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SUSITNA HYDROELECTRIC PROJECT

PHASE I FINAL REPORT

BIG GAME STUDIES

Volume I BIG GAME SUMMARY REPORT

ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the Alaska Power Authority

March 1982

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INTRODUCTION

The Susitna River Basin is one of the most important wildlife areas in Alaska. It supports relatively high populations of a variety of species of special interest to man. close proximity to human population centers and ease of access by aircraft, highway vehicle, off-road vehicle and boat have made the Basin one of the highest public use areas of the State. For example, Game Management Units 13, 14 and 16 through which the Susitna River runs, have been the three highest moose harvest units in Alaska in recent years.

When the U.S. Corps of Engineers reactivated proposals for hydroelectric development during the early 1970's, questions were raised about the impact of these proposals on wildlife and the use of wildlife. However, with the exception of caribou, little was known of the importance of the immediate impact area to wildlife. Limited amounts of money became available for studies of moose from the Corps of Engineers, U.S. Fish and Wildlife Service and Alaska Power Authority (APA) between 1974 and 1978. These studies helped define some of the potential problems, but inadequacy and unpredictability of funding prevented any attempts at comprehensive impact assessment. The Alaska Department of Fish and Game conducted extensive studies of predator/prey relationships to the north and west of the impact area. These studies provided a great deal of information useful in understanding potential effects of hydroelectric development, but were not specific to the area of greatest impact.

In 1980 the Alaska Power Authority initiated the first comprehensive studies to evaluate the feasibility of the proposed Susitna Hydroelectric Project. APA contracted with the Alaska Department of Fish and Game to provide big game population data to be used in the feasibility analysis. Species to be studied were 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*).

Furbearers, small mammals, birds and plants were to be studied by the University of Alaska and Terrestrial Environmental Specialists, Inc. of Phoenix, New York was responsible for interdisciplinary coordinations, actual impact analysis and preparation of exhibits for APA's application for a Federal Energy Regulatory Commission license to construct the project.

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

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

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

The basic study approach was to delineate "subpopulations" of each species that use areas likely to be altered by the project, determine the seasonal ranges and movement patterns of these subpopulations, determine the degree of dependency of each population on areas likely to be impacted by the project and estimate the approximate number of animals likely to be impacted. The definition of "subpopulation" varied depending on the species. It ranged from a pack of wolves to the entire Nelchina caribou herd. Generally, studies focused initially on animals in or near areas likely to be impacted, then expanded to the remainder of the subpopulation. As a result, the boundaries of the study area varied among species and may expand as the ranges of subpopulations become more evident. During Phase I, studies were confined to assessing the impacts of proposed impoundments and facilities in the vicinity of the impoundments. The one exception was moose for which the possible effects of downstream habitat alteration were examined. Phase I studies were not intended to address impacts on other species downstream or along transmission corridors.

Specific study objectives for each species varied according to suspected differences in the nature of their use of proposed impoundment areas and in the likely mechanisms of impacts. The specific objectives developed at the beginning of Phase I by species are:

<u>Moose</u> (upstream)

To identify moose subpopulations using habitats 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.

<u>Moose</u> (downstream)

To identify moose subpopulations using habitat that will be altered by changes in stream flow below Devils Canyon.

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 altered flow regimes of the Susitna River.

Wolf

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

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

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

To determine the food habits of each pack.

Wolverine

To determine the distribution and abundance of wolverine in the vicinity of proposed impoundments.

To determine movement patterns and home range size of wolverines.

Bear (black and brown)

To determine the distribution and abundance of black and brown/grizzly bears in the vicinity of proposed impoundment areas.

To determine seasonal ranges, including denning areas, and movement patterns of bears.

To determine seasonal habitat use of black and brown/grizzly bears.

Caribou

To delineate calving areas.

To determine the numbers and sex and age composition of caribou occupying habitats on both sides of proposed impoundments at different seasons.

To determine migration routes and the timing of major movements in the vicinity of proposed impoundments.

Dall Sheep

To determine the distribution and abundance of Dall sheep adjacent to proposed impoundments.

The Final Phase I Big Game Report contains data collected between late winter 1980 and fall 1981. However, data from other studies conducted by ADF&G are incorporated whenever they appear useful. The report is organized in the following eight volumes.

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

This volume (Volume I Summary Report) contains excerpts from the other seven volumes. It is intended to provide a brief overview of our current state of knowledge of how each species uses the area and to identify the most serious impacts of hydroelectric development on the upper Susitna River. Individuals desiring more detailed information should consult Volumes II through VIII.

Readers should recognize that, because studies are not complete and our understanding of wildlife/habitat relationships is imperfect, our evaluation of impact mechanisms is often speculative. We have tried to identify possible problem areas that we feel warrant attention. Some of the problem areas may be alleviated by final project design and further study might show some to be less serious than suggested in this report. Conversely, it is possible that some impact mechanisms have been overlooked.

Finally it should be recognized that these studies are simply designed to evaluate the effects of the proposed Susitna Hydroelectric Project on certain species of wildlife and ultimately to suggest ways of minimizing adverse effects. Statements in this report should not be construed to be judgements on the overall feasibility of the project or to imply that the Susitna Hydroelectric Project will be any more or less damaging to wildlife than any other alternative method of meeting Alaska's energy needs.

METHODS

Techniques used during Phase I are presented in Volumes II through VIII and will not be discussed in detail here. The primary techniques used were radio telemetry and aerial surveys. Samples of all species except Dall sheep were captured with drug filled darts fired from a helicopter. Captured animals were marked with tags and in most cases fitted with a radio-collar. Information on sex, age, reproductive condition and physiologic status were collected at the time of capture. Radio-collared animals were periodically relocated from fixed-wing aircraft. Over 2,700 radio-relocations of moose, 683 of caribou, 1,175 of wolves, 518 of brown bears, 724 of black bears and 104 of wolverine were made in the upper basin. In the downstream study area 1,114 relocations of moose were made. When an animal was relocated the activity of the animal and characteristics of the habitat were recorded and the location marked on a map. These data were entered into a computer and analyzed in a variety of ways to determine home ranges, movement patterns, habitat use, proximity to proposed impoundments etc.

Wolf and bear den sites were examined in more detail from the ground. Activity of wolves during the denning period was studied intensively in an attempt to evaluate effects of disturbance and formulate guidelines for minimizing adverse effects.

A variety of types of aerial surveys were used to determine animal distribution, population composition and, in the case of caribou and moose, population size.

SUMMARY OF FINDINGS

MOOSE-DOWNSTREAM

In its 215 km course from Devil Canyon to Cook Inlet, the Susitna River is an outstanding component of a very productive watershed. Perhaps the innate value of the lower Susitna River Valley as wintering habitat for moose is unsurpassed elsewhere in the State.

Objectives of this study were to determine the probable nature and approximate magnitude of impacts of the proposed Susitna River hydroelectric project on moose (*Alces alces gigas* Miller) in areas along the Susitna River downstream from the prospective Devil Canyon dam site.

To ascertain productivity, habitat use, patterns of movement and to identify populations of moose that are ecologically affiliated with riparian habitats along the Susitna River, 2 samples of moose, 4 males and 6 females and 5 males and 24 females, respectively, were captured and radio collared in riparian habitats along the Susitna River between Devil Canyon and the Delta Islands on 17 April 1980 and 10-12 March 1981, respectively and were radio-relocated through 15 October 1981.

Information on productivity and condition was obtained from most individual moose captured. The bulk of data on habitat use, patterns of movement and identity of populations was synthesized from information collected at sites of relocation for three males and three females and four males and 23 females radio-collared in the 1980 and 1981 samples, respectively.

These data were complimented with information collected on three aerial censuses for moose, conducted during the early parts of December, January and February 1981-82, in riparian habitats along the Susitna River between Devil Canyon and Cook Inlet, to assess the relative magnitude and regional use of riparian habitats. These census data also provided additional information on productivity/survival of moose which winter in riparian habitats.

To relocate radio-collared moose, surveys were conducted at about biweekly intervals through 16 March 1981 and at about weekly intervals from that time through 15 October 1981. This schedule provided two, five, seven and five relocation sites for most individual moose during the winter (1 January thru 28 February), calving (14 May thru 17 June), summer (1 July thru 31 August) and breeding (14 September thru 15 October) periods, respectively.

Relocations with dates not included within those periods were categorized into spring, summer, autumn and post-breeding transitory interval periods.

Types of vegetation observed within a 2-4 ha area surrounding each relocation site were recorded and a rating for percent canopy dominance was given to each type which covered 10 percent or more of the field area. Vegetation types included spruce, birch, alder, cottonwood, willow, aspen, sedge, grass, sedge x grass, muskeg, devilsclub, fern and horsetail.

Preliminary findings exhibited grossly different patterns of behavior and geographically discrete breeding areas for three groups of moose within the radio-collared samples and resulted in a subpopulation classification for individuals with breeding ranges centered in 3 areas: 1) to the north of Talkeetna (northern), 2) to the south of Talkeetna and on the eastside of the Susitna River (eastside) and 3) to the south of Talkeetna and not in eastside areas (westside).

In most interpretive analyses, sex, seasonal period and subpopulation categories were considered.

Since magnitude of use of moose winter ranges is partly related to severity of climatic conditions, information contained in this report must be interpreted tentatively because of the relatively mild winters of 1979-80 and 1980-81.

All moose radio-collared south of Talkeetna were captured within the outmost banks of the Susitna River. Because of the relative scarcity of moose available in riparian habitats to the north of Talkeetna, some individuals were captured up to 400 m from the river.

None of the 5 moose captured in riparian habitats in April of 1980 were relocated in those habitats in the winter of 1980-81, though numerous other moose were present.

Most moose radio-collared south of Talkeetna in 1981 had departed from Susitna River riparian habitats by mid-April; males appeared to precede females. Directions of departure were not random; most moose retreated to the west and several remained in or near an extensive large island complex throughout the study period.

Differences in general patterns of movements observed between the 1980 and 1981 samples of moose captured south of Talkeetna were in part attributed to differences in the response of local populations to snow cover and plant phenology.

Moose radio-collared to the north of Talkeetna were relocated on south-southeast-facing slopes on the north-northwest side of the Susitna River basin. This behavior was attributed to local population phenomena and/or habitat selection.

Most females radio-collared north of Talkeetna were commonly relocated in riparian habitats during the calving period, apparently in response to the availability of highly nutritious and easily digestible forage plants. After the calving period these females returned to the south southeast facing slopes above the river basin where they remained throughout the period of study.

Females radio-collared south of Talkeetna, which departed Susitna River riparian habitat by mid-April, did not return to those riparian areas during the calving period, as did radio-collared females in areas to the north. Instead they were commonly relocated in relatively open, medium-height spruce/ muskeg habitats to the west of the Susitna River. A noteworthy concentration of radio-collared females occurred near Trapper Lake during the calving season. As for females in more northern areas, use of these moist habitats during the calving period was attributed to the availability of high quality herbaceous forage.

Moose radio-collared north of Talkeetna were seldom relocated more than 3 mi from the Susitna River. Moose in westside areas were nearly as frequently relocated at distances greater than 3 mi from the Susitna River as they were at distances nearer to the River. One eastside male was seldom relocated nearer than 10 mi from the Susitna River; females in that area were more commonly relocated farther than 5 mi from the Susitna River than at closer distances.

In comparison to females in other areas, each of the three seasonal ranges for those radio-collared north of Talkeetna averaged smallest in size and were located nearest to the Susitna River.

Data indicated that the average moose radio-collared in areas north of Talkeetna did not have to travel as far from its winter range to locate habitats required during other seasonal periods. Though this appears to imply that areas north of Talkeetna are a more heterogeneous and complete assemblage of habitats, it may also be interpreted to indicate that adjacent habitats are of such poor quality that moose cannot physiologically afford to venture far from nor to travel far to winter on the Susitna River, or that in this area the Susitna River is not very attractive as winter range for moose.

Alder was the dominant vegetative type observed at relocation sites for females north of Talkeetna. Spruce, a species valuable to moose for cover, occurred at most sites but was not very dense. Relocation sites south of Talkeetna were dominated by birch and spruce. Although spruce occurred more than birch and rated higher in canopy coverage than at relocation sites to the north, it still ranked considerably lower than birch in canopy coverage.

Perhaps it was the prevalence of alder and the relatively poor representation of birch and spruce that may make areas north of Talkeetna less desirable for female moose than those areas south of Talkeetna.

Three aerial censuses conducted between early December and early February revealed 322, 324 and 239 moose, respectively in riparian habitats along the Susitna River from Devil Canyon to Cook Inlet in the relatively mild winter of 1981-82. Moose observed on each census were not evenly distributed. On each census about 90 percent of the moose were observed between Montana Creek and Cook Inlet. Even within the latter area some locales exhibited extremely dense concentrations of moose.

About 50 percent of the moose observed in riparian habitats were calves and their dams. Twenty nine, 26 and 22 percent of the moose observed on the three respective censuses were calves. If moose seek Susitna River riparian habitats to avoid deep and persistent snow cover in non-riparian habitats, it would seem that this behavior would be particularly important for calves whose legs are considerably shorter than those of adults and would have more difficulty negotiating deep snow.

Profiles of condition-related blood parameters from the samples of moose captured and radio-collared were rated in below average condition and resembled those from a low productivity population. However, this implication is questionable because of the relatively high rate of productivity observed for radio-collared individuals and moose observed on aerial censuses. Eighty-one percent of the 26 females for which data were available in 1981 were observed with young. Considering the occurrence of twins at least 93 calves may have been produced by every one hundred of the cow moose that wintered on the Susitna River.

Although predators occurred in the study area, and no instances of predation were observed. Circumstantial evidence indicated that most predation which does occur is probably attributable to black (*Ursus americanus*) and brown bears (*Ursus arctos*). Brown and black bears occur throughout the Susitna River Valley. Brown bears are probably most dense in mountainous areas with black bears found more commonly in lowland and riparian habitats. The apparent similarity in habitat requirements between moose and black bears may place them both in like habitats during the calving and summer periods.

Wolves are rare in the study area and have never been observed.

Data indicated that radio-collared moose captured between Devil Canyon and the Delta Islands, a linear river distance of about 155 km, ultimately ranged over an area encompassing about 5000 km^2.

Based on general patterns of movement documented for radio-collared moose, large geographical units where radio-collared moose were never relocated and areas along the Susitna River where data have yet to be collected, nine hypothetical local populations of moose are delineated.

MOOSE-UPSTREAM

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CARIBOU

The Nelchina caribou herd which has occupied a range of about 20,000 mi^2 in southcentral Alaska has been important to hunters because of its size and proximity to population centers. Overall objectives of this study were to evaluate potential impacts of the proposed hydroelectric project on Nelchina caribou and to suggest possible mitigating measures. Because of the changeable nature of caribou movement patterns short-term studies of distribution and movements must be tempered with historical perspective. Fortunately, the Nelchina herd has been studied continuously since about 1948 and records previous to that time have been reviewed. The primary methodology for this study was the repetitive relocation of radio-collared caribou. Population estimates were made with a modified version of the aerial photo-direct count-extrapolation census procedure.

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

During spring migration females moved across the Lake Louise Flat onto the calving grounds in the eastern Talkeetna Mountains on a broad front from Lone Butte to Kosina Creek. Some caribou utilized the Susitna River in the area of the proposed Watana impoundment as a travel route. A small portion of the herd appeared to migrate across the plateau north of the Susitna River crossing the Susitna between Deadman Creek and Jay Creek enroute to the calving grounds. Open spruce forest was still the primary vegetation type utilized, however, shrublands and tundra-herbaceous types became increasingly important. Females were found at elevations ranging from 1,900 to 5,600 feet (x=2886). Males lagged behind females during spring migration using mostly spruce forests. Elevations averaged 2,280 feet, ranging from 2,000 to 3,100.

During the calving period, virtually all females from the main Nelchina herd were found from Kosinia Creek into the Oshetna River in the eastern Talkeetna Mountains. Tundra-herbaceous vegetation accounted for 75% of the sightings and shrublands for 25%. Elevations for females ranged from 2,400 to 5,400 feet (x=3871). Nelchina bulls were found scattered throughout the range during calving mostly in transit to summer ranges. Spruce forests were still the primary vegetation type used by bulls. Elevations averaged 2,872 feet (range 2,100 - 4,400).

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

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

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

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

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

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

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

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

WOLF

In 1980 and 1981, wolf packs which potentially could be impacted by the proposed Susitna Hydroelectric Project were studied. Thirty-six wolves from six separate packs were radio-collared and relocated a total of 1175 times from fixed-winged aircraft. Several packs occupying areas in or adjacent to the impoundments were not studied because poor snow conditions precluded their capture.

From radio-relocations, ground observations, and previous studies we were able to describe the histories of individual wolves and their associated packs. Interactions between pack members and between separate packs were observed throughout the study.

Wolves in the Watana pack were most frequently observed in shrub (50%) habitats with ecotones being of particular importance. No slope or aspect selection was observed. Approximately 1/3 of all radio-locations of the Watana pack were located in areas to be inundated by the proposed impoundment.

Of 83 wolf kills observed for 6 packs, 57% were moose, 33% were caribou and the remainder were small mammals. Fifty-one percent of the moose and 7% of the caribou killed by wolves were calves. Food habits and predation rates data suggested that wolves were annually preying upon from 11-13% of the moose population and from 2-10% of the Nelchina caribou herd. These data suggested that the percentage of caribou in the wolves' diet may be a function of their availability. As caribou become more abundant, they make up a greater proportion of the wolves' diet.

The minimum estimated wolf population in the study area ranged from a fall high of 80 to a spring low of 40. These wolves were divided into 13 packs. Pack territory sizes ranged from 346-981 mi^2 and averaged 545 mi^2.

Wolf harvests in GMU 13 from 1971-1981 ranged from a high of 128 in 1977-78 to a low of 45 in 1980-81. The low harvest in 1980-81 was attributed to poor weather and relatively low wolf densities. Shooting was the most common harvest method throughout the period.

Twenty-three wolf den and rendezvous sites were examined. Most dens were located on slightly elevated, well-drained sites with a south or east exposure usually near the center of the territory. Wolves traditionally return to the sites annually. Average distance between contiguous natal dens was 28 miles.

Intensive ground observations of active wolf den sites in May and June of 1980 and 1981 allowed us to detail summer activity patterns and food habits. These observations revealed that wolves were present at den sites throughout the day. Helicopters flying near dens always annoyed wolves; however, they became more tolerable over time. Judging from observed behavior patterns and a review of the literature, it was recommended that all human ground activities be restricted within a 1.5 mile radius of active dens. This is particularly important in spring to avoid den site abandonment. If human activity must occur near dens, these activities should be limited to early morning and late evening hours.

BLACK BEAR AND BROWN BEAR

Projected impacts of proposed hydroelectric development on upper Susitna River populations of brown and black bears were investigated in 1980 and 1981. The preliminary investigations for Phase I of the impact assessment that are reported here were designed to reveal the kinds of impacts which might result from the proposed project, quantitative assessments of actual impacts were, in most cases, postponed until Phase II of the assessment studies scheduled to begin in 1982.

In Phase I a sample of both species was radio-collared and periodically monitored in order to identify the patterns of use of areas that would be impacted by the proposed project. This analysis was based primarily on a total of 518 brown bear and 724 black bear locations in the study area, collected between April 1980 and October 1981 for black bears and between April 1980 and 1 September 1981 for brown bears. These termination dates represent analytical deadlines, data collected subsequently are being analyzed.

The sample of radio-collared adult brown bears was considered representative in terms of age structure but biased against males. In comparison with other North American brown bear populations, the study area population appeared highly productive and moderately dense. An estimate of 1 bear/41-62 km^2, obtained in 1979 in a nearby study area, was considered the best available approximation of brown bear density in the study area.

Brown bear harvests by hunters have averaged 64/year in 1973-1980 in Game Management Unit 13 (range 44-84), 15/year in the project study area (9-24).

The mean elevation of 29 brown bear den sites was 4,818 feet (range=2330-5150 feet). No brown bear den discovered to date would be inundated by the proposed impoundments but some were in areas where disturbance during project construction or operation could result in abandonment or avoidance of den sites.

Brown bear home ranges were highly variable between individuals and years. The mean home range of 11 bears in 1980 was 422 km^2, 487 km^2 in 1981. Home range sizes varied from 50-2655 km^2. Larger home ranges in 1981 relative to 1980 may have resulted from a relatively poor berry crop in 1981. Brown bears captured along the Susitna River ranged over a total area of 8,473 km^2. This represents a minimum estimate of the area in which brown bears would be affected by the proposed impoundments.

The period of peak use of areas directly impacted by the proposed impoundments was in spring and early summer. During this period 62% of radio-collared brown bears were located within 1 mile of the proposed impoundment in 1981, 50% in 1980 (excludes females with newborn offspring). In both years 30% of all observations of these bears were within this, conservatively defined, impoundment impact zone. We suspect that brown bears tend to move to lower elevations near or in the impoundments in early spring because of the relatively earlier availability of vegetable forage in these areas; prey, especially moose calves, may also be more available in this impoundment impact area. This pattern was not followed by females with newborn cubs, these bears tended to remain at high elevations away from the impoundments. Perhaps this avoidance of areas where other bears concentrate is adaptive in minimizing intraspecific predation on their cubs.

This same pattern was verified by statistical analyses of locations of brown bears within 3 nested regions of the study area: The actual impoundment, within 1 mile of the impoundment shoreline, and 1-5 miles from the shoreline. Here observed use in the actual impoundment area was greater than would have been expected on the basis of the relative size of the impoundment area. This difference was especially marked in the spring when observed use was 4 times greater than expected under the null hypothesis of no selectivity.

This same pattern was evident in analyses of the habitats where relocated brown bears were found. Use of spruce habitats which occur primarily in the vicinity of the impoundments was significantly higher in the spring than during the rest of the year.

Data on availability of different vegetation types based on the type maps prepared by the Plant Ecology Subtask were not partitioned in a way that would permit meaningful analyses of selectivity of these different vegetation types for the area mapped at the 1:63,360 scale. Appropriate partitioning of these data were available for the actual area that would be flooded by the proposed impoundments, however. Analyses of these data suggested that brown bears tended to select for mixed conifer-deciduous forest types in the Watana impoundment area.

Brown bear movements to areas of seasonally reoccurring food abundance may include movements to Prairie Creek or downstream along the Susitna to fish for salmon (both have been documented), or movements to moose or caribou concentration areas such as calving grounds (movements to caribou concentrations were also documented). Movements to Prairie Creek by bears from an area of 5,773 km^2 were documented in this study, these movements required crossing the impoundments and the proposed access roads.
Brown bear predation rates were intensively monitored (once/day) in spring 1981. A kill rate of 1/10.2 days was observed, substantially lower than has been recorded in more intensive studies conducted in 1978 in nearby areas. The observed kill rate was suspected to be biased because of relatively infrequent monitoring and relatively poorer visability caused by more dense vegetation in the study area.

The sample of radio-collared adult black bears was considered representative in terms of sex ratio and age structure. In comparison with other North American black bear populations, black bears in the study area appeared to be productive although possibly having an older age of reproductive maturity and higher rate of cub mortality than an intensively studied population on the Kenai Peninsula. No good density estimate was obtained for the study area although a rough estimate of 1 bear/4.1 km^2 was obtained in one relatively open area based on aerial observations of marked and unmarked bears.

Black bear harvests have averaged 66/year in 1973-1980 in Game Management Unit 13 (range=48-85), 8/year in the project study area (1-15).

Fourteen black bear den sites used in 1980/81 were located and measured, an additional 19 dens being used in 1981/82 have been tentatively located from the air. All but one den was below 3,000 feet elevation, most were in the immediate vicinity of the proposed impoundments. Of 13 dens found in the vicinity of the proposed Watana impoundment, 9 will be flooded at an impoundment elevation of 2,200 feet, the mean elevation of these dens was 2,177 feet (1,800-2,750 feet). In the vicinity of the proposed Devils Canyon impoundment, 1 of 16 known dens would be flooded at an impoundment elevation of 1450 feet, the mean elevation of these dens was 2,178 feet (1490-4340 feet). A higher proportion of black bears in the study area den in natural cavities and re-use den sites than has been recorded in other Alaskan studies suggesting relative scarcity and competition for acceptable den sites in the study area.

Black bear home ranges were significantly larger in 1981 (mean= 251 km^2, range=19-1051) than in 1980 (mean=31 km^2, range=3-136). We suspect the increased movements observed in 1981 reflect, for the most part, the relatively poor berry crop which forced bears to move greater distances in search of forage. The total area encompassed by movements of radio-collared black bears was 4,196 km^2; much of this area away from the river was considered unacceptable or poor black bear habitat.

Acceptable black bear habitat in the study area was largely confined to a narrow finger of forested habitat along the Susitna River; these are the areas which will be most impacted by the proposed impoundments. In late summer many black bears moved to shrubland habitats adjacent to these spruce forests to forage for ripening berries, generally returning to the forested habitats to den in September. Such shrubland habitats that are also adjacent to forested escape habitat are limited in extent and would be impacted by construction facilities (such as the current site of Watana Camp), borrow areas D and F, and access roads.

Analysis of the location data within the 3 nested zones of the study area (impoundment area, 1 mile from impoundment shoreline, and 1-5 miles from the shoreline) revealed exceptionally high selectivity by black bears. In the area that would be flooded by the proposed Watana impoundment, black bear use was 2-4 times higher than expected based on the relative area of this zone, use was also higher than expected in the zone 1 mile from the impoundment shoreline. For the Devils Canyon impoundment observed use exceeded expected values in the area within 1 mile of the impoundment shoreline.

Analyses of selectivity for the different vegetation types mapped at the 1:63,360 scale by the Plant Ecology Subtask could not be accomplished as discussed for brown bear. However, as for brown bear, such analyses were possible in the area that would actually be flooded by the Watana Impoundment. Here use varied significantly from values expected under the hypothesis that black bears were randomly using all vegetation types. Open birch and closed birch habitats appeared to be the most favored types. A high proportion of these 2 vegetative types would be inundated by the proposed impoundments.

Three radio-collared black bears moved downstream below the Devils Canyon damsite in 1981. These movements were suspected to be motivated by spawning salmon in this region. It is not known whether these movements occur also in years of normal berry production.

As discussed for brown bears, relatively low predation rates by black bear on moose calves were observed. Biases resulting from relatively infrequent monitoring and poor sightability of kills are expected to account for the low observed predation rates.

WOLVERINE

During Phase I studies, 6 wolverine (5 males, 1 female) were radio-collared in an attempt to identify potential impacts of hydroelectric development on wolverine. A total of 114 point locations were obtained; 104 of the locations were of radio-collared wolverine. The annual home range for an adult male (040) was 627 km^2 (237 mi^2). Home range sizes for two males monitored 6 and 8 months were 378 km^2 (146 mi^2) and 272 km^2 (105 mi^2), respectively. Comparing home range sizes for males from the Susitna River Basin, northwestern Alaska, and northwestern Montana, suggested that Susitna Basin male wolverine home ranges were larger than those in Montana but smaller than those in northwestern Alaska. Differences were probably related to prey diversity and density.

An estimated 65 to 123 wolverine inhabited the study area during 1980 and 1981 providing a density range of 1/76 km^2 (1/29 mi^2) to 1/143 km^2 (1/55 mi^2)

Trappers and hunters harvested 27 wolverine from the study area during Phase I studies. Ninety-three percent (25/27) of the wolverine trapped were along the borders of the core study area. Harvest locations appeared related to accessibility.

Wolverines were distributed throughout the impoundment area. Availability and utilization of different habitat types by radio-collared wolverine were compared. There were apparent seasonal shifts in habitat utilization from tundra dominated habitats (summer) to forested areas (winter). The shift was probably influenced by available prey species; ground squirrels and caribou in summer and moose and small mammals in winter. Ecotones were found to be important throughout the study area.

Observations of social and breeding behavior of wolverine were described.

DALL SHEEP

Aerial surveys were flown on 3 and 25 March, 1981, to assess winter habitat use by Dall sheep (*Ovis dalli*). Areas flown were the Watana Hills count area, and the Mt. Watana-Grebe Mountain complex.

Ground observation of the Jay Creek mineral lick located at the 2200 ft. elevation revealed heavy utilization by sheep and moose (*Alces alces*). Soil samples were taken for chemical analysis.

Frequent observations of the Jay Creek mineral lick were made in conjunction with other Susitna studies. Sheep were seen at the Jay Creek site on 34 of 50 occasions (68%) from 6 May to 24 June 1981.

The Watana Hills count area was surveyed on 28 July, 1981, to determine population trend and summer distribution. No sheep were observed at the Jay Creek site. However, Dall sheep were observed at another known mineral area in the drainage of the E. fork of Watana Creek, approximately 7 miles to the north.

The largest number of sheep observed at the Jay Creek mineral site was 15 which represents 7 percent of the observed summer population and 17 percent of the observed winter population.

POTENTIAL IMPACTS

Definition of Impact

Impacts of the Susitna Project on wildlife may range from the permanent elimination of animals to minor inconvenience to users of wildlife. Clearly, some impacts are more serious than others. We focused our attention on those impact mechanisms that have the potential to cause or significantly contribute to changes in size or productivity of wildlife populations.

Most obvious are changes in the capacity of the habitat to support animals. However, factors which affect the productivity and life expectancy of individuals remaining in the population may be of equal importance. A population in which productivity and survival rates are reduced may maintain its size under normal conditions, but be less able to sustain stressful climatic conditions, predation or hunting.

The following are categories of impact mechanisms considered most important:

1. Loss of habitat

2. Alteration of habitat

3. Loss of a food source

4. Barrier to movements

5. Increased vulnerability to predators, hunters or hazards.

6. Disturbance - when it affects the productivity or survival of animals.

Since some impact mechanisms are indirect and some big game populations migrate, impacts may occur far from the impoundments and construction facilities. Generally, impacts become less severe and affect a smaller proportion of the animals as you proceed away from the project area. This makes it difficult to delineate a meaningful zone of impact. A large zone will include a higher percentage of animals that will not be significantly impacted, while a narrow zone will miss a higher number of animals that will be impacted. Therefore it is necessary to be somewhat arbitrary in selecting a zone of impact.

One approach to this problem was to assume that animals found within one home range diameter of project facilities were likely to be exposed to a variety of impact mechanisms. We focused our attention on these animals, then expanded or contracted our area of attention, depending on the nature of the suspected impact mechanism.

Consequently when we discuss impact zones or groups of animals to be impacted, we do not intend to imply that every animal in that area will be lost or seriously affected, nor that no animal outside of that area will be lost or seriously affected. These are areas where we expect changes in population size or productivity might be great enough to be measured by available techniques or perceived by users of wildlife.

MOOSE - DOWNSTREAM

Much of the potential for impacts on populations of moose downstream from the impoundments will result from the effects of altered and/or controlled flow regimes on riparian vegetative communities.

Effects need not be direct; as in spring we have observed moose feeding on trees felled by beavers and should altered flow regimes have a negative affect on populations or distribution of beavers, secondary effects will be transmitted to moose. Likewise, activities of beavers falling trees may open the canopy and encourage new growth of forbs and other understory vegetative types consumed by moose. Trees killed by beavers also lead to instability of stream banks and result in erosion which may secondarily bring about changes in vegetative succession that are favorable to moose. Dams built by beavers create favorable conditions for lush growth of aquatic plants, an important forage for moose.

The value of the Susitna River to moose is founded on its innate instability which results in continual creation and maintenance of seral vegetative communities; any change that would bring about stability and not interfere with normal successional processes would tend to have a negative impact on the types of riparian habitats that are of value to moose.

Predications of project impacts on moose are in part, dependent on predications of the effects of water levels on vegetative communities which, in part, depend on predications of water occurrence and levels which in part, depend on regulation of flow regimes and contours and depths of the river bottom. Due to the unavailability of those sorts of data, at present, we will attempt to point out areas, habitats and/or seasonal periods which appear to be of particular importance to moose and which may be affected by the proposed project.

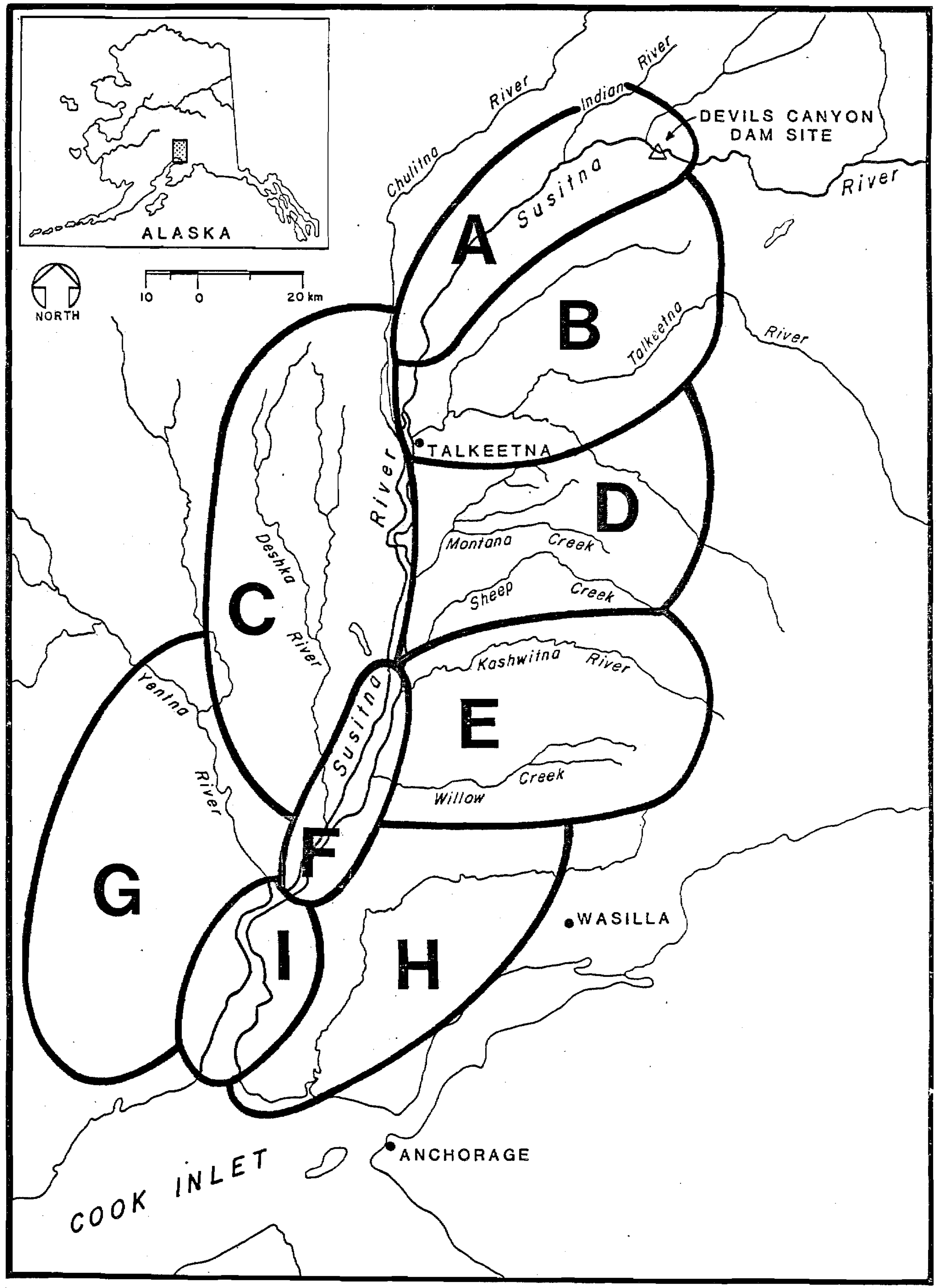

Figure 1. Spatial relationships for hypothetical subpopulations of moose in the Susitna River watershed between Devils Canyon and Cook Inlet, Alaska.

Though a relatively low density of moose appear to occur in the Susitna River valley north of Talkeetna, the island and riparian habitats appeared to be particularly important to females during the calving season. Loss of these habitats, in that area, could seriously affect production, survival and recruitment into that local population of moose.

If the timing of calving for moose in areas north of Talkeetna is adaptive and indirectly synchronized to occur with plant phenology for nutritional reasons, and the warmer water temperatures of the Susitna River resulting from hydroelectric development accelerate the growth and development of aquatic and riparian vegetation, moose would have to alter their behavior accordingly, or be confronted with diets of different composition and probably of lower quality.

Though few moose north of Talkeetna appeared to use riparian habitats during seasons other than calving, we suspect that during a severe winter, and knowing the extreme quantity of snowfall which can occur in this locality, that those habitats may be relatively more important to moose in that area than are similar habitats to moose in areas downstream from Talkeetna.

If the Susitna River is ice-free year-round down to Talkeetna, as projected, we envision this as having a detrimental impact on the local population of moose. During cold parts of the winter, the warm open water may lead to the formation of ice fog and result in a tremendous buildup of frost or ice on all vegetation in the river basin. We do not know if moose can metabolically tolerate the increase in energy required to warm the frost and to process the increase in dietary water.

The fact that thin ice and ice flows or jams will not occur during the early spring period prior to calving, probably will decrease the mortality of female moose as they travel to island or riparian habitats or cross the river during this time period. However, the occurrence of open water during the cold parts of winter when air temperatures may reach -35 to -45°C, may prevent moose from efficiently utilizing riparian habitats and preclude all use of island habitats and all crossings of the river. We question whether moose would enter water or swim under such extreme environmental conditions or if they could survive from the exposure if they did.

Since many more moose are ecologically affiliated with the Susitna River downstream from Talkeetna than upstream, impacts in the former area will affect a larger number of moose, and because of their more extensive patterns of movement, effects will be realized at much greater distances from the Susitna River. Impacts in this area will generally occur directly or indirectly through the response of vegetative communities to altered and relatively stable hydrologic flow regimes. Elimination of extreme peaks of water levels will lead to stabilization of those plant communities which will not be periodically inundated and result in habitats of lesser value to moose as plant succession progresses. For the same reasons, a decrease in water levels in other areas will create habitats similar to the type lost. One ultimate result of this process is the localization or centralization of riparian habitats to a point more near the main channel of the river. Since moose are traditional in their use of particular local habitats, we do not know if they would readily be aware of and/or make use of newly created habitats in different areas along the river.

Consequences of changes in flow regimes will be drastically different in the narrow deep channeled portion of the Susitna River north of Talkeetna compared to those in the very broad shallow watered channels, sloughs and marshes which occur between Talkeetna and Cook Inlet. Increases or decreases in water may affect many more times as much land surface area in the Delta Islands as would similar changes in water levels at Portage Creek.

Though some moose in the extensive large island complexes utilize riparian habitats year-round, many more moose use the riparian habitats along the Susitna River exclusively during the winter.

Even during the mild winters of 1979-80 and 1980-81, substantial numbers of moose used these riparian habitats. During severe winters the same habitats probably harbor 2 to 3 times as many moose.

Not only are more moose using riparian habitats during late winter, but late winter-early spring is also a critical time, a time when both sexes of moose are most dependent on riparian habitat for high quality browse. Pregnant females must maintain themselves in good nutritive condition to meet the demands required for fetal growth; a low quality diet would affect not only the condition of the pregnant females but also the number and quality of young they produced. Males, on the other hand, are at this time attempting to recover condition lost in the rigors of the rut.

Since there is no reason to believe that empty niches or surplus foods are presently available in riparian habitats, any decrease in distribution or abundance of riparian habitats, caused by altering natural flow regimes of the Susitna River, will likewise decrease the numbers of moose that can presently be maintained in good nutritive condition.

Activities associated with construction of impoundments and transmission line facilities also pose potential impacts on populations of moose. Past projects in Southcentral Alaska indicate that construction of vehicular or transmission line corridors will probably temporarily discourage moose from using those immediate areas during the active construction phase and subsequently will encourage their use of these areas through creation of habitats that favor growth of preferred moose winter browse. In winter, moose will gather and feed in these disturbed areas as long as early successional stages and associated vegetative types persist. If transmission line corridors are "maintained", these preferred habitats would be available indefinitely.

It is important not to create such facilities in areas immediately near present highway systems or the Alaska Railroad rightof-way, since numerous moose are killed by trains or vehicles in these areas every year. In severe winters when numerous moose are attracted to these habitats, trains alone have been reported to kill about 500 animals annually.

Of course these habitats may act as a substitute to replace, in quantity, not location, riparian habitats that may have been lost through altered flow regimes.

It is not known whether the "hum" characteristic of high voltage transmission lines will discourage moose from using transmission line corridors.

Another potential impact on moose may secondarily result from the development of an access network for construction and maintenance of the impoundments and transmission line structures. Impacts resulting from increased access into the now remote areas north of Talkeetna may be relatively greater in magnitude than in areas south of Talkeetna where a substantial amount of access and development is already present.

If access into these areas remains open for the public following the construction phase, the intensity of human activities and moose hunting in the respective areas will increase substantially. A level of management more precise than is presently necessary will be required for those populations of moose.

MOOSE - UPSTREAM

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

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

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

Limited observations made by plant ecology studies (Subtask 7.12) personnel suggest that habitat within the Watana impoundment area may not support greater use by moose. They suggested that in November 1980 willow stands along Watana Creek and portions of

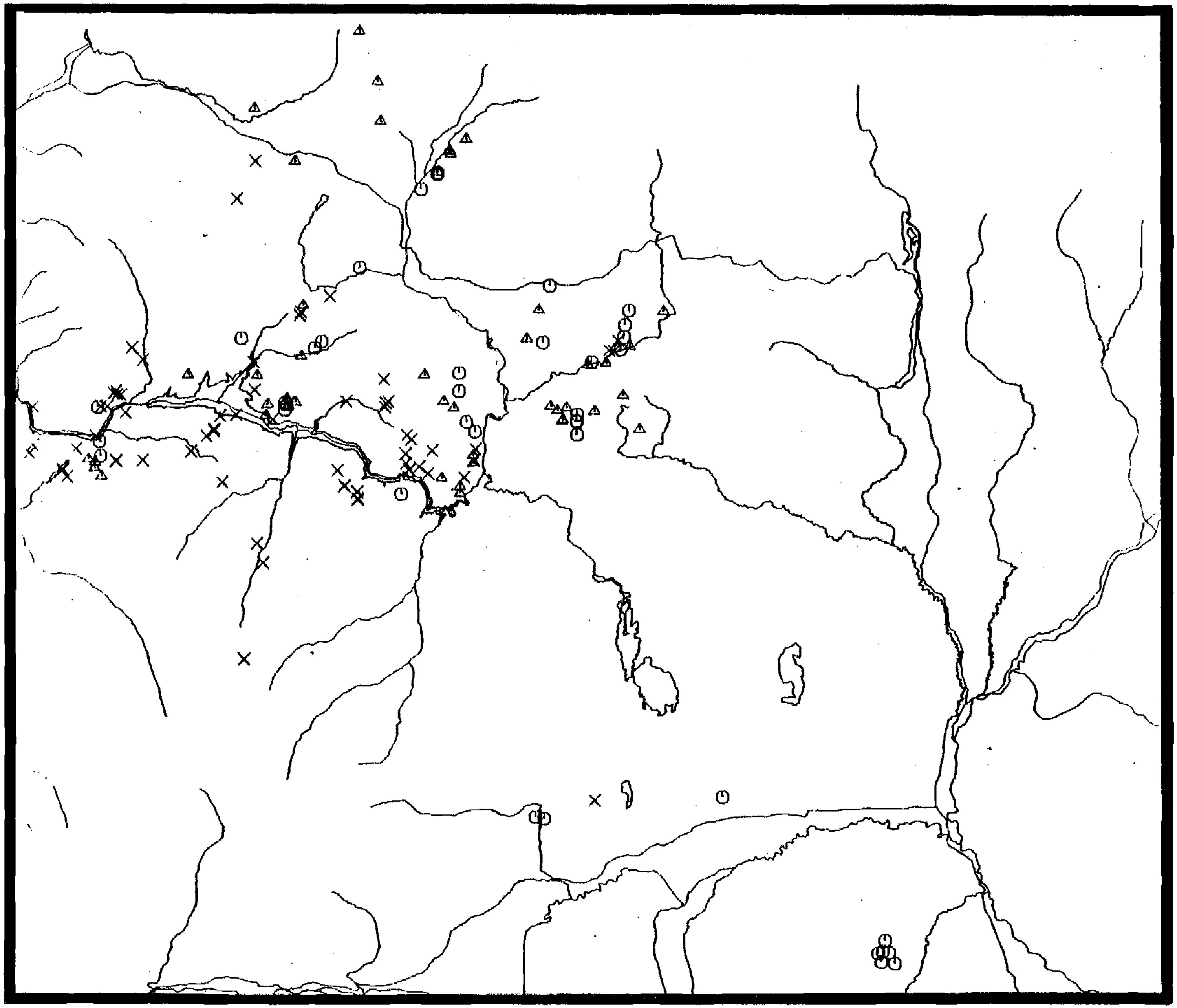

Figure 2. Locations of radio-collared moose during the rut (20 September–20 October) from 1977 through fall 1980 in the Nelchina and upper Susitna River Basins of Southcentral Alaska. (scale: 1 cm = 12500 meters)

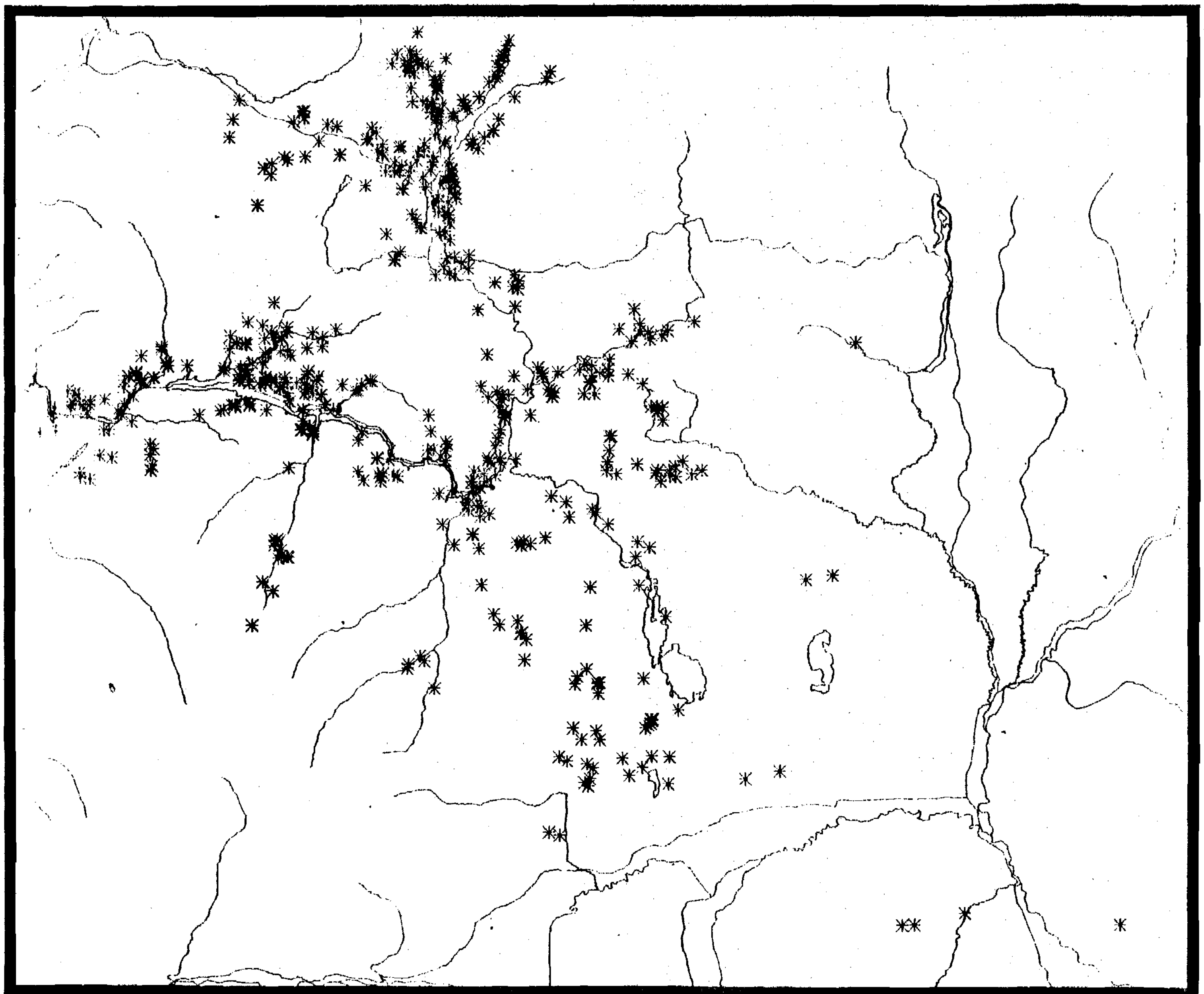

Figure 3. Distribution of winter (January, February and March) observations of radio-collared moose from 1977 through 1981 in the Nelchina and upper Susitna River Basins of Southcentral Alaska. (scale: 1 cm = 12500 meters)

the Susitna River within the Watana impoundment area had already been heavily browsed by moose. They continued, "consequently, it appears that browse supplies in the bottoms of the Susitna River Canyon and its tributaries may already be depleted before they would have much value as a browse reserve in late winter or during severe winters". Although no data were presented on available browse, browse utilization, browse vigor or pellet groups this possibility can not be overlooked. More complete studies of the habitat are required.

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

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

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

Spring Habitat Loss - We found that moose use of impoundment areas was greatest in spring and early summer. This may be a response to earlier snow melt and vegetation emergence at lower elevations. This is a critical period for moose, especially following severe winters. Moose tend to have a negative energy

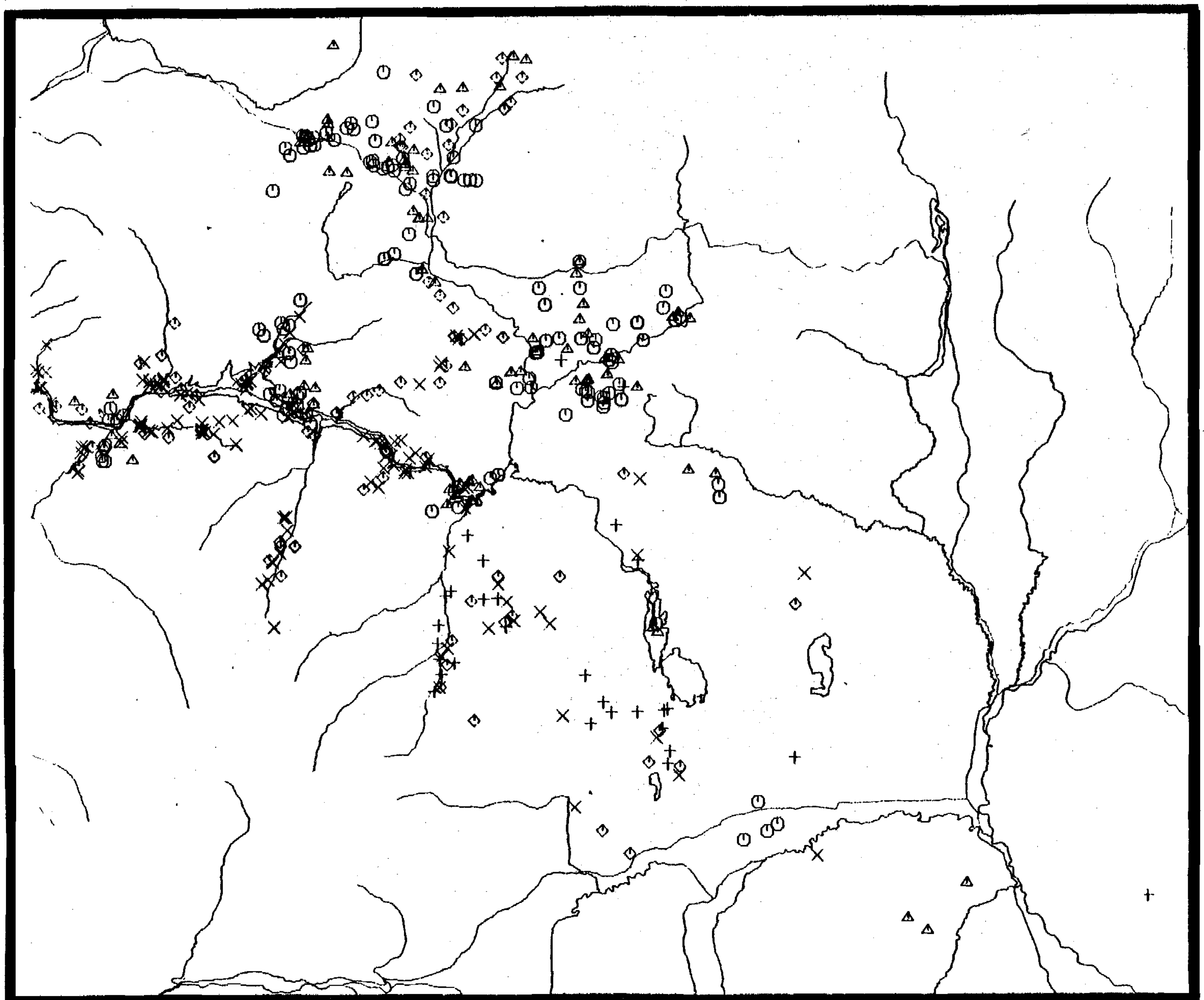

Figure 4. Locations of radio-collared moose during parturition (15 May-15 June) from 1977 through 1981 in the Nelchina and upper Susitna River Basins of Southcentral Alaska. (scale: ,1 cm=12500 meters)

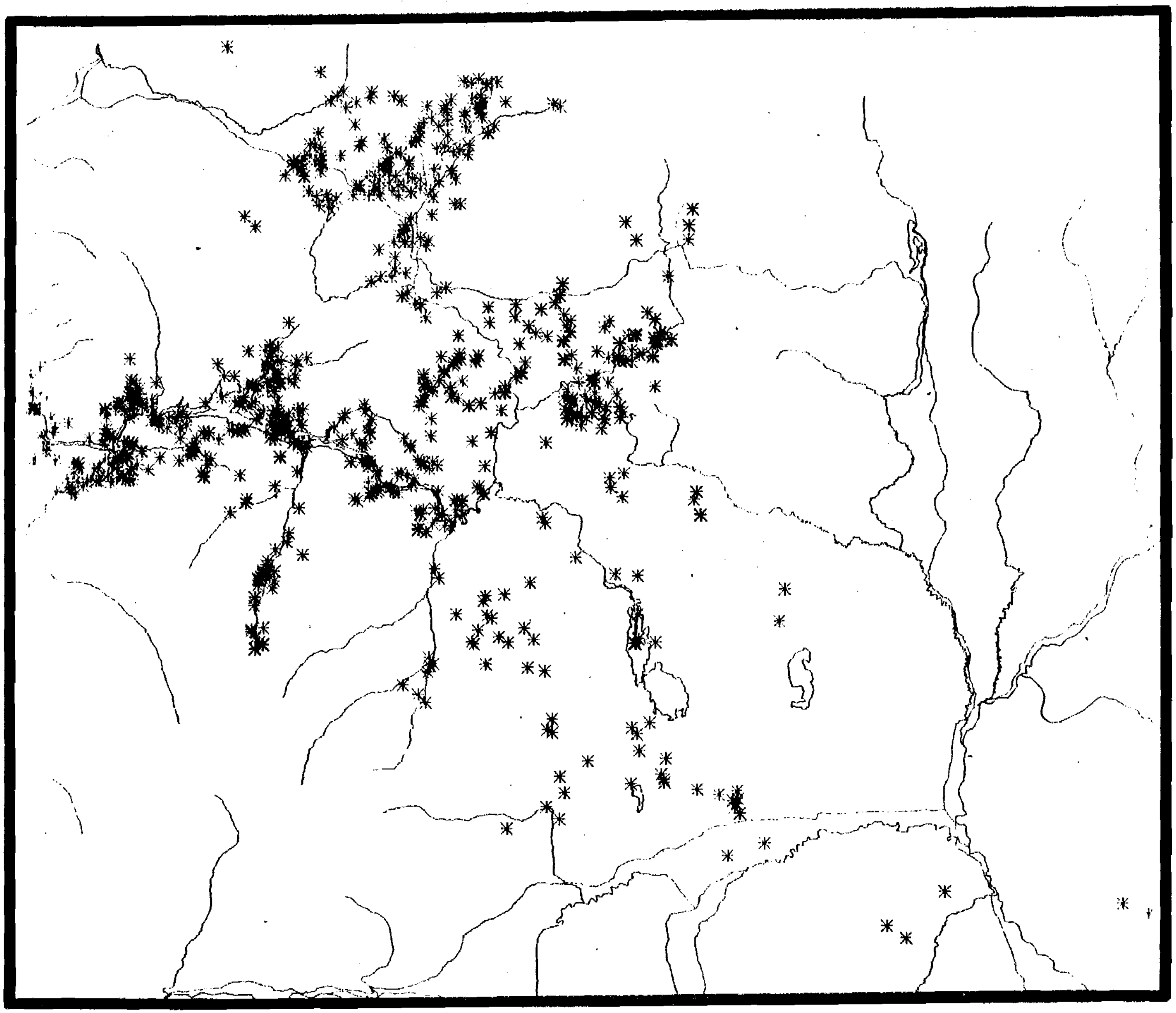

Figure 5. Distribution of summer (June, July and August) observations of radio-collared moose from 1977 through 1981 in the Nelchina and upper Susitna River Basins of Southcentral Alaska. (scale: 1 cm = 12500 meters)

balance during winter. Their physiologic condition deteriorates usually reaching a low point around April. This trend is abruptly reversed when melting snow and new plant growth greatly increase the quantity and quality of available food. In a nutritionally stressed population, many moose may be near the point where their survival or, in the case of pregnant cows, their unborn calf's survival is in question. If availability of emergent vegetation is delayed, either by climatic conditions or loss of habitat where emergence is early, the population may suffer significant mortality.

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

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

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

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

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

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

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

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

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

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

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

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

Numbers of Moose to be Impacted by Susitna Hydroelectric Development above Devil Canyon.

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

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

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

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

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

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

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

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

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

CARIBOU

Construction of the proposed Watana dam would create an impoundment which would intersect a major historical migratory route(s) of the Nelchina caribou herd. During most years between 1950 and 1973 most or all of the female-calf segment of the herd crossed from the calving grounds in the Talkeetna Mountains to summer in the greater Deadman-Butte Lakes area. This movement sometimes occurred in June after calving but more commonly took place in late July. Most crossings of the Susitna in the proposed impoundment area occurred between Deadman Creek and the big bend of the Susitna.

Varying proportions of the herd have wintered north of the proposed impoundment in drainages of the upper Susitna, Nenana and Chulitna Rivers in many years. Between 1957 and 1964 this was the major wintering area. Spring migration routes during these years would have undoubtedly crossed the impoundment area apparently between Deadman Creek and Jay Creek.

Some use of the proposed impoundment also occurred during the autumn dispersal period as animals moved from the Talkeetna Mountains north across the Susitna or vice versa. Some crossings by bulls which summered at various locations throughout the Nelchina Range and moved towards the female-calf segment prior to the rut occurred every year.

Large movements of caribou across the proposed impoundment have not occurred during the study period, nor have they been recorded since about 1976. Sixteen of 32 radio-collared caribou from the main Nelchina herd were either located in the proposed impoundment area or locations of sequential sightings indicated a high probability that they had been in the area a total of 22 times. Radio-collared caribou were found in the impoundment area during two periods, spring (about 10 April - 31 May) and autumn (1 August - 30 September); fourteen sightings were in spring while eight were in the fall. During spring 1981 it appeared from both relocations of radio-collared animals and sightings of tracks and caribou that many animals were using the Susitna River as a travel route. They apparently traveled the river from its confluence at the Tyone and Oshetna Rivers to Kosina Creek and Watana Lake where they moved west into the Talkeetna Mountain foothills. Nine crossings of the proposed Watana impoundment by six radio-collared caribou were documented (six were north to south and three south to north). Five occurred in spring and four in autumn. The uppermost portion of the Watana impoundment received the most use by radio-collared animals in both spring and autumn.

Even though crossings of the proposed Watana impoundment by Nelchina caribou have been relatively infrequent (when compared to historical records when virtually the entire herd crossed two or more times per year) it seems inevitable that they will again cross in large numbers. The area north and west of the Watana impoundment was used extensively as summer and winter range in the past and Skoog (1968) considered some of the area as the most important habitat for year around use in the Nelchina range.

It appears that major herd crossing of the impoundment area usually occurred when population levels were relatively high. During recent years when major crossings have not occurred the herd has been at low to moderate population levels and has only used about a third of its historical range (7,000 mi^2/20,000 mi^2). It has been suggested that the range use, frequency of shifts in range and seasonal splitting were positively correlated with herd size. It appears likely that the probability of major crossings of the impoundment area and increased use of the northwestern portion of the range will increase as herd size increases.

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 would 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. This could reduce use of the northwestern corner of the Nelchina range or change and extend the migration route to avoid the impoundment.

Another possible reaction would be avoidance by some components of the herd and attempted crossing by other segments. Other researchers have 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 and migratory barriers which normally could be easily circumvented could become sources of mortality. 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. Several instances of injuries and death resulting from falls on or through ice have been documented. Ice covered shores, ice sheets and steep ice shelves formed by winter draw-down of the reservoir could present formidable obstacles to movement. Ice shelving has been suggested 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.

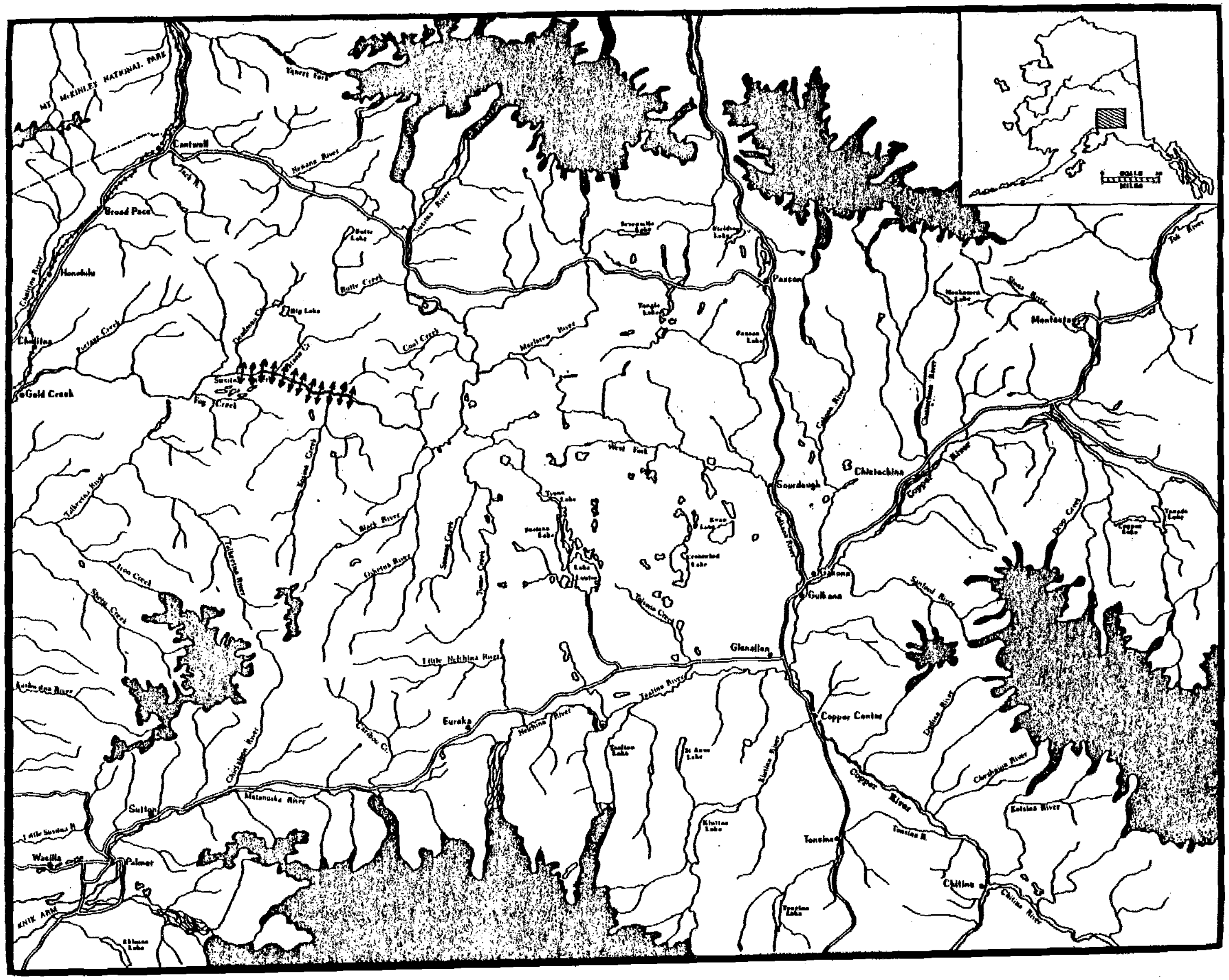

Figure 6: Area where historically the Nelchina caribou herd crossed the proposed impoundment area.

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. 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 than more placid bodies of water such as a reservoir. Open water may pose a barrier, particularly during post-calving movements and mid-summer migration. Large lakes are often crossed at traditional sites, often narrow points or where islands provide interim stopping points. They state "caribou prefer to avoid open water."

Relocations of radio-collared caribou demonstrated that at least during the study period three relatively discrete subherds occurred in the western portion of the Nelchina range. Two of these subherds, the Chunilna Hills and Susitna-Nenana groups, would probably become even more isolated from the main Nelchina herd by construction of the Susitna hydroelectric project although the extent probably would depend on locations of access corridors. The importance of periodic infusions of animals from the main herd for long-term persistence of these smaller groups is unknown.

Developments which would accompany construction and operation of the hydroelectric project such as roads, railroads and air fields and associated human activity might also negatively impact Nelchina caribou although the extent is virtually impossible to predict. Roads and railroads and resulting traffic have been suspected in obstructing movements of caribou and reindeer. However Nelchina caribou continue to cross the Richardson Highway, often in large numbers and have done so during many years since about 1960. Several studies have recorded responses of caribou to aircraft disturbance and speculated on deleterious impacts. Cows and calves were most responsive to disturbance. Caribou showed increased sensitivity during the rut and calving.

Electrical transmission lines have been reported to disrupt movements of reindeer in Scandinavia because of associated noises (hum) and because they are foreign objects in otherwise familiar surroundings. If electrical transmission lines 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. Several papers have been recently published dealing with caribou behavior and reactions to development and human activity. These studies provide guidelines which may help design developmental activities to minimize adverse impacts.

The proximity of the Nelchina calving grounds to the proposed Watana impoundments is of concern. According to some researchers, 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. Abandonment of a portion of the calving grounds of the central Arctic herd concurrent with development of the Prudhoe Bay oil fields has already been demonstrated.

Dr. Arthur Bergerud presented a somewhat different view and suggested that caribou are quite adaptable and will adjust to human construction and development. He stated 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 did 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.

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

WOLF

The most severe 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 or caribou density in the immediate vicinity of the impoundments would probably cause reductions in wolf densities for at least six to seven 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 by inundating den sites, rendezvous sites, travel corridors, and feeding areas. Loss of habitat would force wolf packs to readjust territory boundaries with neighboring packs which probably would result in an undetermined amount of mortality due to social strife. Lower wolf densities in the vicinity of the impoundments may also result in lower densities elsewhere. If populations reach low enough levels, wolves will no longer be able to disperse from the impoundment area to territories vacated 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

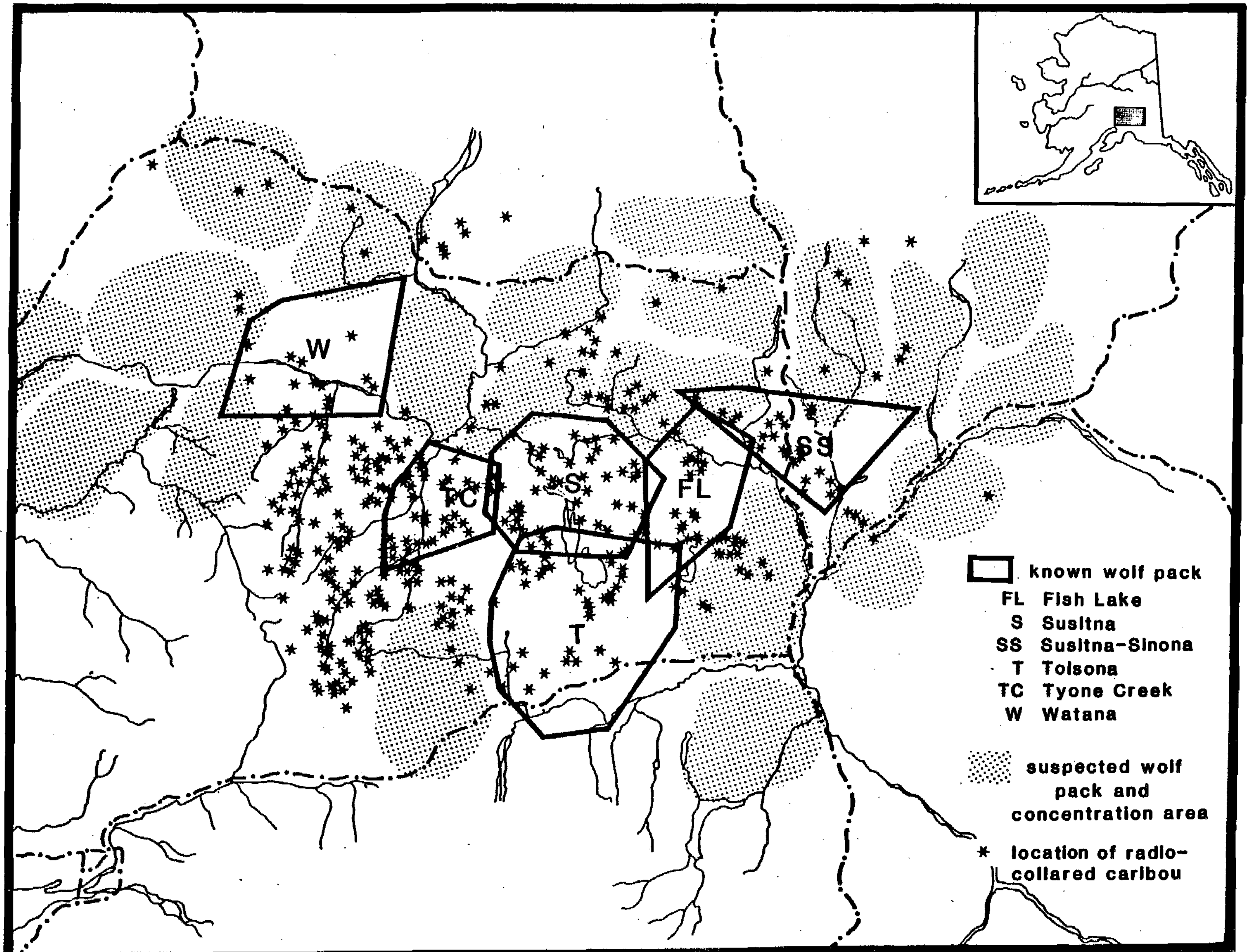

Figure 7. Distribution of main Nelchina radio-collared caribou, 14 April 1980 through 29 September, 1981 (from Pitcher 1981) in relation to known and suspected wolf packs and concentration areas within the Susitna and Nelchina River Basins of southcentral Alaska (from this study and Ballard et al. 1981).

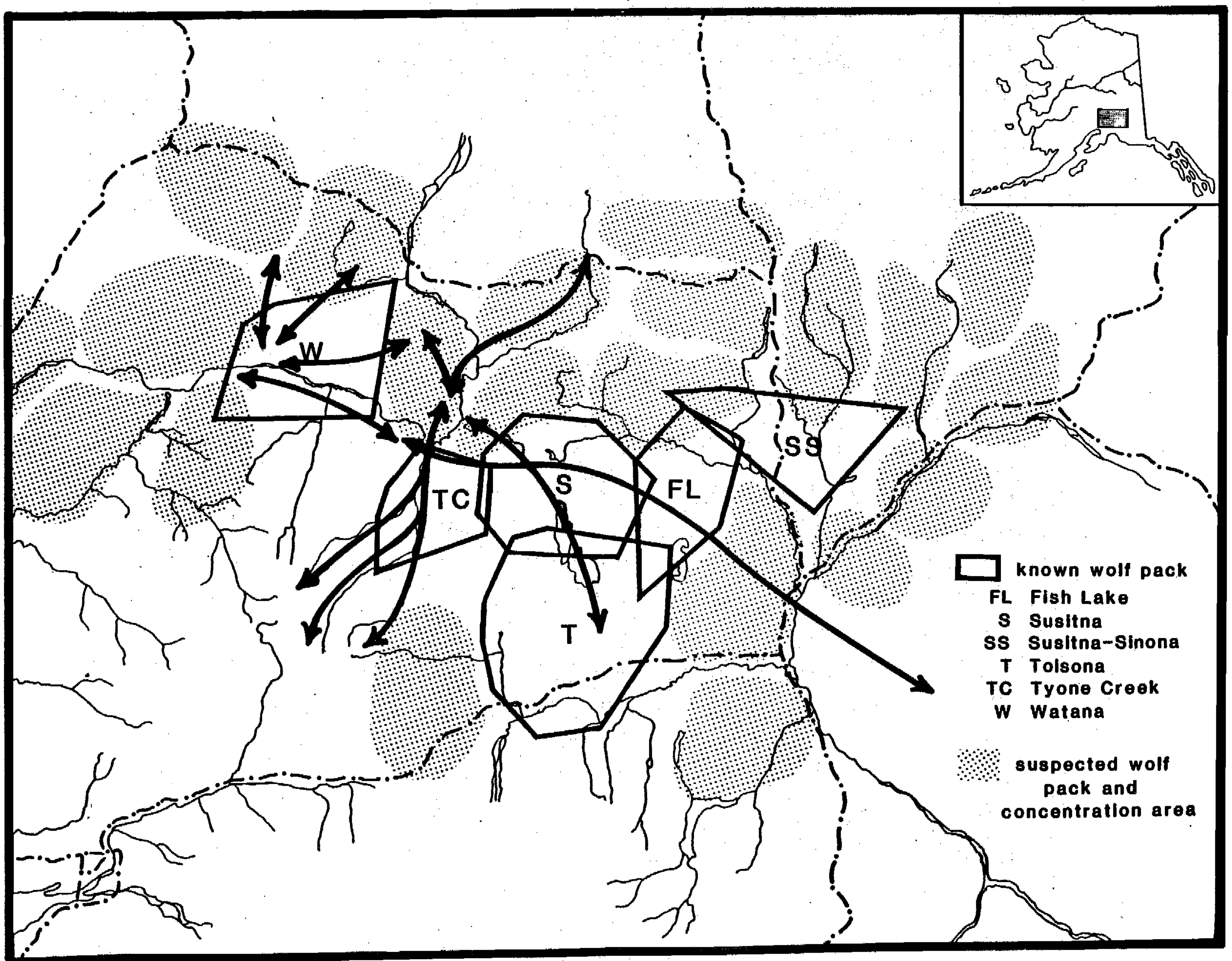

Figure 8. Migration routes and movement patterns of radio-collared moose in the Susitna and Nelchina River Basins (from Ballard and Taylor 1980; Ballard and Gardner 1981, 1981a; Ballard et al. 1981) in relation to known and suspected wolf territories (from this study and Ballard et al. 1981a).

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.

BROWN BEAR

Anticipated project impacts on brown bears are similar in type for both impoundments but are likely to be more severe in degree for the Watana impoundment than for the Devils Canyon impoundment. This is because the upper impoundment is in prime brown bear habitat while the lower impoundment appears to grade into habitat which is relatively better for black bears and poorer for brown bears. In order of suspected degree of impact, the proposed project is likely to influence brown bear populations in the following ways:

1. Reduction in the amount of lowland habitats along the river utilized by many bears early in the spring and by a few bears throughout the year. These habitats are the first to be cleared of snow in the spring (especially on south-facing slopes) and overwintered berries as well as early spring growth are available in these habitats relatively earlier than elsewhere. Nutritionally, early spring is likely to be the most critical period for bears. Much of the area used in the early spring will be inundated by the impoundments. Areas more distant from the impoundment shoreline may be affected by climatic changes caused by the impoundment (particularly delay of spring green-up).

2. Increased human presence during construction and operation of the dams will result in increased disturbance and hunting pressure which will lead to corresponding displacements and reductions of brown bear populations in the study area. Increased frequency of bears killed in defense of life and property situations is also an inevitable result of an increased human population; this can be minimized by proper preventative regulations during construction and operation.

3. Inhibition or blockage of directional seasonal movements to areas of reoccurring food abundance. Routes followed in these movements will be intersected by the impoundments, by

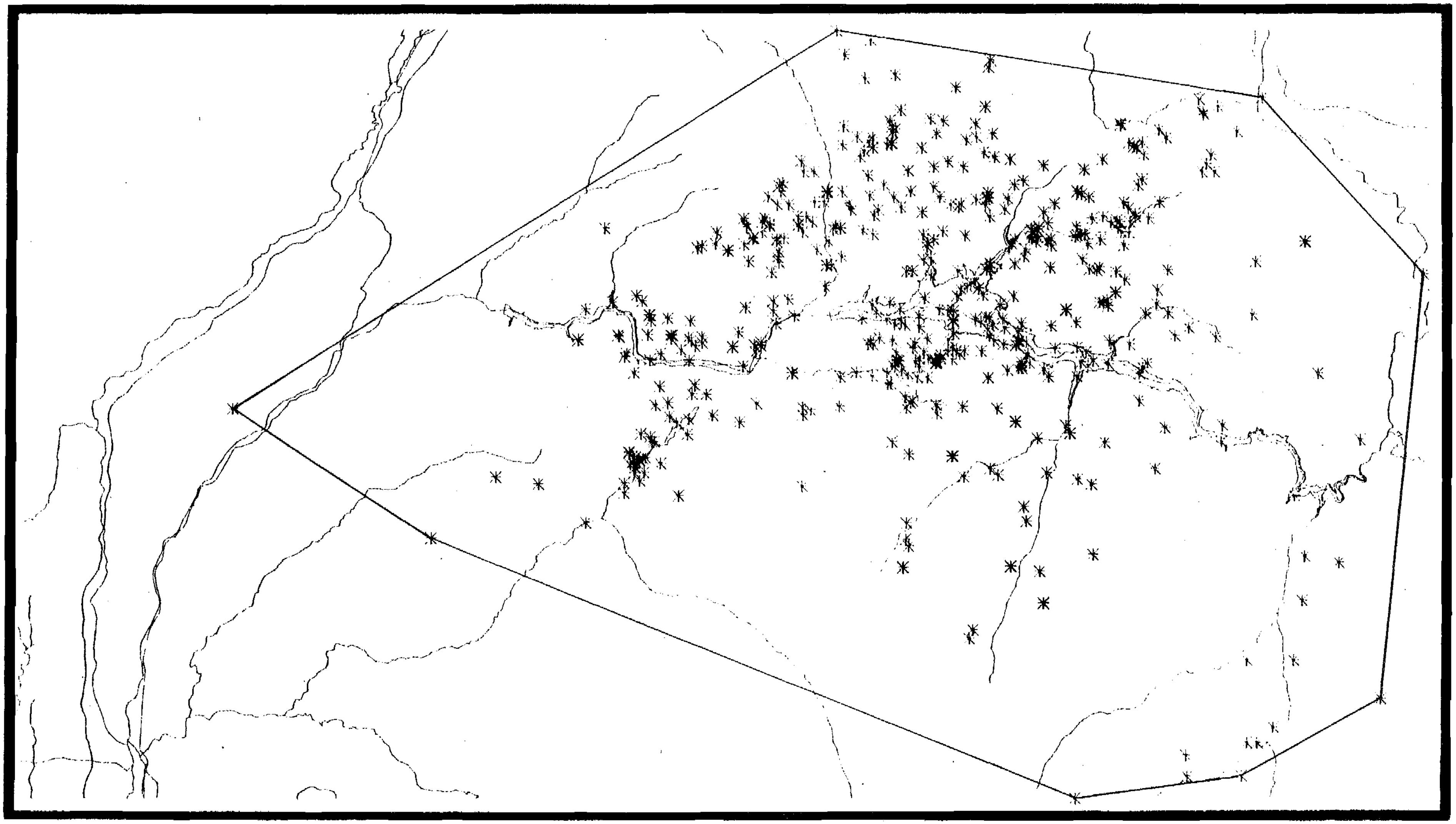

Figure 9. Brown bear study area (8473 sq. km). 513 brown bear locations are illustrated. (1 cm=7250 meters)

access routes, by borrow areas, and by construction and operation facilities and activities. The areas affected include caribou and moose concentration areas (especially calving areas), salmon fishing areas (especially Prairie Creek), and sites where vegetable forage is seasonally available.

4. Disturbance, but probably not much direct inundation, of brown bear den sites.

5. Indirect impacts through reduction of availability of salmon in Prairie Creek and downsteam of Devils Canyon. Based on available evidence, Prairie Creek salmon runs are unlikely to be significantly affected and there is little documentation, as yet, that many brown bears in the existing study area make seasonal movements downstream of Devils Canyon to fish. Brown bear populations that are resident downstream of Devils Canyon, however, are likely to be impacted by the anticipated project-related reduction or elimination of salmon spawning between Talkeetna and Devils Canyon.

6. Reduction of ungulate prey. This potential is listed last only because the importance of ungulate prey to bear populations was not part of the Phase I study plan. Studies elsewhere, including the upper Susitna River, suggest that predation on moose calves by brown bear in the spring is very common. Indirect evidence suggests that brown bear predation on caribou, especially on caribou calving grounds, may also be frequent.

BLACK BEAR

Upper Impoundment Residents and Transients

Black bears using the upper impoundment area can conveniently be broken into resident and transient subpopulation. The most affected subpopulation will be residents that have all or most of their annual home ranges upstream of the Watana Dam site, it is our suspicion that this group will be essentially eliminated by the proposed project through a combination of the following factors (listed in order of suspected degree of impact):

1. Inundation of den sites and scarcity of acceptable post-construction alternative den sites.

2. Elimination of habitat through inundation. Acceptable spring, summer, and denning black bear habitats in this area appear largely limited to the impoundment area and immediate vicinity, much of these habitats will be flooded.

3. Increased hunting and disturbance. Black bears in this area are currently very vulnerable to hunting by virtue of the constricted nature of their primary habitat (spruce forests along the river), this vulnerability will increase as the impoundment further constricts acceptable upstream spruce habitats. At present black bears are little hunted in this area because of its remoteness and difficulty of access; this pattern will change as project construction and operation improves access and augments the human population resident in the area.

4. Reduction of availability (through disturbance, habitat destruction, and/or climatic changes) of tableland areas used for forage in late summer and early fall. The tablelands between the spruce forests along the Susitna River and the adjacent mountains north of the river appear seasonally important for black bears. Access roads, borrow areas and construction facilities which transect these tablelands are

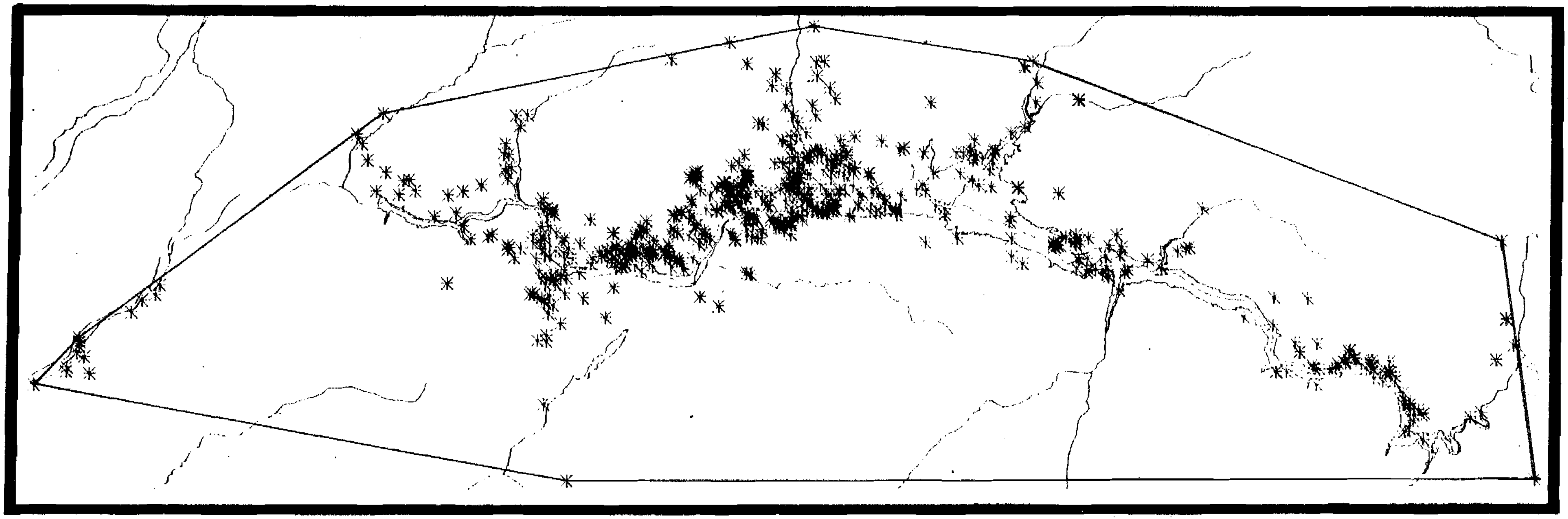

Figure 10. Black bear study area (4196 sq. km). 722 black bear locations are illustrated. (1 cm=6000 meters)

anticipated. These habitats in the vicinity of the upper impoundment are used both by bears resident in the upper impoundment area and by many transient bears that are resident in the vicinity of the lower impoundment earlier in the year.

5. Climatic changes. The nature, extent, and direction (deliterous or beneficial) of climatic changes resulting from the impoundment are uncertain. It is considered likely, however, that establishment of winter snow cover will be delayed by a warm-body effect of the mass of water behind the dam. This, in turn, may reduce the potential for berries (suspected important food in the early spring) to successfully overwinter because of the absence of a protective snow cover in the fall and early winter (this apparently happened naturally during the winter of 1980/81 when snow cover was abnormally slight and delayed). The warm impoundment waters may also cause some early winter precipitation to fall as rain rather than snow and may increase the amount of precipitation because of increased local humidity. Climatic impacts from the impoundment may be more serious in the spring when breakup may be delayed because of a possible cold-body influence of the frozen impoundments. This may retard the phenology of plants important to bears as early spring forage at the most vulnerable portion of the bear's annual life cycle (immediately following den emergence). Finally, climatic changes resulting from the impoundment (temperature changes, precipitation changes, etc.) may alter the distribution or abundance of berries (suspected critically important late summer and early spring foods) or other forage plants. *Vaccinium spp.* production, for example, appears naturally variable from year to year and appears to correlate with bear behavior; perhaps years of low *Vaccinium* production correlate with winter conditions or climatic conditions during pollination (increased spring precipitation may inhibit pollination). Although the types of climatic change which may result from the proposed impoundments are uncertain, as are the impacts of any such

changes on bears, it is noteworthy that black bears in this area are on the northern limit of their natural distribution south of the Alaska Range and are, correspondingly, likely to be in a somewhat precarious balance with their environment.

6. Elimination or reduction of salmon runs downstream of the Devils Canyon impoundment may eliminate an important alternative food source for upstream bears. This alternative may be important only during years when berry crops are subnormal. Based on available data the number of Watana impoundment-area residents that move downstream to fish for salmon during poor berry years may be small but has been documented (see discussion and range maps for B348 and B343).

7. Increased interspecific competition with brown bear including increased predation by brown bears. It is likely that the constricted distribution of black bears in the spruce forests along the river is adaptive to black bears in limiting the degree and effectiveness of brown bear predation, black bears can climb trees and brown bears cannot. If this is true, decreases in the amount of forested habitat could result in increased predation by brown bears, especially in the early spring when the two species are most sympatric.

8. Indirect impacts through reduction of ungulates, especially moose calves, that may be important prey items in early spring. This potential factor is listed last because of the lack of adequate data to reveal the level of predation that exists as well as uncertainties relative to the project's impact on moose populations. If such predation is important to black bear populations and if moose populations are markedly affected, this factor may rank first or second in importance.

The transient bear population, usually resident in the vicinity of the lower impoundment but moves to the upper impoundment in late summer to forage, will be affected in the upper impoundment area, by the same factors listed above in approximately the following order:

1. Reduction of availability of tableland areas used for forage in late summer and early spring (see #4 above).

2. Increased hunting and disturbance (see #3 above).

3. Climatic changes (see #5 above).

4. Reduction of downstream salmon runs (see #6 above).

5. Reduction of escape habitat on late-summer foraging grounds (see #7 above).

Lower Impoundment

The proposed Devils Canyon impoundment will doubtless have less severe impacts on local black bear populations than the Watana impoundment but impacts will be marked regardless. The topography of the lower impoundment area as well as the wider distribution of forested habitats downstream, will result in loss of a relatively lower proportion of acceptable black bear habitat downstream. In order of suspected degree of influence the anticipated impacts of the lower impoundment are:

1. Elimination of important early spring habitats through inundation and associated impacts of climate (retardation of spring phenology) on spring forage.

2. Reduction of the availability (through disturbance and/or climatic changes) of tableland area used by Devils Canyon-area black bears are upstream in the vicinity of Tsusena-Deadman- Watana Creeks. Impacts on these areas were discussed in points 4 and 5 above for bears resident in the upper impoundment area.

3. Increased hunting and disturbance (discussed in point 3 above).

4. Elimination or reduction of downstream salmon runs (point 6 above). This factor is of relatively greater importance to the black bears resident near the Devils Canyon impoundment because of their closer proximity to these runs. In late summer 1981 three radio-collared bears resident in the Devils Canyon impoundment area moved downstream, apparently to fish for salmon.

5. Inundation of den sites.

6. Reduction of ungulate prey. As noted above the importance of this factor is unknown which is why it is listed last. Potentially this could be the #1 or #2 impact on this sub-population of black bears.

Downstream impacts

The above predicted changes in black bear population density in the vicinity of the proposed impoundments may affect adjacent populations as well. The most likely source of this type of impact would be through reduction in the number of bears dispersing from the reduced population in the study area to adjacent areas, mostly to the west. As mentioned above, some documentation of such dispersals has been obtained in this study. However, the significance of this to adjacent populations is unknown. On the short-term, activities and disturbance associated with project construction and perhaps project operation as well could force some individuals to disperse. Some of the larger movements and dispersals observed to date could, arguably, be interpreted as resulting from the increased human activity associated with Phase I activities conducted during the last 2 years, this is considered unlikely however. Over the long-term, it would be more significant if the project area was a source of dispersing individuals moving to adjacent areas.

Available data collected by Su-Hydro fisheries biologists indicate that salmon spawning in mainstem Susitna between Talkeetna and Devils Canyon will be greatly reduced or eliminated as a result of the proposed project. If so, this would be likely to have a major negative impact on black bear populations in this area that may depend on salmon for food. Reduction of periodic flooding of downstream riparian habitats which would result from the project may also reduce the availability of early-successional stage forage which may be particularly important in the spring. These possibilities are conjectual as downstream bear studies were not conducted in Phase I, they should be a part of any Phase II studies.

WOLVERINE

The most obvious potential impact of the Susitna Hydroelectric Project on wolverine is loss of over 20,600 hectares due to inundation and associated construction of camps, roads, borrow pits, and transmission corridors. Human-wildlife contacts may also be severe. According to Robert J. Krogseng, Resident Manager for Terrestrial Environmental Specialists, Inc., at the height of construction there will be 5,000 workers within the area. The potential for an increase in both harassment and hunting and trapping pressure due to human activity and easier access into the area is likely and can be seriously detrimental to a low density species like wolverine.

The scavenging nature of wolverine could bring them in contact with the camps lending to additional mortality if garbage disposal and the use of firearms are not strictly regulated. If the population is now being harvested at maximum sustained yield this could have a serious impact on the population.

Once construction is completed, a permanent core area will be built to house a minimum of 120 maintenance workers (Robert Krogseng pers. comm.). The long term effect on wolverine distribution will probably be a significant shift away from the permanent facilities. This will probably cause a decrease in wolverine numbers due to an increase in competition for food, mates and territories.

The loss of habitat as it affects the wolverine's prey species will probably cause reductions in wolverine densities. A decrease in the food base would probably increase competition between wolverine, and between wolverine and other scavengers and predators. These changes could alter home range size and seasonal movements and result in lower wolverine densities.

An additional potential long term impact on wolverine is that once the project is operational, commercial development may occur on lands adjacent to the impoundments since much of the area may be in private ownership due to the Alaska Native Claims Settlement Act.

DALL SHEEP

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. However, the proposed borrow pit and the corresponding roads to be located on upper Tsusena Creek could potentially cause a significant shift in sheep distribution and a loss of critical winter range. 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. This distribution was not confirmed by the July 1980 or the single winter survey. More survey information is needed.

The Watana Hills sheep population appears to be the most vulnerable to severe impact from the proposed Watana impoundment. Its close proximity to the impoundment makes the population extremely vulnerable to disturbance from construction and transportation activities which could alter behavior, affect lambing success and force abandonment of the Jay Creek mineral lick.

The Watana Hills sheep population appears to be isolated from other sheep populations. Thus, recovery of this population, if severly impacted by short term construction activities, could be slow relative to other sheep populations.

A portion of the Jay Creek mineral lick will be inundated by the Watana impoundment. The importance of this lick to the sheep population is not known but our preliminary observations suggest that a significant portion of the sheep population utilize the area during late May and June. Sheep also use the area during other months of the year but adequate documentation does not exist. If sheep utilize the mineral lick similarly to those recorded elsewhere in Alaska, significant portions of the Watana Hills sheep population could be influenced, particularly if late spring snow depths are influenced by the impoundment. Another lick 7 miles to the north could provide an alternative source of mineralization for the sheep utilizing the Jay Creek lick, but the chemical content of both licks is unknown at this time. Also the season and type of use at the alternative lick could be a significant factor dictating whether additional use could or would be tolerated. Additionally, if only certain sex or age classes traditionally utilize the licks, different segments of the sheep population may not be aware of the existence of alternative areas.

The scope of the Phase I sheep studies was not adequate to assess the potential impacts of the project on sheep. Considerable expansion of study efforts will be required during Phase II.