susitna study area and because of the large home range sizes of Nelchina brown bears (average=570 km^2, range=192-1,380 km^2, Miller and Ballard 1980), it will be expensive to obtain a precise estimate.

An imprecise estimate of brown bear density was obtained from intensive trapping and mark-recapture techniques conducted in the Susitna River headwaters in 1979 (Miller and Ballard 1980). This estimate is compared with other North American estimates in Table 8.

Table 8. Reported brown bear densities in North America.

mi^2/bear	km^2/bear	Location	Source
0.6	1.6	Kodiak Island, AK	Troyer and Hensel 1964*
6.0	15.5	Alaska Peninsula, AK	Unpublished data (Glenn pers. comm.)**
8.2	21.2	Glacier Nat. Park, Montana	Martinka 1974*
11.0	28.5	Glacier Nat. Park, B.C.	Mundy and Flook 1973*
9-11	23-27	SW Yukon Territory	Pearson 1975*
16-24	41-62	Upper Susitna R., AK	Miller and Ballard 1980
88(16-300)***	288(42-780)***	Western Brooks Range (NPR-A), AK	Reynolds 1980
100	260	Eastern Brooks Range, AK	Reynolds 1976

* Taken from Pearson 1975.

** Data refer to a 1800 mi^2 intensively studied area of the central Alaska Peninsula.

*** Mean is for the whole of the Nat. Pet. Reserve, AK, the range represents values for different habitat types in this reserve where the highest density occurred in an intensively studied experimental area.

Based on this density estimate of 1 bear/41-62 km^2, the Susitna study area of 3,500 km^2 would have a population of 56-85 brown bears. It is our subjective evaluation that brown bear density in the Susitna study area is more likely to be higher than that estimated in our earlier study, rather than lower. However, using the midpoint of this estimate, 70 bears, it can be seen that only approximately 37 percent of the bears inhabiting the study area have been captured and that only 15 percent are currently radio-collared. An accurate density estimate may be obtainable only when escentially all brown bears utilizing the study area have been captured and marked.

Black Bear Seasonal Distribution and Movements

Relocations in 1980 for 23 radio-collared black bears (excluding offspring and sequential relocations at the same den site) totaled 181 points (Table 9). For the 16 bears with active radios prior to October 1980, 143 relocations were obtained (4-19 per individual) (Table 9). Dens were located for 14 of these 16 bears. The two black bears without den site locations had not been found since early September 1980, possibly their radios failed. Sightings of unmarked black bears totaled 48, yielding a total of 229 point locations for black bears in 1980. Complete analysis of this point location data will be delayed until digitization is completed and more points are available, only general and preliminary conclusions from these data will be presented here.

Black bear distribution in the study area primarily was confined to a finger of habitat along the Susitna River and its major tributaries. This finger becomes progressively narrower and supports fewer bears as one procedes upstream. We did not see black bears from Kosina Creek to Clarence Creek, however reports indicate that their distribution is continuous to the mouth of the Oshetna River. Small numbers occur upstream at least as far as the confluence of the Tyone and Susitna Rivers.

Table 9. Number of black bear relocation records in 1980 - Susitna Hydro Project.

Brown Bear #	Sex	1980 Age at capture	Capture Date- Last Location	Number Relocations	No. River Crossings	80/81 Den Located	Status
287	M	10.5	5/1/80 - 10/13/80	15	0	yes	Active transmitter
(288)	F	10.5	5/1/80 - <8/27/80	15	0	-	Collar shed
289	F	9.5	5/2/80 - 10/13/80	13	4	yes	Active transmitter, bear had ylg. cubs when captured probably have new cubs in 1981
290	F	8.5	5/2/80 - 10/13/80	19	4	yes	Active transmitter,bear had ylg. cubs until 6/12/80
(291)	M	3.5	5/2/80 - 7/20/80	5	0	-	Bear died between 7/20 and 7/28
(296)	M	10.5	5/3/80 -	-	-	-	Capture mortality
(300)	M	7.5	5/4/80 -	-	-	-	Possible capture-induced mortality
301	F	7.5	5/4/80 - 10/13/80	19	2	yes	Active transmitter, ylg. abandoned by 6/23/80
(302)	M	8.5	5/4/80 - <8/4/80	5	0	-	Collar shed
303	M	7.5	5/4/80 - 9/9/80	14	2	no	Possible collar failure, recaptured on 8/19/80
304	M	10.5	5/4/80 - 9/9/80	14	0	no	Possible collar failure
(305)	M	9.5	5/5/80 - 8/30/80	8	2	-	Killed by hunter
307	M	2.5	5/5/80 -	-	-	-	Not radioed
310	M	2.5	5/6/80 -	-	-	-	Not radioed
(316)	F	12.5	5/7/80 - 8/28/80	3	0	-	Killed by hunter on 8/28/80,collar not working
317	F	7.8	8/18/80 - 10/13/80	5	0	yes	Active transmitter, had cubs (adopted from 326?) in 1980, cubs prob. in den
318	F	5.8	8/18/80 - 10/13/80	5	0	yes	Active transmitter, had 1 cub in 1980, cub should be in den
319	M	3.8	8/18/80 - 10/13/80	5	4	yes	Active transmitter
(320)	M	4.8	8/18/80 - 9/9/80	0	1	-	Killed by hunter 9/9/80, 45 mi south
321	F	10.8	8/18/80 - 10/13/80	5	0	yes	Active transmitter
322	M	4.8	8/19/80 - 10/13/80	4	0	yes	Active transmitter
323	M	2.8	8/18/80 - 10/13/80	5	2	yes	Active transmitter
324	M	5.8	8/19/80 - 10/13/80	5	0	yes	Active transmitter
325	F	11.8	8/18/80 - 10/13/80	5	0	yes	No cubs seen in 1980
(326)	F	5.8	8/19/80 - 8/28/80	2	0	-	Killed by hunter 8/28/80, had cubs when captured, poss. adopted by #317
327	F	5.8	8/19/80 - 10/13/80	5	1	yes	Active transmitter, probably has 2 cubs in den
328	F	6.8	8/19/80 - 10/13/80	5	0	yes	Active transmitter, may have newborn cubs in 1981

( ) Indicates dead bear or shed collar.

Within the study area black bear numbers appeared to be much higher on the north side of the Susitna River than on the south side. In the spring it is reasonable to speculate that this preference may result from relatively advanced plant phenology on the south-facing slopes along the north side of the river. However, the north side of the river apparently was preferred throughout the rest of the summer as well, reasons for this are unclear.

Black bears are well known to be primarily restricted to forested biomes; this may be because trees are needed to avoid predation on cubs (Herrero 1972). The distribution of black bears in the study area follows this pattern. Especially in upstream portions of the study area, srpuce-forested habitats are primarily restricted to the vicinity of the Susitna River and its major tributaries, black bears were seldom observed very far from these spruce habitats. Black bears occur farther from the Susitna River in downstream portions of the study area, an apparent correlation with the equivalent wider distribution of spruce forests downstream relative to upstream.

No quantitative data are yet available on the proportion of black bear range which is forested, therefore selectivity or preference for forested areas in the study area cannot yet be demonstrated. However, a preliminary and superficial analysis of the number of point locations of radio-collared bears which occurred in spruce habitats (habitat categories 1-9) and non-spruce habitats was attempted (Table 10). As can be seen, black bears were most commonly found in spruce forested habitats in the spring (72% of the point locations in May) and least commonly found in these habitats in September (35% of the point locations) (Table 10). Throughout the year 55 percent of the point locations occurred in spruce habitats. These data probably underrepresent the importance of spruce habitats to black bears as many observations classified as in non-spruce habitats were in close enough proximity to spruce habitats that

Table 10. Monthly occurrence in spruce habitats for 23 radio-collared black bears in the Susitna study area (capture and den sites not included).

Month	No. Observations In Spruce Habitats	In Non-Spruce Habitats	In Unspecified Habitats	Total	% In Spruce Habitats
May	23	9	2	34	72
June	17	9	1	27	65
July	11	14	0	25	44
August	28	24	1	53	54
September	9	17	0	26	35
Totals	88	73	4	165	55

these habitats were readily available to the bear should they be needed for escape or other purposes. This situation can be clarified when vegetation maps become available.

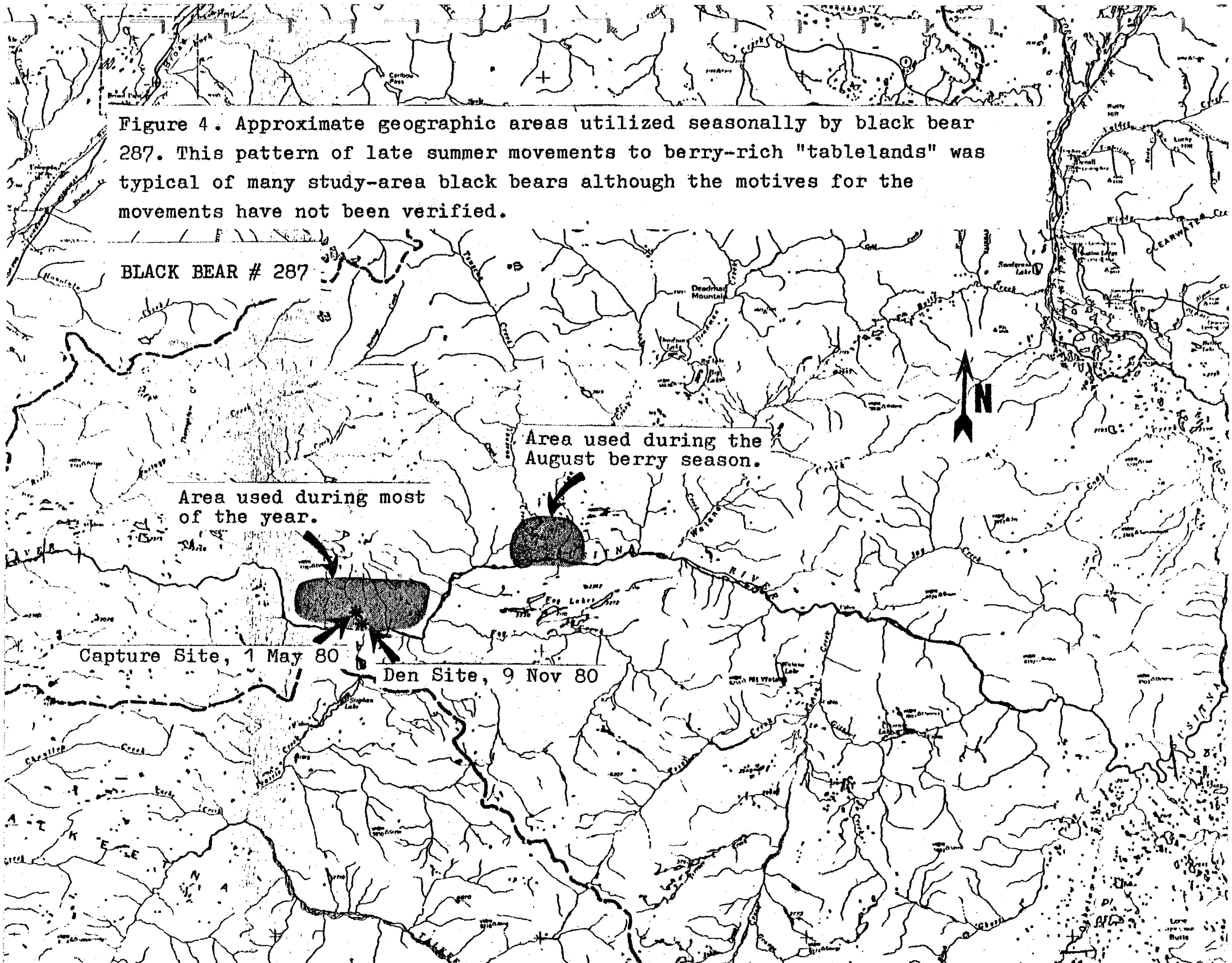
From the perspective of a black bear it is evident that not all spruce forests in the study area are created equal. Some areas are much more densely populated by black bears than others that appear equivalent with respect to the superficial appearance of the spruce component. An example of this is the apparent preference of black bears for the north side of the Susitna River, mentioned above. Detailed analyses of vegetation composition in these stands as well as food habits studies and, perhaps, behaviorial studies will be necessary to identify the habitat components which govern black bear distribution and abundance.

Data collected to date suggest that black bears are found least frequently in spruce habitats in late summer (July-September) (Table 10). At this time black bears increasingly concentrated on the tablelands between the Susitna River spruce habitats and the nearby foothills to the north. Observations as well as feces collected in August 1980 suggest that bears were seeking the ripening berries (*Vaccinium* spp.) which appeared much more abundant on the tablelands than in the spruce forests.

The most important tableland areas identified included the area around the Watana campsite, between Tsusena Creek and Delusion Creek, and the uplands between Devil Creek and Tsusena Creek, especially the eastern portion of this area (T31-32N/R4E). At the time black bears were using these tablelands, brown bears occurred primarily at higher elevations.

Black bears do use the south side of the Susitna River. They were occasionally located on the Fog Lakes Plateau and other areas, but data collected to date suggest the south side of the river is not preferred. One unmarked black bear was seen about

Figure 4. Approximate geographic areas utilized seasonally by black bear 287. This pattern of late summer movements to berry-rich "tablelands" was typical of many study-area black bears although the motives for the movements have not been verified.



1 mile from Prairie Creek on August 4, however, Prairie Creek salmon do not appear to be an important food source for Susitna area black bears. Possibly the abundance of brown bears around Prairie Creek during the salmon run deters black bears. Residents of Stephan Lake Lodge report that they have not seen black bears along Prairie Creek during the salmon run.

Of the black bears with four or more radio-locations, eight crossed the Susitna River at least once during 1980 and 12 had no crossings documented (Table 9). Three black bears were documented to have crossed the river four times (Table 9). Black bears crossed the river more frequently than brown bears and a higher proportion of the black bear population crossed the river. This was not unexpected as all radio-collared black bears were in the immediate vicinity of the Susitna River while the home ranges of many brown bears were not adjacent to the River. Reasons for frequent river crossings by black bears and the importance of those crossings to the bear population are not known.

Black bear den sites were located only from the air (Fig. 5, Table 11). Den characteristics, including exact elevation, slope, aspect, habitat-type, will be recorded from the ground after the bears have left. However, our aerial locations indicated that most black bear dens were below or near the proposed high water mark of the proposed impoundments (2,200 feet for the Watana dam and 1,450 feet for the Devil Canyon dam). All five of the radio-collared black bear dens in the impact area of the proposed Watana impoundment were below the impoundment level (average elevation=1,925 ft, range=1,750-2,000 ft). Two of the nine black bears denning in the impact area of the Devil Canyon impoundment had dens apparently below the impoundment level (average elevation=1,935 ft, range=1,300-2,750 ft).

Figure 5. Black bear den site locations, winter 1980-1981.

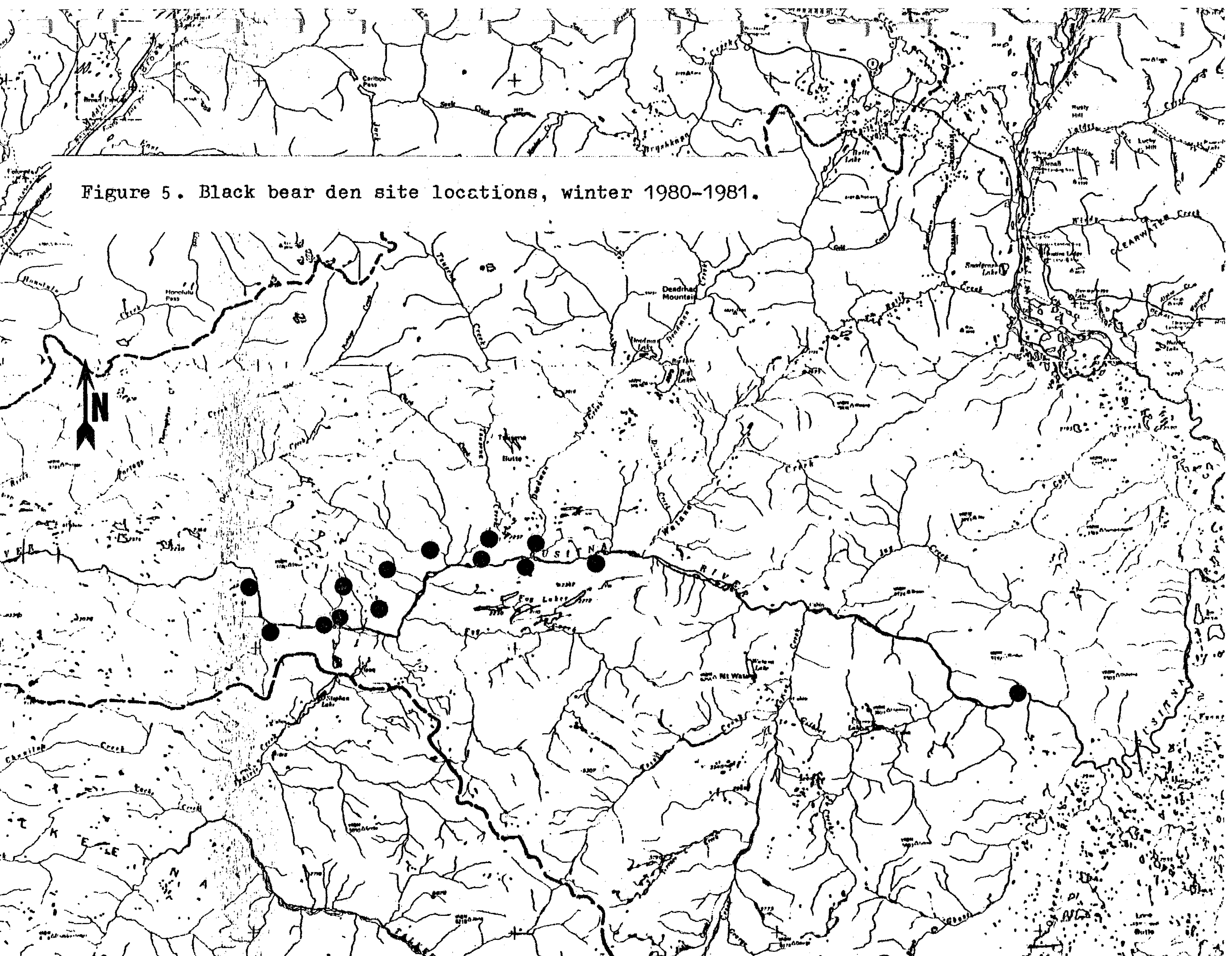


Table 11. Capture and den site locations for black bears captured in 1980.

Bear Number*	USGS Quadrangle	Township	Range	Meridan	Elevation (feet)
Capture Sites					
B287	Talkeetna Mts.	31N	3E	Seward	1850
B288	Talkeetna Mts.	31N	3E	Seward	1950
B289	Talkeetna Mts.	32N	5E	Seward	2050
B290	Talkeetna Mts.	31N	2E	Seward	1900
B291	Talkeetna Mts.	32N	5E	Seward	1625
B300	Talkeetna Mts.	30N	10E	Seward	2450
B296	Talkeetna Mts.	30N	10E	Seward	2850
B301	Talkeetna Mts.	30N	10E	Seward	2250
B302	Talkeetna Mts.	31N	8E	Seward	1850
B303	Talkeetna Mts.	32N	4E	Seward	2225
B304	Talkeetna Mts.	32N	4E	Seward	2225
B305	Talkeetna Mts.	33N	5E	Seward	2150
B307	Talkeetna Mts.	33N	4E	Seward	2350
B310	Talkeetna Mts.	31N	3E	Seward	2400
B316	Talkeetna Mts.	32N	4E	Seward	1750
B317	Talkeetna Mts.	32N	5E	Seward	2260
B318	Talkeetna Mts.	31N	4E	Seward	2025
B319	Talkeetna Mts.	31N	4E	Seward	1990
B320	Talkeetna Mts.	31N	4E	Seward	2400
B321	Talkeetna Mts.	31N	3E	Seward	2350
B322	Talkeetna Mts.	32N	6E	Seward	2375
B323	Talkeetna Mts.	32N	5E	Seward	2225
B324	Talkeetna Mts.	32N	5E	Seward	2400
B325	Talkeetna Mts.	31N	3E	Seward	2150
B326	Talkeetna Mts.	32N	5E	Seward	2400
B327	Talkeetna Mts.	32N	5E	Seward	2200
B328	Talkeetna Mts.	32N	5E	Seward	2225
Den Sites					
B287	Talkeetna Mts.	31N	3E	Seward	1750
B289	Talkeetna Mts.	32N	6E	Seward	1950
B290	Talkeetna Mts.	31N	3E	Seward	1850
B301	Talkeetna Mts.	30N	10E	Seward	2000
B317	Talkeetna Mts.	32N	4E	Seward	1850
B318	Talkeetna Mts.	32N	4E	Seward	2500
B319	Talkeetna Mts.	31N	2E	Seward	1300
B321	Talkeetna Mts.	31N	3E	Seward	2750
B322	Talkeetna Mts.	32N	5E	Seward	1950
B323	Talkeetna Mts.	32N	5E	Seward	1750
B324	Talkeetna Mts.	31N	4E	Seward	2190
B325	Talkeetna Mts.	31N	5E	Seward	1500
B327	Talkeetna Mts.	32N	5E	Seward	1975
B328	Talkeetna Mts.	32N	5E	Seward	1725

All of the dens in the vicinity of the proposed Watana impoundment are in spruce habitats along the river or tributaries such as Deadman Creek, and four of the nine black bear dens in the vicinity of the Devil Canyon impoundment are in spruce habitats along the river or tributaries such as Tsusena Creek.

Black bear denning sites may be influenced by human activities, notably access routes, as well as by direct inundation by impoundments.

Any conclusions based on the available data must be considered extremely tentative. However, the narrow finger like distribution of black bears and the apparent strong correlation between bear numbers and certain gross habitat characteristics suggests that the amount of acceptable black bear habitat in the area is very limited. Much of this habitat, particularly the portion used in spring, would be inundated by proposed impoundments. Any remaining habitat could be indirectly affected if the "cold body" effect discussed above becomes a factor.

Future studies should be directed at identifying habitat components critical for black bears and assessing the availability of these components outside of proposed impoundment areas. Such critical components may vary between years. For example a food source used only lightly during years of abundant berries, might be critical in years of berry crop failure.

Black Bear Density

No black bear density estimates are available from the study area or adjacent areas. Our subjective impression is that portions of the study area were very densely populated by black bears relative to other Alaskan habitats. The only available data that permit even a crude density estimate come from sightings of marked and unmarked black bears during the August tagging operation.

In 1½ days of spotting effort (August 18-19), 35 bears were seen in approximately 259 km^2 of search area, four of these were marked. A radio-tracking effort on August 14 verified the presence of seven radio-collared black bears in the search area. A straightforward Lincoln Index on these observations yields an approximation of 61 bears in this area or 1 bear/4.1 km^2. An "adjusted" index (Richer 1975) yields an estimate of 58 bears (s.d.=19). These estimates should be viewed cautiously as there are many possible sources of bias in the technique and it covers only a small portion of the study area at a season when bears might have concentrated in search of a locally abundant food source. Regardless, the density estimate of 4.1 km^2/bear falls roughly at the mid-point of reported black bears densities in North America (Table 12). Our subjective evaluation is that further studies in the Susitna study area are more likely to reveal that the above density approximation is too low rather than too high, at least in the habitats where black bear density is highest.

Needs For Further Study

A larger proportion of bear populations in the study areas must be radio-collared in order to clearly establish seasonal use patterns and more accurately estimate density. This process will continue throughout the remainder of Phase I and into Phase II. The most cost-effective time to capture black bears is in early August when black bears appear to be most visable and vulnerable to capture. At this same time efforts should be made to mark black bears in portions of the study area where bears appear to be less dense, noteably from Watana Creek to the gaging station. This will provide a more complete perspective of black bear populations and movements in the

Table 12. Densities of black bears as estimated in studies conducted in different localities (adapted from Modafferi 1978).

Source	Location	mi^2 Per Bear	km^2 Per Bear
McIlroy (1972)*	Alaska (coastal population)	0.1	0.3
Lindzey and Meslow (1977)	Washington (an island population)	0.3	0.8
Poelker and Hartwell (1973)	Washington (mainland population)	0.7-1.0	1.8-2.6
Piekielek and Burton (1975)	California	0.8-1.0	2.1-2.6
Beecham (1980)	Idaho (Councial area)	0.8	2.1
	Idaho (Lowell area)	0.9	2.3
Jonkel and Cowan (1971)	Montana (Bear Creek)	0.8-1.7	2.1-4.4
LeCount (1980)	Arizona	0.8	2.1
Pelton and Burghardt (1976)	Tennessee	0.5-1.0	1.3-2.6
Kemp (1972)	Alberta	1.0	2.6
Modafferi (1978)	Prince William Sound, Alaska	1.2	3.1
Erickson and Petrides (1964)	Michigan	3.4	8.8
Spencer (1955)	Maine	5.6	14.5
Clarke (1977)	New York (Adirondacks)	2.6	6.7
	New York (Catskill)	3.7	9.6
	New York (Allegany State Park)	10.0	25.9

* Probably estimated during seasonal concentration.

vicinity of the whole impoundment-impact area. Brown bear tagging efforts will be most effective in early spring (April-May).

An effort is planned for August 1981 to directly and intensively census areas of high black bear density and thereby to refine Lincoln Index density estimates.

Black bear and brown bear dens will be visited and marked in the winter of 1980/81 for subsequent studies of den site characteristics. Radio collars will be replaced at this time for some black bears and some yearling black bears will be collared with experimental expandable radio collars to document foci of black bear dispersal.

Both species will be intensively monitored following emergence from dens in order to document suggested intensive early spring usage of south-facing slopes along the river.

Bear feces will be collected whenever encountered, and the precise location where feces were found recorded. Feces will be analyzed to evaluate seasonal food habits during Phase II if funds are available. Preliminary tests on a chromatographic technique (Major et al. 1980) which may be useful in separating black bear feces from those of brown bear are presented in Appendix A.

The apparent heavy utilization by black bears of riparian habitats in the immediate vicinity of the Susitna River strongly suggests that downstream bear studies may be needed in Phase II. Under impoundment regulation procedures which would restrict periodic flooding and corresponding vegetational changes, the potential for downstream impacts on bears, especially black bears, cannot be ignored. Seasonal selection by bears for early successional, riparian habitats has been reported for brown bears in Montana (Singer 1980), black bears in Montana (Tisch 1961) and black bears in California (Kelleyhouse 1980).

Continuity of data on the same animal throughout both phases of the study is highly desirable. Radio collars placed on bears during 1980 have a maximum life span of 24 months and can not be expected to last until the start of Phase II. Therefore, recollaring for Phase II studies should be done during 1981. These collars should be ordered by March 1981.

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Appendix A. Preliminary results testing technique to chemically differentiate between scats of black and brown bear.

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A technique for identification of field collected carnivore scats by recovery of bile acids through thin-layer chromatography (TLC) has recently been developed (Major et al. 1980). This method was applied to known samples of brown bear and black bear feces, two types of scats which cannot be distinguished visually. Samples from two brown bears and three black bears were used in the preliminary experiment. Samples were prepared for TLC according to Major et al. (1980) and the plates were examined under long-wave (366 nm) and short-wave (254 nm) ultraviolet light as well as visually under white light. Because of the lack of bile acid standards, along with other limitations due to the preliminary testing aspect of the experiment, results obtained were necessarily tentative. Nevertheless, results indicate possible differences between the two scat types. Further experimentation to fully delineate the nature of bile acid differentiation between brown and black bear fecal samples is recommended.

Three compounds with Rf values (ratio of the distance the solute moved to the distance traveled by the solvent front) comparable to Rf values of known bile acids (Major et al. 1980) were found on the test TLC plates. These were lithocholic acid (Rf = 0.75), chenodeoxycholic acid (Rf = 0.47) and cholic acid (Rf = 0.15). Two other unidentified compounds located on the bear scat test plates had Rf's comparable to unidentified compounds listed by Major et al. (1980): Rf = 0.87 (brown and black bear) and Rf = 0.72 (brown bear). In addition, all samples tested showed a compound with an Rf value of 0.06, and both brown bear samples showed a compound with an Rf of 0.97.

Of the components corresponding in Rf value to those of known bile acids, the black bear samples showed lithocholic acid; brown bear samples showed chenodeoxycholic acid, and both types showed cholic acid. Further testing is needed to determine what, if any, variation exists within species, and also to determine if the above indications are independent of diet. Tentative results indicate that the presence of chenodeoxycholic acid in brown bears and the presence of lithocholic acid in black bears may be a key to identification.

Brown bear samples showed a component (Rf = 0.97) which did not appear in the black bear samples. While Major et al. (1980) stated that compounds traveling above lithocholic acid (Rf = 0.75) were probably not bile acids, this component may still provide an identification key if found to be constant within the species and absent within black bears.

The differences between the two scat types are presented in Table 1. The most striking aspects between brown and black bear samples tentatively appear to be the presence of chenodeoxycholic acid (Rf = 0.47) and two unidentified compounds (Rf = 0.72 and 0.97, respectively) in brown bears with a corresponding absence in black bear; and the presence of lithocholic acid (Rf = 0.75) in black bears with a corresponding absence in brown bear scats.

Summary of TLC results on bile-acid and unidentified steroid recovery, brown and black bear fecal samples.

	Rf	Brown Bear	Black Bear
Unidentified	0.06	X	X
Cholic Acid	0.15	X	X
Chenodeoxycholic Acid	0.47	X	
Unidentified	0.72	X	
Lithocholic Acid	0.75		X
Unidentfied	0.87	X	X
Unidentified	0.90	X	X
Unidentified	0.97	X	

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SUSITNA HYDROELECTRIC PROJECT
ANNUAL PROGRESS REPORT

BIG GAME STUDIES

PART VII SHEEP

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ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the
Alaska Power Authority

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SUMMARY

An aerial survey of known or suspected Dall sheep habitat in the vicinity of the proposed Susitna Hydroelectric Project was conducted in July 1980 to delineate sheep distribution. Three discrete areas of habitat were identified. Sheep in all three areas may be subject to disturbance from construction activities, helicopter traffic or access routes although disturbance may be reduced or eliminated through routing or scheduling of human activities.

Sheep occupying the Watana Creek hills were observed in habitat that might be inundated by the proposed Watana impoundment. Little is known about the importance of this habitat to the population but it is possible that some attractant such as a mineral lick occurs there. If so, assessment of the impact of the Susitna Project on this sheep population will be more complex than anticipated and an expansion of the scope of the study will be necessary.

INTRODUCTION

Dall sheep (*Ovis dalli*) are known to occupy all portions of the upper Susitna River Basin which contain extensive areas of habitat above 4000 feet elevation (Alaska Dept. of Fish and Game 1973). Three such areas lie close enough to proposed Susitna Hydroelectric Project impoundment areas that they may be impacted by the project. These areas are the Portage - Tsusena Creek drainages, the Watana Creek Hills (east of Watana Creek) and Mount Watana including the hills to the southwest.

Because Dall sheep usually are found at elevations above 3000 feet, the most likely adverse impact of the Susitna Hydroelectric Project appeared to be disturbance from construction activities and access roads. As a result the scope of this study was limited to a determination of the seasonal distribution and abundance of sheep adjacent to the proposed impoundments.

The study area includes all drainages flowing into the Susitna River from Gold Creek to Kosina Creek on the south and to the Denali Highway on the north. Survey efforts were confined to three areas of known or suspected Dall sheep habitat within this area however (Fig. 1).

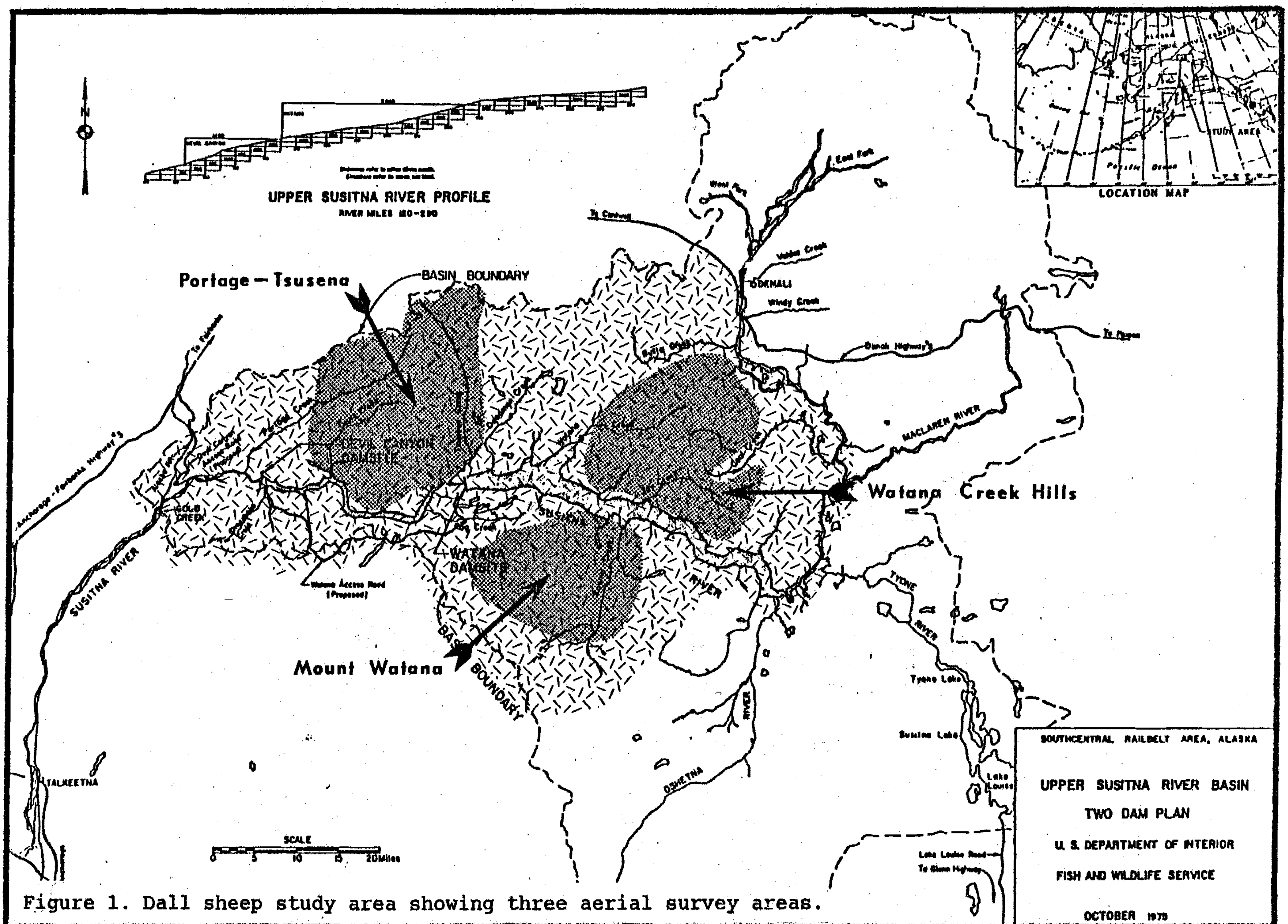


Figure 1. Dall sheep study area showing three aerial survey areas.

METHODOLOGY

Sheep observations were solicited from all Susitna study participants. Date, location, number, sex and age of all sheep observed and subsequently reported were recorded on 1:63,360 U.S.G.S. topographic maps. Winter and spring observations were especially requested because they show seasonal distribution and in some instances, habitat use.

An aerial survey was conducted with a PA-18 Super Cub on 22 and 23 July 1980 in an effort to determine sex and age composition and summer distribution. Sixteen hours were spent surveying sheep. All observed sheep were identified as to number, sex, age class, and locations were plotted on 1:63,360 U.S.G.S. maps. Methods used during the survey were typical of those used to survey sheep elsewhere in Alaska (McKnight and Hinman 1980).

RESULTS AND DISCUSSION

Watana Hills

The Watana Hills were established as a population trend count area in 1967 by ADF&G and have been counted seven times since then. The 1980 count of 174 sheep is higher than the 7 year average of 160 sheep (Table 1). If the low count of 76 sheep in 1974 is eliminated, the 6 year average is 175, suggesting that population numbers have remained stable. Also, the percentage of legal rams and lambs were similar. Some yearly variation is expected in count data because differences in observers and counting conditions and minor population fluctuations.

The distribution of sheep observed in the Watana Creek Hills trend count area on 22 July is presented in Figure 2. Sheep were generally widespread and all were at elevations above 3000 feet. Sheep distribution is likely to be more restricted during winter when deep snow and ice make portions of their range inaccessible. We would expect greater use of lower elevations, south facing slopes and windswept areas during winter. A late February or early March 1981 survey is planned to document winter distribution.

Several observations suggest significant use of habitat that may be directly impacted by the Watana impoundment. Three sheep observations reported in June 1980 were near the 2200 foot elevation on Jay Creek (Fig. 3). One group consisted of 23 animals or 13 percent of the number sheep counted in July. Other observations at the same time of year were near the 3000 foot level. The significance of these sightings is not known however sheep often use mineral licks at that time of year. Some licks profoundly influence sheep distribution and movements (Heimer 1973). Two other licks have been identified in the area (Fig. 3) but little is known of their use. Therefore, further investigation of sheep use of Jay Creek is warranted.

Table 1. Compilation of highest yearly counts completed in Watana Hills sheep trend count area.

	Legal Rams*	Lambs	Total	% Legal Rams	% Lambs		
1950			0			Scott	
1967	--	--	220	--	--	Nichols	
1968	--	--	183	--	26.6	Nichols	Aug.
1973	10	40	176	5.6	22.7	McIlroy	Aug. 1973
1974	6	18	76	7.9	23.7	Harkness	April
1976	4	30	130	3.1	23.0	Eide	Aug.
1977	4	33	152	2.6	21.7	Spraker	July 11
1978	5	34	189	2.6	18.0	Eide	July 23
1980	9	42	174	5.1	24.1	Tobey	July 22

* A legal ram is defined as having a 3/4 curl or greater horn.

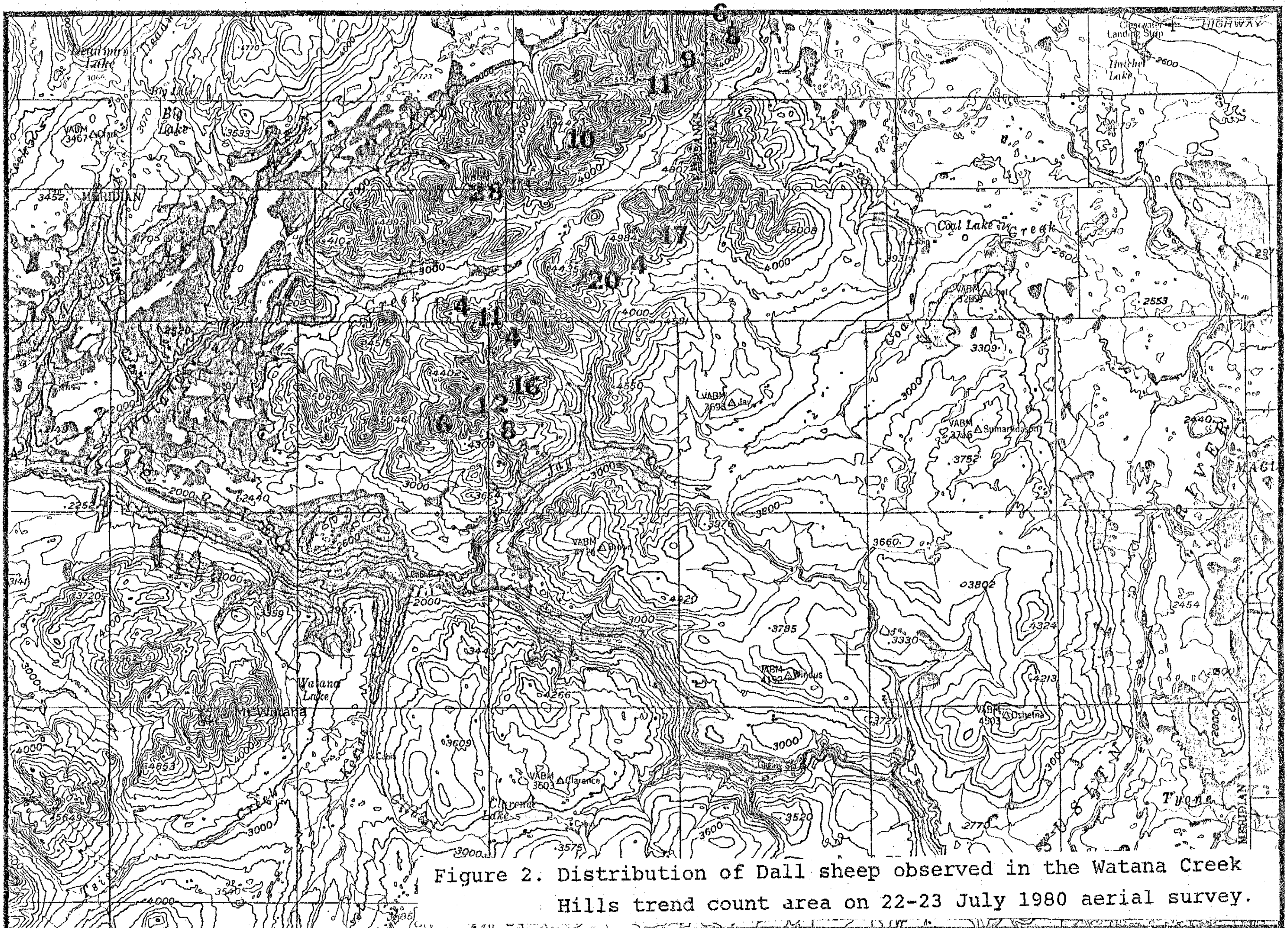


Figure 2. Distribution of Dall sheep observed in the Watana Creek Hills trend count area on 22-23 July 1980 aerial survey.

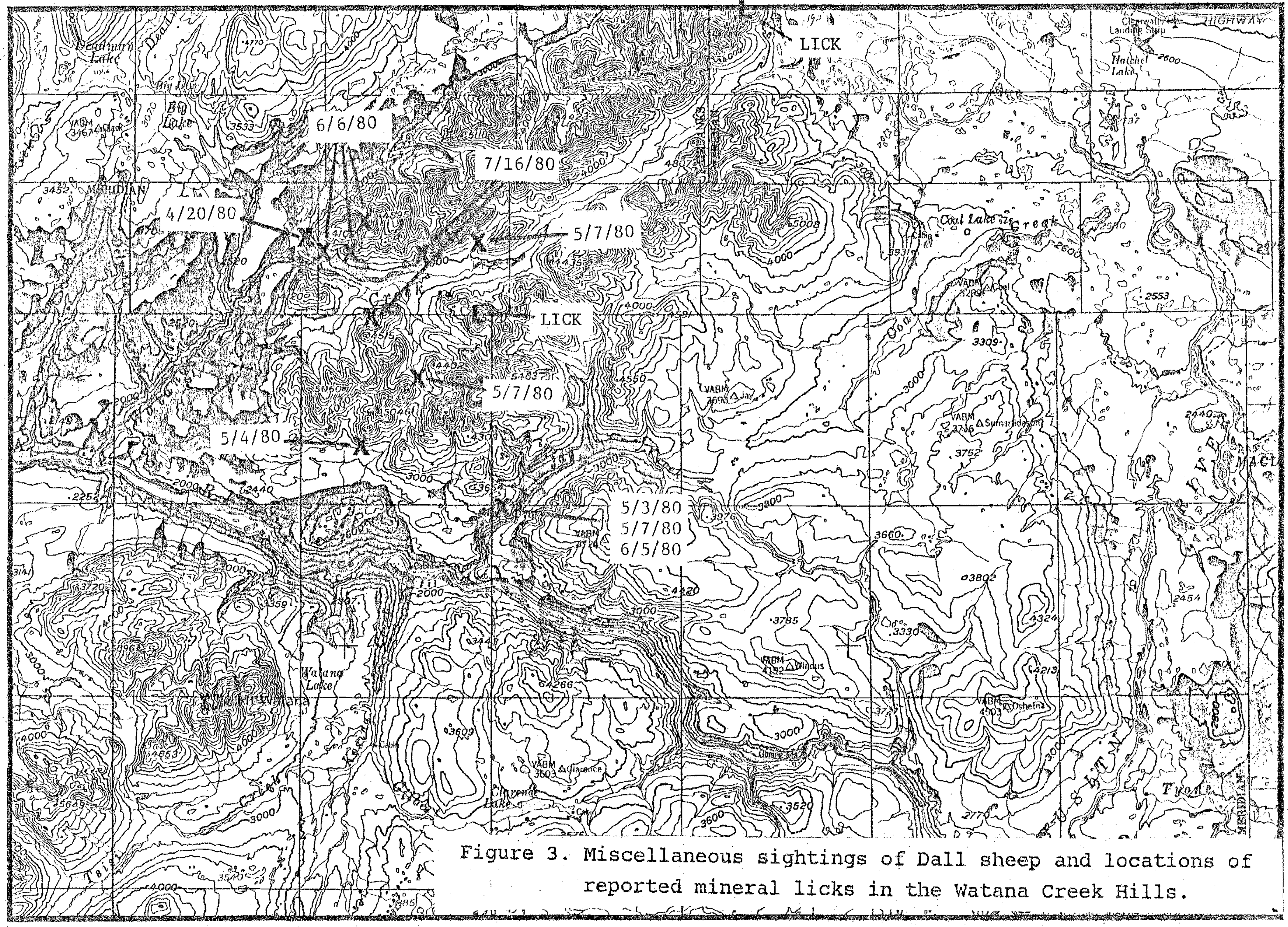


Figure 3. Miscellaneous sightings of Dall sheep and locations of reported mineral licks in the Watana Creek Hills.

Mount Watana

An intensive search from Mt. Watana to Grebe Mountain resulted in a total of eight sheep (1 ram, 7 unidentified) being observed (Fig. 4). While few historical data from this area exist past observations indicate that larger numbers of sheep sometimes occupy this area. For example in 1977, 34 sheep were seen on Mt. Watana. Numerous observations have been made around Terrace Creek in recent years and a few sheep have been harvested in that vicinity from this area. Either sheep moved from the area or they were missed on the 1980 survey.

The pattern of sheep distribution to the south of the survey area suggests that sheep using the Mount Watana area may be part of a larger Talkeetna Mountains population (ADF&G 1973).

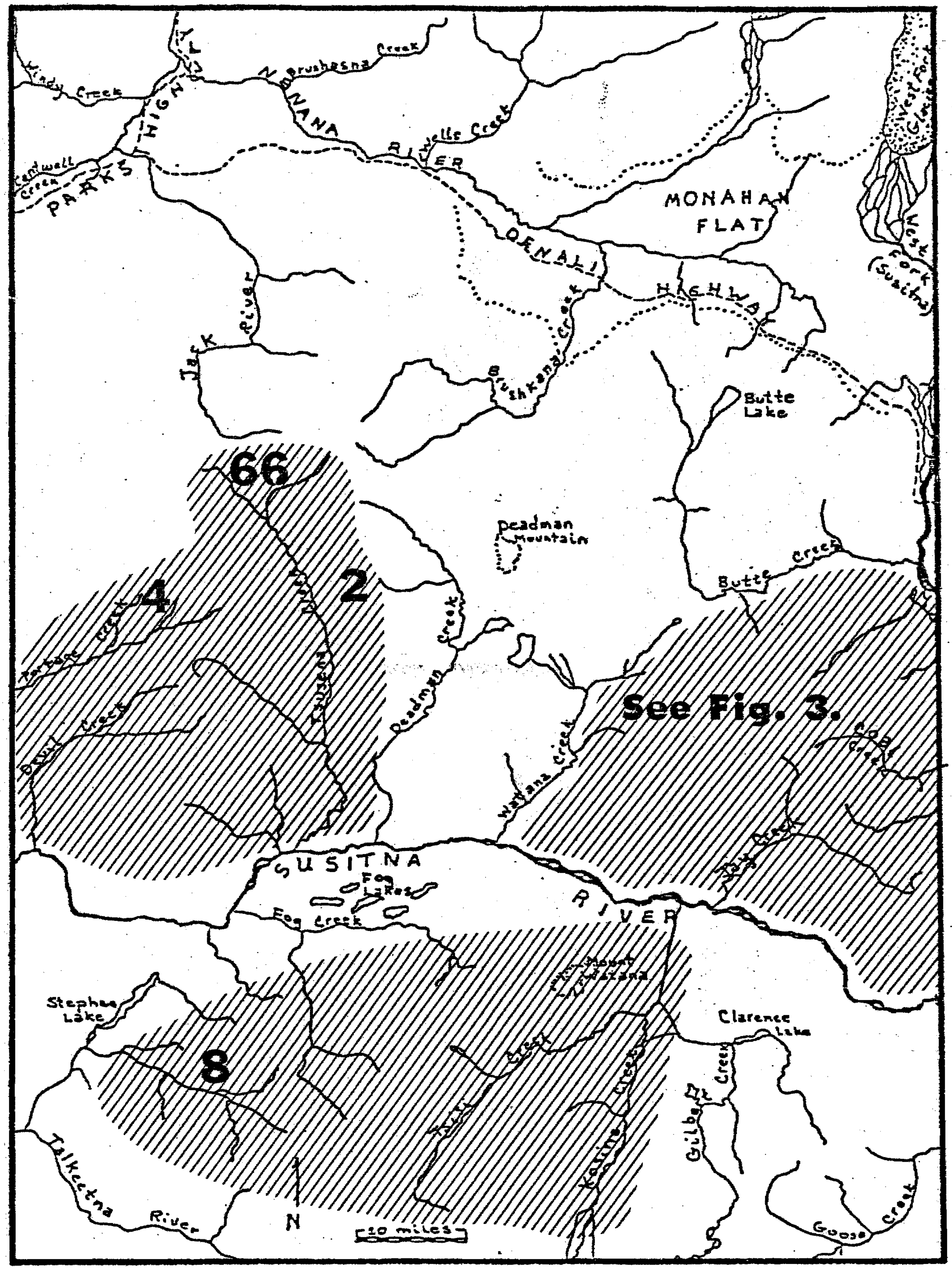
Portage - Tsusena Creek

A total of 72 sheep (6 legal rams, 12 lambs and 54 unidentified) was counted in the Portage Creek and Tsusena Creek drainages. The only previous ADF&G survey in this area was a 1977 count of 91 sheep (8 legal rams, 18 lambs, 65 others). The 1977 survey included the Jack River drainage which was not surveyed in 1980. The sheep sighted were fairly high in the drainages and relatively far from proposed impoundments. Sheep may concentrate closer to the Susitna River in winter and may occupy habitat close to potential access routes. Therefore a winter distribution survey of the area will be conducted.

Hunter Use

The 1980 harvest within the Sustina sheep study area was 13 sheep. Eight of these were considered to be trophy quality with horn lengths greater than 35 inches. Most of the harvest occurred in the Watana Creek Hills.

Figure 4. Areas surveyed and distribution of Dall sheep sighted on 22-23-July 1980 aerial survey.



Potential Impacts

At the time this study was designed it was assumed that the only significant impact of the Susitna Hydroelectric Project on Dall sheep would be from disturbance from construction activities, helicopter traffic, etc. Such impacts could be moderated by avoiding areas used by sheep or scheduling activities at seasons when sheep use of an area was reduced. However, sightings of sheep along Jay Creek indicate a possibility of direct loss of habitat.

The Portage - Tsusena Creek sheep are likely to be impacted only by disturbance. With adequate data on seasonal distribution serious disturbance probably can be avoided. The status of the Mount Watana population is less clear. Limited data indicate that sheep occupied habitat close to the proposed Watana impoundment where disturbance and perhaps even habitat loss could be problems but this distribution was not confirmed by the July 1980 survey. More information is needed.

The Watana Creek Hills populations appears to be the most vulnerable of the three sheep populations. Its close proximity to the Watana impoundment and possible access routes makes disturbance a concern. The possibility of loss of seasonally important habitat has been raised by sightings of sheep on Jay Creek in June. The Watana Creek Hills population appears to be relatively isolated from other sheep populations. If the population were reduced below carrying capacity recovery might be slower than it would be in a less isolated population where immigration from unaffected areas is more likely.

The scope of the Phase I sheep studies is not adequate to assess the impact of habitat loss. An attempt will be made to further document the use of lower elevations along Jay Creek in spring of 1981, but if a special attraction such as a mineral lick occurs there, expanded studies including ground observations and marking of animals would be necessary to evaluate its use.

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