SUSITNA HYDROELECTRIC PROJECT

PHASE II PROGRESS REPORT

RECEIVED
APR 2 8 1983
ALASKA POWER AUTHORITY

ALASKA
DEPARTMENT OF FISH AND GAME

BIG GAME STUDIES

Volume I BIG GAME SUMMARY REPORT

ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the Alaska Power Authority

April 1983

SUSITNA HYDROELECTRIC PROJECT

PHASE II PROGRESS REPORT

BIG GAME STUDIES

VOLUME I. BIG GAME SUMMARY REPORT

ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the

Alaska Power Authority

April, 1983

PREFACE

In early 1980, the Alaska Department of Fish and Game contracted with the Alaska Power Authority to collect information useful in assessing the impacts of the proposed Susitna Hydroelectric Project on moose, caribou, wolf, wolverine, black bear, brown bear and Dall sheep.

The studies were broken into phases which conformed to the anticipated licensing schedule. Phase I studies, January 1, 1980 to June 30, 1982, were intended to provide information needed to support a FERC license application. This included general studies of wildlife populations to determine how each species used the area and identify potential impact mechanisms. Phase II studies continued to provide additional information during the anticipated 2 to 3 year period between application and final FERC approval of the license. Belukha whales were added to the species being studied. During Phase II, we are narrowing the focus of our studies to evaluate specific impact mechanisms, quantify impacts and evaluate mitigation measures.

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

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

The reports are organized into the following 9 volumes:

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

TABLE OF CONTENTS

DOWNSTREAM MOOSE

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 Cook Inlet. To accomplish this objective one must thoroughly understand how moose depend on floodplain habitats along the Susitna River. Only then, will one be able to assess the relative importance of various floodplain characteristics to moose and integrate those findings with hypothetical post-project conditions to fully evaluate project impacts on subpopulations of moose. This report is primarily based on data gathered between 15 October 1982 and 15 October 1983 but also includes pertinent findings from the Phase I study final report (Modafferi 1982).

Data on patterns of movement, habitat use, productivity, survival and identity of subpopulations for moose ecologically affiliated with the Susitna River were primarily synthesized from 2178 radio relocations up to 15 October 1982 of 57 moose captured and radio-collared in floodplain habitats along the Susitna River between Devil Canyon and Cook Inlet (Fig. 1). Radio-collared moose were relocated at about biweekly intervals through 16 March 1981 and about 10-day intervals from that time through 15 October 1982. This schedule provided 7, 10, 12, 7, 7 relocation sites for most individuals monitored during the winter (1 January thru 28 February), calving (10 May thru 17 June), summer (1 July thru 31 August), "hunting season" (1 September thru 30 September) and breeding (14 September thru 15 October) periods, respectively. Most data collected from radio-collared moose were analyzed relative to these periods in the life history of moose. Effects of sex, subpopulation and year factors were considered in interpretive analyses. Radio-relocations dated outside of these periods were grouped within spring, summer, autumn and post-breeding transitory intervals.

To assess magnitude of seasonal and regional moose use of floodplain habitats along the Susitna River from Cook Inlet to Devil Canyon, radio-relocation data were integrated with information collected on 6 and 7 aerial censuses for moose conducted between 9 December 1981 and 12 April 1982 and between 29 October 1982 and 22 February 1983, respectively.

Data from river censuses, in turn provided additional and independent information on productivity/survival of moose which winter in Susitna River floodplain habitats. In these interpretive analyses, sex, seasonal period and subpopulation categories were considered.

Some individual moose were found to range mostly within Susitna River floodplain habitats, other individual moose only used those habitats during the winter and/or more frequently during the

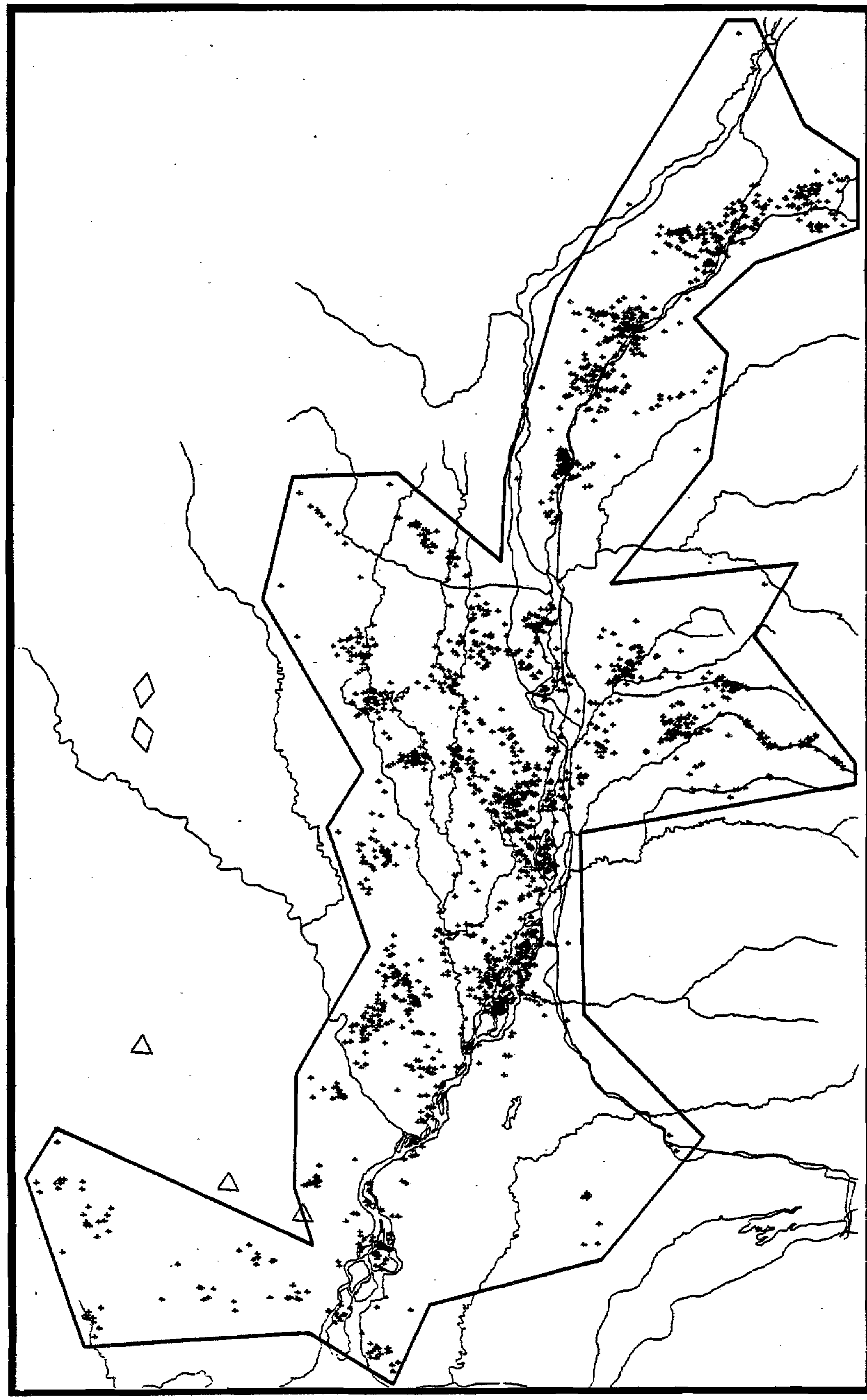

Figure 1. Polygon encompassing 2178 relocation points for 10 moose radio-collared 17 April, 1980, 29 moose radio-collared 10-12 March, 1981 and 17 moose radio-collared 26 February - 10 March, 1982 along the Susitna River between Devil Canyon and Cook Inlet, Alaska and monitored through 20 October, 1982. (inclusive area = 8938 km^2)

calving period, and other moose used floodplain habitats during one of those periods and also traversed riparian areas when moving from one range to another. Though most radio-collared moose used the Susitna River primarily as a winter range between January through April, about 16 percent of the radio-collared moose frequented floodplain habitats in extensively islanded areas throughout the year. For the second consecutive year of study, radio-collared female moose north of Talkeetna sought island and riparian habitats along the Susitna River near the time of calving. The later movement pattern was attributable to availability of nutritous food and/or avoidance of predators.

Preliminary findings from radio-collared moose that winter in the Susitna River floodplain resulted in 3 subpopulation classifications for individuals with breeding ranges centered in areas: 1) to the north of Talkeetna, 2) to the south of Talkeetna and on the eastside of the Susitna River and 3) to the south of Talkeetna and not in eastside areas. Observations of movement patterns from more recently radio-collared moose suggest that two other discrete subpopulations of moose which winter in the Susitna River floodplain frequent the Little Susitna River/ Wasilla area or the Mt. Susitna/Beluga Lake area at other seasonal periods.

Radio-collared moose north of Talkeetna seldom ranged farther than 8 km from riparian habitats; moose south of Talkeetna commonly ranged farther than 8 km from the Susitna River and relocations up to 40 km from floodplain areas were not uncommon for the later area. Though moose north of Talkeetna did not range far from riparian habitats, some did travel greater distances, parallel to the river, during each annual cycle.

Large variation was observed in movements and sizes of ranges for radio-collared moose. Males generally ranged over greater distances than females. Many individual moose were found to range over larger areas during the second year of study. Similar but smaller increases in range size were observed after 2 years of study. Most but not all radio-collared moose returned to floodplain habitats each winter. One male did not return to Susitna River riparian habitats for two consecutive winter periods.

Since magnitude of use of winter range by Susitna River Valley subpopulations of moose is partly related to severity of climatic conditions, findings presented in this report must be considered as preliminary since sampling occurred and data were accumulated during the relatively mild or average winters between 1979 and 1983. The later winter, which was characterized by large amounts of snowfall through December and was subsequently followed by mild conditions and recession of snowcover provided some information on weather related variations in behavior of moose and substantiated importance of this concern.

In the winter of 1981-82, a maximum of 369 moose were observed in 6 censuses of floodplain habitats along the Susitna River between

Cook Inlet and Devil Canyon. A maximum of 934 moose were observed in 7 similar censuses conducted in the winter of 1982-83. For the later winter, densities of moose greater than four per km^2 of surface area were calculated for moose occupying floodplain habitats between the Yentna River and Cook Inlet in late December. Overall observations indicated unequal distribution of moose within and between four geographic zones of the Susitna River. Within and between year variation in moose use of floodplain habitats were associated with winter weather conditions.

Movements and distribution of radio-collared moose substantiated that impacts to moose which seasonally use Susitna River floodplain habitats may ultimately be realized at great distances from the Susitna River. In addition, each subpopulation of moose may be vulnerable to different types of impacts. Similarly, mitigation measures need not be limited to floodplain areas to be effective, but may have to be specific for a particular subpopulation of moose.

Ninety-seven percent of the radio-collared female moose were known to produce young in 1982; of them 59 percent produced twins. Calf production in 1982 appeared greater than in 1981 after parturition, but by November ratios of calves per female were similar for both years. Early winter weather conditions were more severe in 1982 than in 1981 and may account for the decrease in calf survival observed in 1982.

Moose in subunits 14B and 16A provide recreational opportunity and sustenance for large numbers of hunters, many of which are from urban areas. Subpopulations of moose in areas along the Susitna River north of Talkeetna provide for significantly fewer people (mostly local residents).

Mortality of moose recorded during the study was attributed to hunting (on male and female moose), accidents associated with the Susitna River such as slipping on ice, drowning, perhaps on ice or log jams during high water, and predation by brown bears. Data indicated that males sustained higher rates of hunting mortality and females experienced higher rates of non-hunting mortality.

Moose winter use of sites where vegetative associations have been altered to more seral communities by activities of humans was documented. During the winters of 1981-82 and 1982-83, it was not uncommon to observe 40-60 moose in each of several sub-climax sites about 3 km^2 in size. Because of the potential for habitat rehabilitation as a mitigation option, it was recommended that research studies designed to more fully understand the interrelationships between rehabilitated habitat and ecology of moose in the lower Susitna River Valley be initiated.

Limitations of sampling methods and present samples and their relationship to differential behavior and winter weather conditions were discussed. It was proposed that more radio-collared moose, particularly males, need to be studied north of Talkeetna. It was also suggested additional males be radio-collared and monitored in other areas further downstream. The need for a contingency plan designed to study all subpopulations of moose during a severe winter, was reiterated.

Potential Major Impact Mechanisms and Associated Effects

Altered Seasonal River Flow Patterns and Loss of Annual Variation in River Flow: soil erosion and deposition, inundation, drought, ice jams, ice scouring (influence through destruction of vegetation and influence on main channel erosion and redistribution of soil), fertilizing effects of inorganic and/or organic nutrient loads, water or ice surface area, redistribution of debris, terrestrial floodplain surface area, floods, effects on beavers, bears or other subpopulations of moose, composition, distribution and/or abundance of plant species or plant communities.

Altered Water Temperature: ice fog/fog (physical, physiological, visual, insolation and insulation); frosting of vegetation; plant phenology; composition, distribution and/or abundance of plant species or communities; ice scouring; ice jams; open water in winter.

Alteration of Habitat: transmission corridors, railway and vehicle rights of way; project facilities, attractant for predators and conspecific competitors.

Increased Access: transmission corridors; railway and vehicle rights of way; winter boating.

Human Encroachment: construction and maintenance employees; hunters; visitors; recreators.

Increased Railway and Vehicular Traffic: disturbance, interference with movement, direct mortality.

Impoundment: inundation displaces predators and conspecific competitors.

Altered Turbidity: composition, distribution and/or abundance of aquatic plant species.

Salt Water Encroachment at Cook Inlet: composition, distribution and/or abundance of aquatic and riparian plant species.

Altered Ecosystem: secondary and tertiary effects from impacts on plant and other wildlife species as salmon, beaver, bears, wolves and other subpopulations of moose.

UPSTREAM MOOSE

Phase I moose studies (Ballard et al. 1981; 1982) were directed at determining how moose use the area in and around the two proposed impoundments, determining the approximate number of moose using the area, and identifying potential impact mechanisms. Phase II moose studies were designed to provide refinement of the information gathered during Phase I studies. The principal objectives of Phase II studies are as follows:

(1) To delineate a zone of impact of the Susitna Hydroelectric Project on moose.

(2) To determine the number of moose using the zone of impact and habitat which will be altered by construction of the Susitna Hydroelectric Project during winter and early spring.

(3) To determine changes in moose use of an area before and after a prescribed burn.

(4) To evaluate moose use of potential mitigation lands.

(5) To develop a habitat-based assessment of the current value of lands that will be lost or altered to moose.

This report updates some of the findings presented in the Final Phase I report (Ballard et al. 1982) with additional data collected from mid-August 1981 to early June 1982.

Preliminary analyses of movements of 10 adult cow moose radio-collared in a proposed experimental burn area near the Alphabet Hill revealed the presence of 3 subpopulations occupying the area--2 wintering and 1 resident. From an intensive aerial census of the proposed burn and adjacent area during March 1982, an estimated 279 moose occupied the 47,000 acres.

In fall 1982, 22 adult radio-collared moose within the Susitna Hydroelectric Study area were recaptured and recollared in an effort to continue movement and habitat use studies during Phase II. Home range sizes and movements of moose during the reporting period were presented. During 1982, 20 radio-collared moose crossed the Susitna River in the vicinity of the impoundments a minimum of 42 occasions. Forty-nine percent of the crossings were initiated during the month of January, February, May and September.

Based upon locations of radio-collared moose which utilize the impoundment, boundaries of impact zones were delineated. Zones were classified as primary, secondary, and tertiary. The primary zone included radio-collared moose which would be directly impacted by the project, while the secondary zone was comprised of moose which overlapped home ranges of moose occupying the primary zone. Population estimates ranged from approximately 1,900 to 2,600 moose which could be directly impacted by the project. Moose occupied the impoundment areas more during the months of March-May than other time periods. Two hundred and ninety moose were estimated to inhabit the Watana impoundment area from an aerial census on 25 March 1982.

Habitat use of radio-collared moose was assessed by overlapping moose locations on preliminary vegetation maps. In relation to availability, moose preferred woodland black spruce, open black spruce, closed mixed forest, and woodland white spruce types. Lakes, rock, sedge-grass tundra, sedge-shrub tundra and mat-cushion tundra were not preferred.

For the Watana impoundment area on a year-round basis, elevations ranging from 2001-2200 and 2401-3000 ft. were used more by radio-collared moose while elevations ranging from 1201-1400 and in excess of 3200 ft. were used significantly less, in relation to availability. During winter and spring, elevations ranging from 1601-2000 and 2201-2800 ft. were used more than expected. Use of slopes and aspects were not random.

During the reporting period a moose population dynamics model was developed and tested in an effort to predict population trends under preproject conditions. Components of the preliminary model are presented and discussed. Eventually the model will be used to test hypotheses concerning the impacts of Susitna Hydroelectric development on moose.

Impact Mechanisms

Table 1 summarizes the major structural features associated with the construction and operation of the Susitna Hydroelectric Project and a description of their potential impact on moose. In an effort to assess the effects of these impacts on moose, they were related to the basic components of the moose model (Table 2). Based upon this assessment, the proposed project will affect the population dynamics of upper Susitna moose and their predators. The exact magnitude of these effects, however, will require refinement as studies proceed and actual operation is commenced. We estimated that based upon numbers of radio-collared moose utilizing the impoundment areas in relation to the 1980 census, from 1900 to 2600 moose could be directly impacted by construction and operation of the Watana and Devil Canyon impoundments. These estimates comprised 8 to 11% of the total numbers of moose occurring in GMU-13. Including moose which could be secondarily impacted by the project through increased competition from displaced moose, etc., approximately 45% of the GMU-13 moose population could be affected to varying degrees by the proposed projects. Moose modeling efforts currently underway will be adapted to incorporate anticipated effects of the project on the individual components of the moose population.

Table 1. Susitna Hydroelectric Project actions and their potential effect on moose numbers, distribution and habitat in the Susitna River Area.

Project Action	Environmental Effect
Construction and operation of dams (staging zone, camps, and structures)	Loss of winter range. Avoidance of adjacent winter range. Loss of spring-summer range. Avoidance of spring-summer range. Possible impedence to migration.
Spoil sites	Temporary loss of winter-summer range. Temporary avoidance of adjacent habitat.
Borrow areas	Permanent and temporary loss of winter habitat. Permanent and temporary loss of spring-summer habitat. Temporary avoidance of habitat.
Reservoir clearing	Loss of habitat. Temporary avoidance of adjacent areas.
Permanent village facilities	Loss of habitat. Avoidance of adjacent areas.
Main and accessory roads and railroads.	Loss of habitat. Permanent and temporary avoidance (disturbance) of adjacent habitat. Mortality from collisions. Increased human-related mortality (hunting, defense of life, etc.).
Airstrips	Increased commercial and recreational development on adjacent lands. Loss of habitat. Temporary avoidance (disturbance) of adjacent areas. Increased human access and human-related mortality.
Transmission line construction, access and operation	Temporary avoidance of habitat. Increased access. Temporary loss of habitat. Eventual summer habitat improvement. Potential for increased commercial and recreational development
Fill and operation of impoundments	Permanent inundation of winter range. Permanent inundation of spring-summer range. Increased snow depths on adjacent area. Increased snow drifting on adjacent areas. Icing on vegetation due to open water. Impedence of movements due to open water during subfreezing temperatures. Increased mortality from attempting to cross thin ice. Impedence of movements and increased mortality due to ice shelving. Increased mortality crossing mud flats. Unstable slopes causing habitat loss. Crowding on adjacent habitat. Increased human access. Decreased vegetation productivity on adjacent lands due to climatic changes.

Table 2. Potential impacts of Susitna Hydroelectric development on annual moose population parameters.

Moose Population Parameters	Projected Impact of Project Events
Reproduction	Decline in reproduction due to lower population size resulting from increases in winter mortality, accidental mortality, hunting and predator mortality from abnormal concentration of moose and predator.
	Decreased productivity resulting from decreased vigor because of increased snow depths, decreased quality and quantity of forage from weather, icing, and overbrowsing; increased disturbance (both human and predator), and delayed spring green up.
Early spring and summer mortality (excluding predation)	Increase in still births due to reduced vigor of cows.
	Increases in drowning and accidental deaths.
	Increase in incidence of disease and pneumonia from delayed greenup, poor nutrition, and more severe weather conditions.
Spring wolf predation	Temporary increases in numbers of wolves may be influenced by increased availability of prey leading to increased fecundity, double denning and greater pup survival. Results in increased predation on both calf and adult moose because of abnormal concentrations of moose and their reduced health following winter.
	Short term severe overbrowsing of moose habitat and increased mortality result in lower moose moose densities.
	Lack of rapid wolf population response to lower moose numbers intensifies effects of predation and lowers moose population further. Eventually results in lower numbers of predators and prey which "stabilize" at low level.
Summer wolf predation	Similar to above.
Brown bear predation	Temporary increases in density of bears due to decreased availability of south facing slopes and forced concentrations.
	Result: Increased predation on calf and adult moose due to abnormal conditions of moose and reduced vigor of adults and calves from poor nutrition and increased winter severity.
	Bear productivity and survival increase responding to increased availability of prey. Results in increases in bear predation on moose and drives moose population lower. Bears' ability to utilize alternate food source maintains abnormal densities of bears for long period and decreases moose population further. Ultimately both bear population and moose population stabilize at lower level.
Black bear predation	Short term:
	Bears lose den sites and for short period prey intensively on moose before population declines.
	Long term:
	Due to decline in black bear population this source of mortality declines.

Table 2. (cont'd)

Moose Population Parameters	Projected Impact of Project Events
Hunter harvest	Potential increase in harvest due to improved access and increased vulnerability caused by moose occupying new habitat areas not previously occupied. Depresses bull:cow ratios, possibly leading to decreased productivity. Probable that harvests will be limited by regulations; however, dispersal of moose from impoundment areas could temporarily increase and cause temporary increase in numbers of available moose elsewhere in GMU 13. Ultimately, however, declines in population size will reduce dispersals and reduce numbers of moose available for harvest.
Winter mortality	Winter mortality from starvation increases due to overbrowsed range in areas adjacent to impoundments, loss of habitat, icing on vegetation, increased snow depths and delayed spring green-up. Accidents increase from open water, ice shelving, and unstable reservoir ice.
Winter wolf predation	Concentrated wolf and moose populations on winter range result in increases in surplus killing by wolves. Moose more vulnerable due to increased snow depths, lower availability of forage, poorer quality and quantity of remaining forage. In addition, traditional escape routes no longer available due to ice shelving and unstable ice conditions. Increased availability of prey result in wolf population increase. Time lag in response of wolf population to decreased moose density further depresses moose population. Eventually wolf population declines and adjusts to lower moose density. Both populations "stabilize" at lower levels.

MITIGATION

Current investigation is focused on the experimental burn to improve moose habitat in the Alphabet Hills.

CARIBOU

Plans to construct a large hydroelectric project on the Susitna River within the western portion of the Nelchina caribou range have raised concerns about the welfare of this important caribou herd. Impact studies, which began in early 1980, continue with the basic objectives of monitoring herd status, determining range use and migratory routes and delineating subherds. The results of these studies are being used to evaluate potential impacts of project construction, to make recommendations to minimize adverse impacts and to evaluate mitigation measures. Extensive use of historical records of the Nelchina herd has been made in the analyses because of the changeable nature of caribou movement patterns. Primary methodology for the study was the repetitive relocation of radio-collared caribou (Fig. 2). Population estimates were made with a modified version of the aerial photo-direct count-extrapolation census procedure and by direct count.

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

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

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

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

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

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

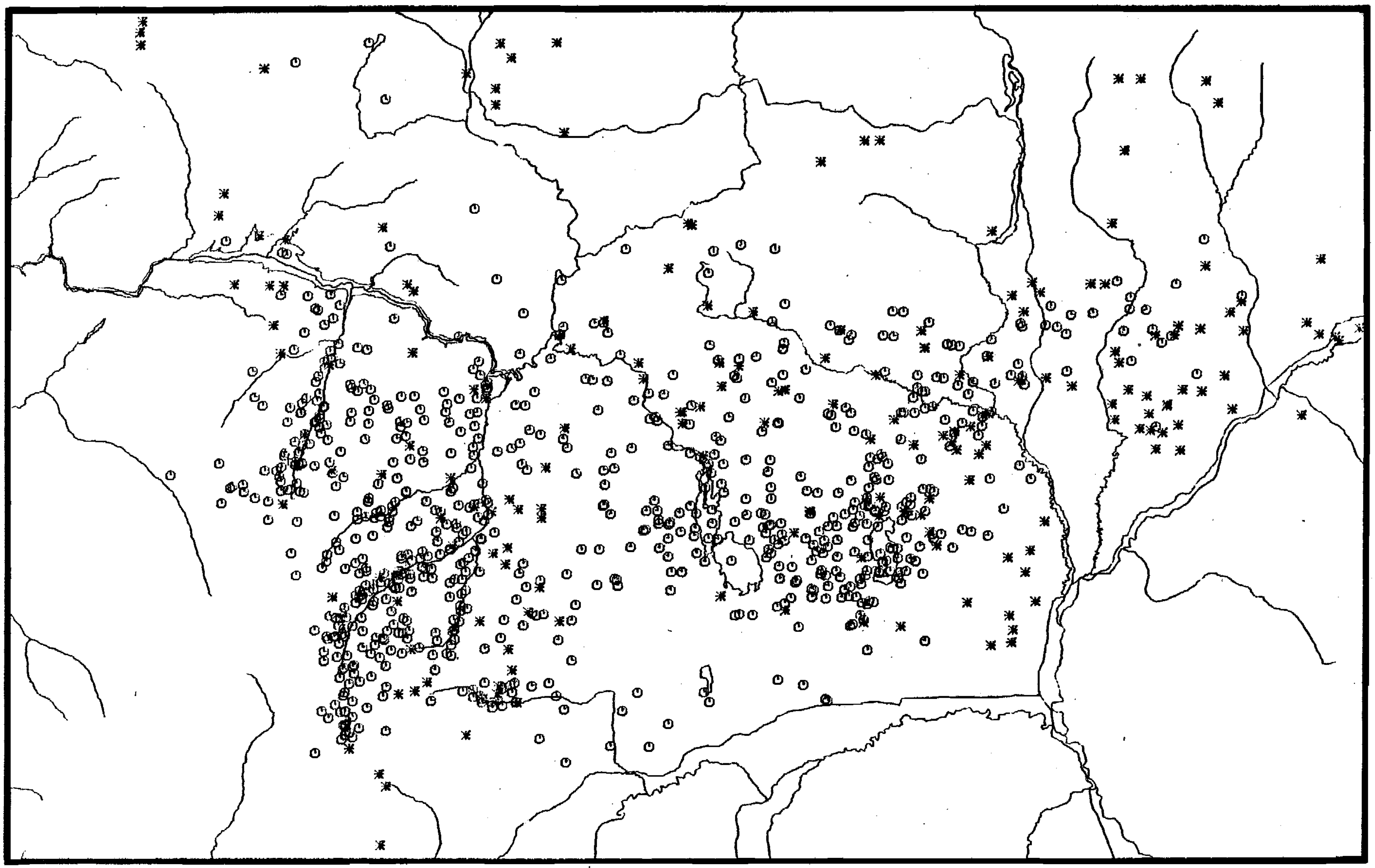

Figure 2. Distribution of main herd Nelchina radio-collared caribou during entire study period, 14 April, 1980 – 15 October, 1982. O = females, ✱ = males.

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

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

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

Observations of radio-collared (and non-collared) caribou indicated the existence of a discrete subherd resident in the upper drainages of the Susitna, Nenana and Chulitna Rivers (upper Susitna-Nenana subherd (Fig. 3). Although overlap with animals from the main Nelchina herd occured during winter, summer and fall they were separated during calving. An initial census (direct count) of this subherd was attempted in October 1982 and 2,077 caribou were counted. Complications in evaluating the count resulting from delays from weather and movement of mainherd animals through the area make it desireable to repeat the census.

Potential Impacts of Project Construction

Significant numbers of Nelchina caribou migrated through the proposed Watana impoundment during three periods in 1982. During spring migration (approximately 7 May - 20 May) perhaps 50% of the female segment moved through the upper reaches of the Watana impoundment area enroute to the calving grounds. In mid-August about 15% of the female segment crossed the upper Watana impoundment area and moved onto the Jay Creek - Coal Creek plateau. During the second week of October about 10% of the herd crossed the Susitna River in the area between Fog Lakes and Kosina Creek and migrated across the Jay Creek - Coal Creek plateau. It was apparent, that even though the massive north-south migrations across the Susitna which occurred with regularity in the past did not occur, that large numbers of Nelchina caribou do currently cross or move along the Susitna River in the area of the proposed Watana impoundment. While it is not possible to predict the impacts of the Watana impoundment on migrating caribou it does appear that the greatest potential for deleterious impacts occurs during the spring migration to the calving grounds. This would be during a period of transition from an ice-covered reservoir at maximum drawdown with ice shelving and ice covered shores to an open reservoir rapidly filling from spring runoff. Particularly hazardous conditions could occur if windrows of broken ice accumulated along the southern shore leaving the northern shore ice

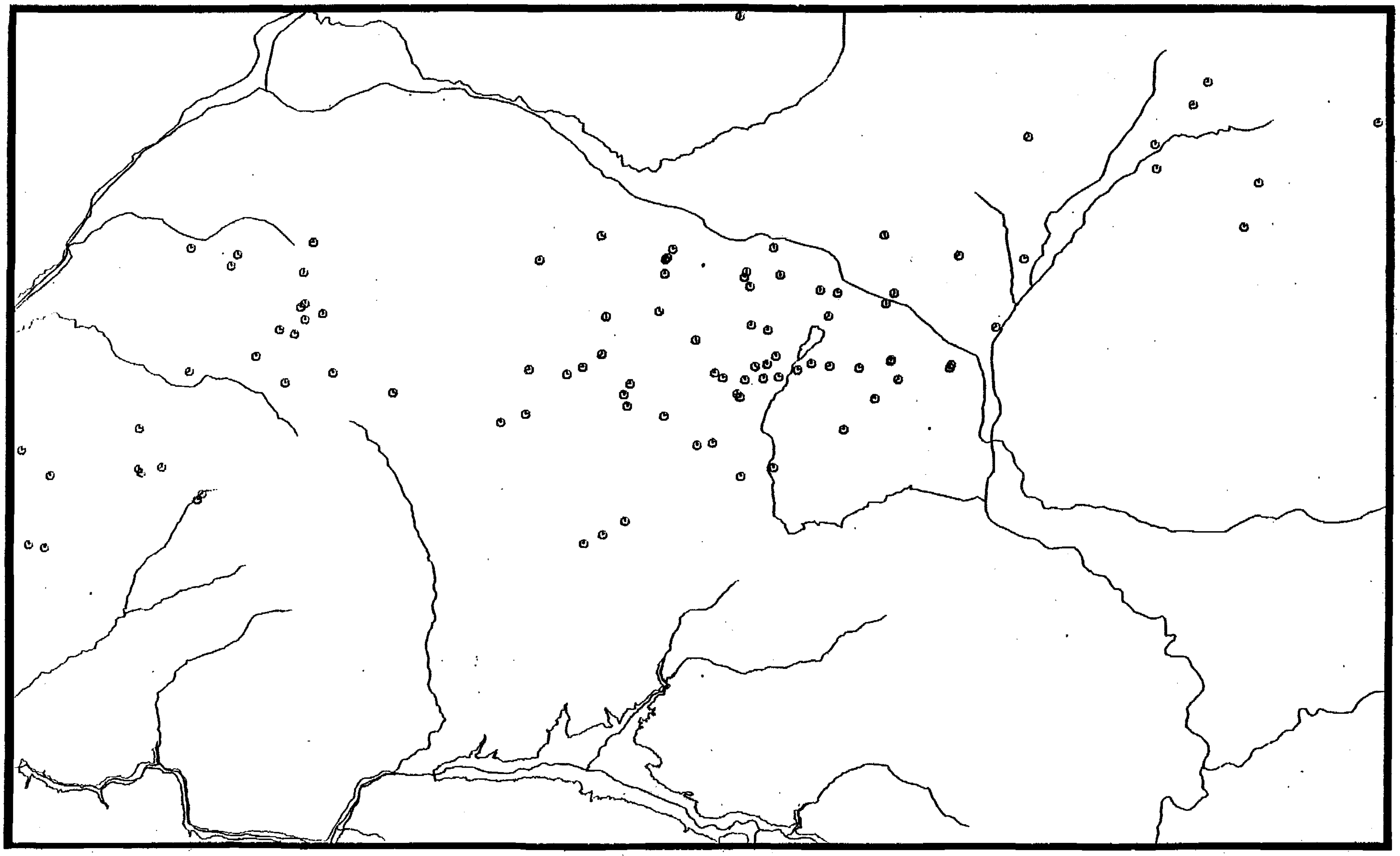

Figure 3. Distribution of Upper Susitna - Nenana subherd radio-collared caribou, 9 May, 1980 through 15 October, 1982.
O = females, ✳ = males.

free. Caribou enroute to the calving grounds would at first encounter open water but might have difficulty leaving the reservoir with the mass of jumbled, broken ice. Pregnant females are often in the poorest condition of the year at this time and might be particularly vulnerable to migratory barriers.

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

Crossings during summer and fall when the reservoir would be ice free appear to pose less hazard. Caribou are excellent swimmers and are known to cross much larger bodies of water than the proposed impoundment. Young calves might have problems if the migrations occurred shortly after calving. Rafts of floating debris could cause problems for the first few years after filling the impoundment. Mortalities of moose who could not reach shore because of floating debris have been reported in impoundments in Canada (Ballard, pers. comm).

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

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

Reports on reactions of caribou to roads and vehicular traffic are somewhat contradictory. Cameron et al. (1979), in the most thorough study to date, documented avoidance of the Trans-Alaskan Pipeline corridor by females and calves during summer (the Denali access route passes through summer range which historically has been important for the female-calf segment of the main Nelchina herd). They also suggested avoidance by large groups, group fragmentation and/or decreased group coalescence near the pipeline corridor. Horejsi (1981) reported that caribou exhibited signs of anxiety and fear when encountering a fast-moving vehicle and speculated that they might avoid well-traveled highways. Klein (1971) reported that well-traveled highways have obstructed the movement of wild reindeer in Norway. It has also been suggested the roads might increases susceptibility of caribou to predators (Robey 1978).

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

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

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

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

Perhaps in the long run the major impact of the Susitna hydroelectric development on the Nelchina caribou herd will be a contribution towards gradual, long term cumulative habitat degradation rather than immediate catastrophic results. The proposed hydroelectric project is only one (although the major one) of a number of developments which will probably occur in the Nelchina range. Considerable mining activity already is taking place in the southeastern Talkeetna Mountains, traditional summer range. A state oil and gas lease sale is planned for the Lake

Louise Flat, a major wintering area. The Bureau of Land Management is planning to open much of the Nelchina Basin to oil exploration. Considerable land is passing from public to private ownership through the Alaska Native Claims Settlement Act and through state land disposal programs. While no single action may have a catastrophic impact it seems likely that long-term cumulative impacts will result in a lessened ability for the Nelchina range to support large numbers of caribou. Habitat destruction, increased access, disturbance, and partial barriers to movement will all probably contribute to this.

WOLF

In 1982, wolf studies continued in the Susitna River Basin to investigate potential impacts of the proposed Susitna Hydroelectric Project. Between 1 November 1981 and 31 December 1982, 46 wolves were captured and outfitted with transmitter-equipped collars to enable researchers to document movements, denning and rendezvous locations, habitat use, and food habits. Throughout the period, a total of 12 packs and 1 lone wolf were known to be using areas in or adjacent to the Devil Canyon or Watana impoundment zones. Because 4 of these packs were not located until December 1982, they were not included in most analyses. Four hundred radio locations yielded 501 wolf sightings upon which this report is based.

A population estimate of 64 wolves at the end of 1982 in the upper Susitna River Basin was made based on knowledge of 9 packs with an average of 4.9 wolves per pack, added to an estimate of wolves in an additional 4 suspected packs (Fig. 4).

Annual fluctuations in wolf numbers were estimated based on several criteria. Recruitment to packs is due to pup production and immigration into the area. Illegal aerial hunting accounted for the highest mortality (24%) within 8 intensively monitored packs. Sixteen dispersals accounted for an additional 18% loss of wolves from the basin.

Territory sizes of 5 intensively monitored packs ranged from 127 mi^2 to 602 mi^2 (329 km^2 to 1559 k^2), and averaged 344 mi^2 (891 km^2) in 1982. Territory sizes vary considerably among packs, probably due to pack size, prey densities, frequency of monitoring, and adjacent pack boundaries.

Distribution of wolf packs is suspected to be virtually complete in the basin, with elevational use generally restricted to less than 4,000 ft. Elevational distribution varies seasonally and is probably dependent on relative densities of major prey. Moose and wolves both displayed use of lowest annual elevations in February, with a general increase in elevational use until October with subsequent declines thereafter.

Analyses of food habits of wolves in 1982 were based solely on aerial observations of wolves at kills. Moose of all age classes represented 55% of the diet, with caribou comprising 36%. No analysis of 1982 scat collections has been done, but it was suspected that aerial quantification of food habits underestimates percentage of small mammals (non-ungulates) in the diet.

Impacts

Impacts of the proposed impoundments and their associated borrow pits, transmission corridors, work camps and facilities are difficult to quantify at this time. However, based on earlier research and that reported herein, some impacts can be estimated.

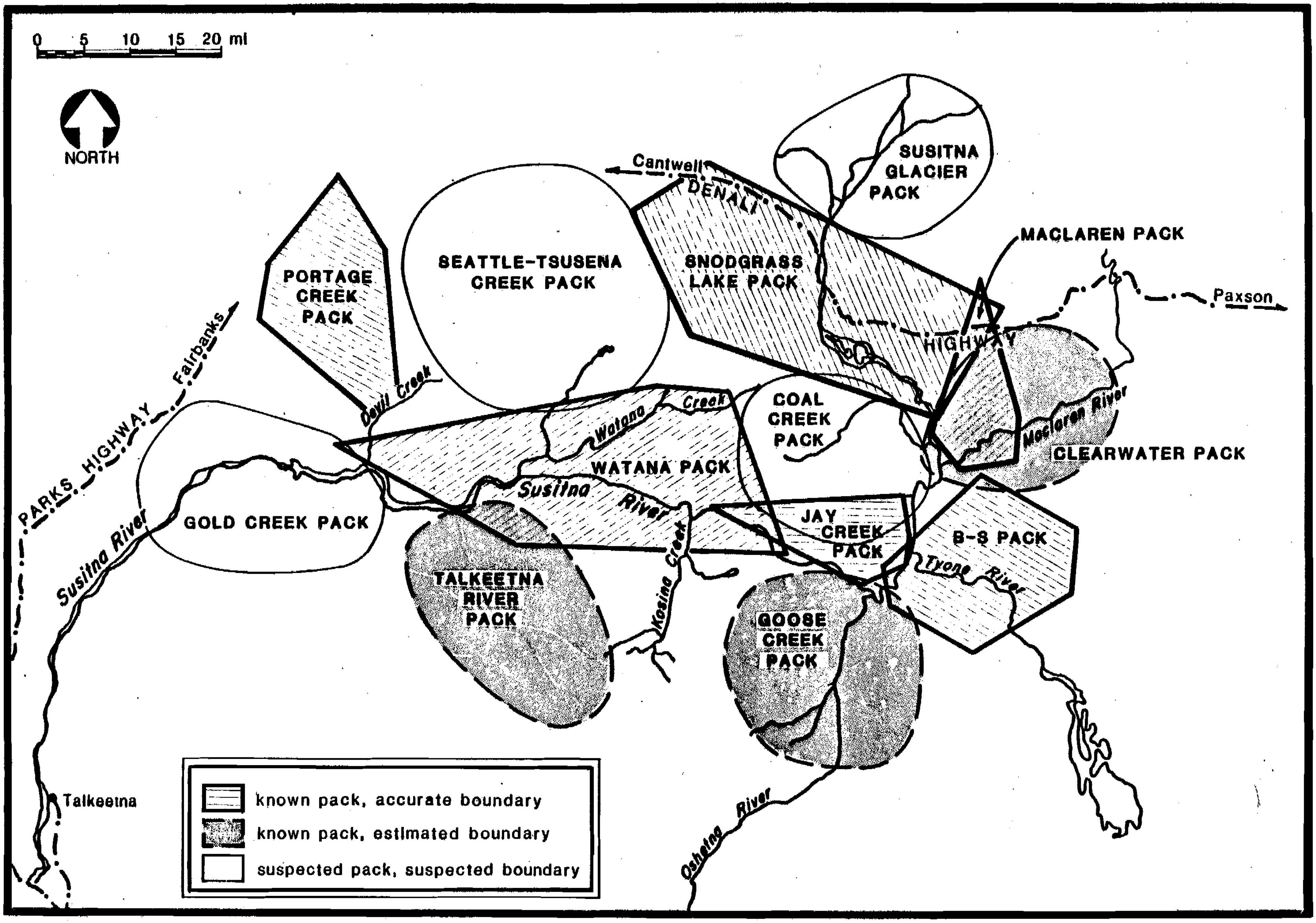

Figure 4. Known and suspected pack boundaries for thirteen wolf packs in the upper Susitna River Basin from December 1981 through December 1982.

Probably the most significant impact the impoundments will have on wolves will result from a change in population density, distribution, sex and age composition and/or physical condition of moose and caribou. The majority of the wolf's diet in this area is moose, and any decrease in prey numbers will probably be reflected in both wolf density and distribution. Ballard *et al.* (1983) estimated that approximately 1,900-2,600 moose will be directly impacted by the impoundments. During the impoundment filling stage and for at least a year following inundation, there will probably be an increase in wolf numbers in response to higher concentrations of moose adjacent to the impoundments. There will be a high number of displaced moose which will be concentrated adjacent to the reservoirs due to the decreased availability of usable habitat. However, the duration of this relatively high moose concentration will probably be short, i.e. 2-3 years. After that, deterioration of the habitat will undoubtedly result in relatively lower moose numbers. Ultimately wolf numbers will be reduced but for a good period of time they will remain relatively high and further depress the moose population and prevent it from recovering.

Access roads and the proposed permanent village for project personnel will result in a significant increase in human use of the area. Correspondingly, there may be a higher incidence of man-caused mortality upon wolves. Trappers and hunters can be expected to harvest more wolves than current levels, but that harvest will probably be of minor importance to overall wolf population numbers. Indirect effects upon wolves resulting from higher human populations will probably also occur. Activity near den and rendezvous sites in early summer will certainly disrupt, and in some cases, will probably cause wolves to abandon den and feeding sites. Den site abandonment could lead to higher pup mortality.

Inundation of den and rendezvous sites, travel corridors and hunting/ feeding areas will eliminate portions of wolf territories. Loss of this habitat will force wolves to readjust territory boundaries and will probably result in increased interpack strife. Since present wolf mortality from some of the packs adjacent to the Susitna River are low (Watana Pack in particular) with subsequent high dispersals to surrounding areas, this area acts as a reservoir in supplying wolves to adjacent areas. Should mortality within these packs increase, there will probably be less dispersal away from the area. Consequently, the reduction of wolf numbers adjacent to the impoundments may well affect not only those packs immediately adjacent to the river, but also packs far removed from the area. Movements of over 50 miles (80 km) away from the Watana territory by wolves which either joined new packs or initiated new packs have been recorded.

To better describe the effects of habitat inundation on wolves, the Watana Pack (because of the relatively high number of relocations) was selected for a further analysis. As mentioned earlier, the Watana Pack occupied a territory of 482 mi^2 (1246 km^2) within and adjacent to both the proposed Watana and Devil Canyon impoundments in 1982. Indeed, 26 out of 58 (45%) of the relocations of Watana Pack members were at or below high pool level of the impoundments. During the first half of the year (January through June) over half (57%) the recorded observations were at or below maximum pool level. Further, it was calculated that of the 482 mi^2 (1248 km^2) Watana Pack territory, 51 mi^2 (132 km^2) was in elevations over 4,000 ft. and thus used very little (<4%) by pack members. Reducing the 482 mi^2 (1248 km^2) territory by 51 mi^2 (132 km^2) leaves 431 mi^2 (1116 km^2) of usable habitat. When the area inundated at high pool level (2200 ft. elevation for Watana, 1450 ft. elevation for Devil Canyon) was planimetered, an area of 55 mi^2 (142 km^2) would be lost to the pack. This would account for 13 percent of the land area utilized by the pack. Forty-five percent of the relocations were recorded on this 13% of the total territory, indicating that those elevations with their associated habitat are preferred by the Watana wolves. As mentioned in an earlier section of this report, this is undoubtedly due, at least in part, to higher concentrations of moose in this elevational stratum.

At the time this report was prepared, information on exact locations and extent of area covered by encampments, borrow sites and road and transmission corridors was not available. However, preliminary site locations have been mapped, and their location will further limit the extent of the Watana territory. The exact percent of habitat loss of the Watana territory is not known. In particular, quarry sites A and B, and borrow sites D, E, F, I, J, and L will at least have portions within the Watana territory and will impact the Watana wolves during and/or after construction of Watana Dam.

The percent of various elevational strata available to the pack (calculated by random selection of 482 points within the Watana territory) compared to the percent of radio-locations at those various elevations shows that between 1801 and 2200 ft. were significantly preferred elevations ($P < 0.005$). These elevational strata were available to Watana wolves in 13 percent of their territory, yet were used on 45 percent of the locations. The inundation of this zone will undoubtedly affect the shape and extent of the Watana territory and subsequent recruitment and mortality.

BLACK BEARS AND BROWN BEARS

In 1982, three components of Su Hydro studies were initiated. These included a black bear census in the upstream area, an analysis of fecal samples, and the initiation of a bear study downstream of the proposed Devils Canyon dam site. This downstream study is designed to reveal impacts of project-related changes in bear food abundance (primarily salmon) on resident downstream bear populations (Fig. 5). Black bears are emphasized in this downstream study.

Preliminary results of the new components of the Su Hydro bear project are discussed in detail in this report. Components of continuing studies were analyzed in detail only when new findings in 1982 altered or significantly strengthened preliminary findings reported in our earlier report (Miller and McAllister 1982). Bear population models intended to assist in predictions of impacts and evaluations of mitigation alternatives are under development and will form a subsequent addendum to this report.

Additional information on brown bear population parameters essential to track project impacts on bear populations through changes in productivity was collected in 1982. Initial post-emergence litter size of new-born cubs in 13 litters (1978-1982) was 2.15 (range 1-3). Nine of 21 cubs in 10 litters (43%) have been lost between emergence from dens as cubs and emergence as yearlings.

Available data suggest a high rate of loss from yearling litters in 1982, the year following an apparent widespread failure of the berry crop. A high proportion of adult females (54%) may produce cub litters in 1983, 2 years after the apparent berry crop failure. Such pulses in cub production would produce an uneven age distribution in the brown bear population and an analysis of the harvest data suggests the presence of this pattern.

Adult females have smaller home ranges in years they have litters of newborn cubs than in other years. Excluding such females from the analysis, home ranges of brown bears were smaller in 1982 than in the preceding year when berry crops were poor. These observations suggest that project-related changes in the distribution, abundance, or availability of food resources will affect bear populations in the study area. This influence would likely be expressed by decreased survivorship of yearling and subadult brown bears and an increase in reproductive interval.

The previously reported movements of project-area brown bears to Prairie Creek to fish for salmon was repeated in 1982. Prairie Creek is considered an area of critical habitat importance to brown bear populations in the study area.

None of the brown bear dens located in this study would be inundated by the proposed impoundments although as suggested in last year's report, some displacement from denning areas would result form access roads and borrow areas.

Figure 5. Downstream black bear study area (intensive), polygon encloses the 527 sq. km used by 10 radio-collared black bears, 117 points. (1 cm = 2.3 km)

Continuing studies on black bear populations in the impoundment area were conducted in 1982. A preliminary summer population estimate of 86 black bears (95% CI=47-172) was made using Lincoln Index techniques. Numerous sources of potential biases were identified in this estimate, most of these would tend to yield an underestimate. This procedure will be repeated in spring 1983 when a different array of sightability biases would exist. The possibility that emigrations of subadult black bears during the poor berry year of 1981 resulted in the lower-than-expected population estimate is discussed.

Limited sampling of bear abundance in two habitats in two locations provided support for the hypothesis that black bear movements in the upstream study area during late summer are motivated by the relative abundance of berries, especially blueberries. At this time bears tend to move upstream and away from the impoundment area. More extensive berry sampling by the Plant Ecology sub-task is recommended for 1983.

Data collected in 1982 support our hypothesis of an inverse relationship between black bear productivity and food abundance. The poor berry crop in 1981 created a situation where 19 of 20 radio-collared black bear females may produce cubs in 1983. This factor is significant because a large proportion of black bear habitat (especially spring habitat) is expected to be inundated by the Watana impoundment. This habitat loss will likely result in decreased productivity in the post-impoundment period.

Analyses of a small sample of black bear scats in the upstream study area suggests the importance of *Equisetum* in spring diets along with grasses and sedges. These data tend to support our hypothesis that early spring food in the area to be inundated by the Watana impoundment may be important to upstream bear populations. The relative availability of these items inside and outside of the impoundment area must be established by Plant Ecology subtask studies.

Of 24 black bear dens found in the vicinity of the proposed Watana impoundment, 13 will be flooded by the impoundment. In contrast, minimal impacts on black bear dens through inundation are anticipated in the vicinity of the Devils Canyon impoundment. Continued high reuse of the same den sites suggest low availability of acceptable den sites and a corresponding major impact through destruction of den sites in the vicinity of the Watana impoundment.

Work was initiated in 1982 to evaluate impacts of reduced salmon spawning in sloughs downstream of Devils Canyon on downstream black bear populations. Salmon spawning sloughs identified by Fisheries subtask workers were inspected in 1982 and ranked relative to bear use and salmon abundance. The movements of all 10 downstream radio-collared black bears (with 1 possible exception) indicated use by the bears of spawning salmon during 1982.

Radio-tracking data indicate 5 bears used identified slough areas, 2 fished in the mainstem Susitna or its tributaries, and 2 others fished in the Chulitna or its tributaries. Another bear may also have fished in the mainstem Susitna but the evidence is inconclusive. Bear feces collected in the vicinity of the salmon sloughs contained more devils club (*Oplopanax horridus*) than any other item. However, there was much direct evidence of bear use of salmon caught in the sloughs. Possible reasons for this bias are discussed. Additional work is required to determine the impacts of reduced salmon spawning in slough habitats on downstream black bear populations.

WOLVERINE

This report summarizes data collected during Phase I, but is updated to include data and analysis through November 1982 of the Phase II studies. Since inception of the project in April 1980, 17 wolverine have been captured a total of 19 times. All were captured by darting from a helicopter and were fitted with transmitter-equipped collars to allow investigators to gather certain ecological data. A total of 303 point locations have been made on wolverine in the middle Susitna River Basin. One hundred ninety-four locations were gathered by radio telemetry, and the rest were from harvest records, track sightings and uncollared wolverine observations.

Minimum home ranges for 12 wolverine in the middle Susitna basin are shown in Fig. 6. Calculations have shown that estimates of wolverine home ranges increase in size depending upon the length of time of radio contact. Thus, calculations that have relied on data gathered for less than 1 year probably underestimate annual home range size. Only one wolverine has been monitored for an entire year (adult male no. 116040) and he occupied a home range of 627 km^2 (242 mi^2). Using this figure, it was estimated that 78 wolverine inhabit the 16,319 km^2 (6301 mi^2) Susitna River Basin, averaging one wolverine per 209 km^2 (81 mi^2).

Elevational movements by instrumented wolverine showed significant differences between summer and winter ranges, averaging 969 m (3,178 ft) and 842 m (2,761 ft) elevation, respectively. It was suspected that this was due to differences in prey distribution and availability on a seasonal basis.

Potential Impacts

The inherent elusiveness and low densities of wolverine throughout their present range have made it largely impractical to conduct ecological studies (van Zyll de Jong 1975). However, throughout most of Alaska, wolverine numbers are probably comparable to what they were a century ago simply because of minimal human activity in the state. Additionally, technological advances in radio telemetry equipment and techniques have enabled researchers to gather previously unobtainable data on movements and other ecological parameters necessary for making sound management decisions regarding predators.

Van Zyll de Jong (1975) and Hornocker and Hash (1981) have suggested that one factor leading to decreased wolverine numbers is probably human disturbance. The recent focus on resource development in Alaska may cause parallel reductions.

Telemetry data suggest that the Susitna River presents no impediment to wolverine, and many crossings were documented. The use of elevations below the high pool level (2200 feet) was mainly

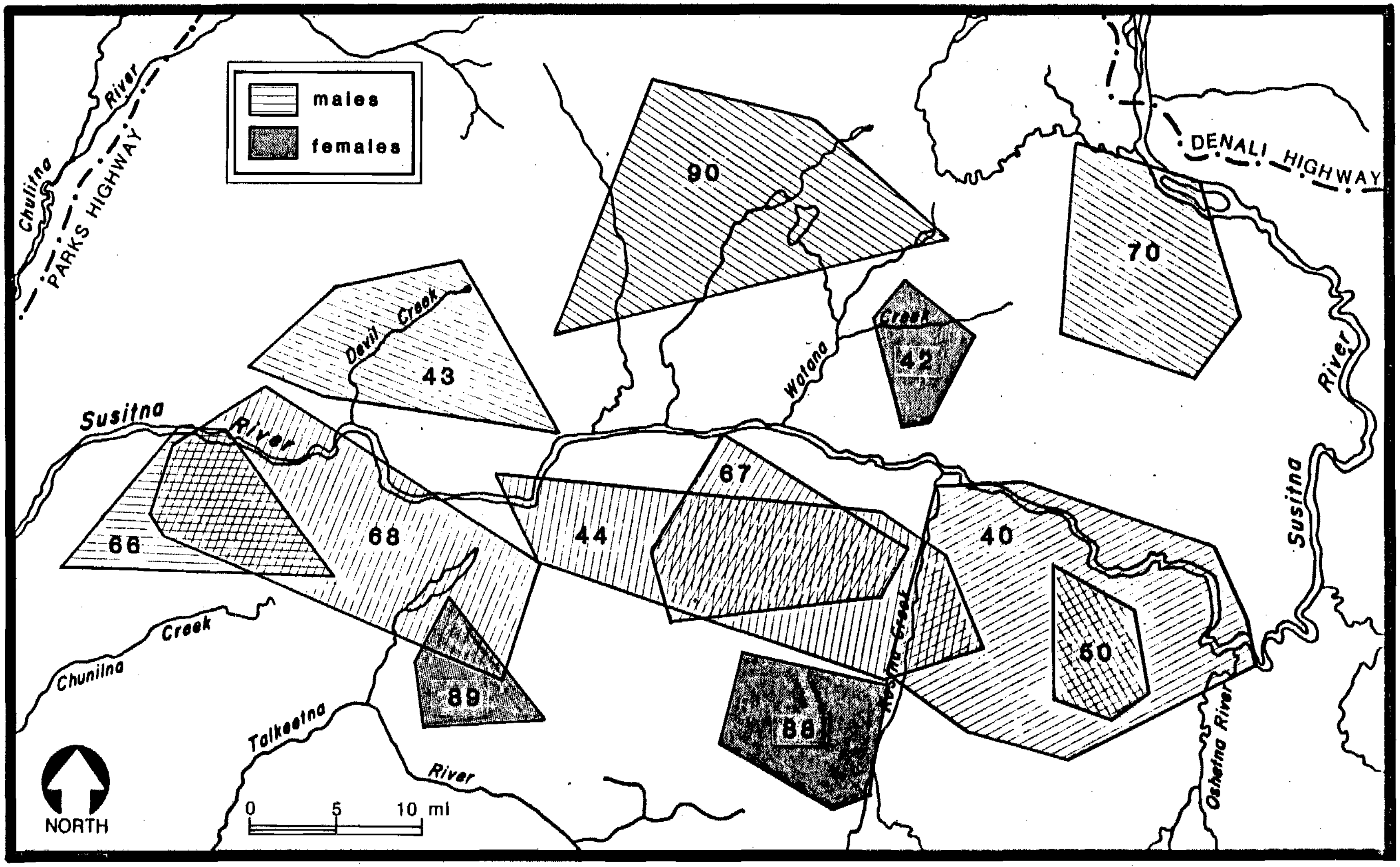

Figure 6. Minimum home ranges of twelve instrumented wolverine in the middle Susitna River Basin, 1980-1982.

during the period November through January, when scavenging on big game is an important portion of the diet, and that food source is distributed largely in the impoundment zone.

Although actual loss of habitat through inundation and facilities development will reduce habitable land areas, this factor alone is not likely to significantly alter the wolverine population. However, of much greater concern is the effect this will have on winter food supplies, thus secondarily impacting wolverine distribution, productivity and abundance.

Ballard *et al*. (1982) estimated that approximately 2,400 moose will be severely impacted by the proposed project. Three scenarios are possible to describe what that moose population will ultimately do. (1) Moose will be concentrated in the remaining habitat along the reservoir borders. This will probably lead to deterioration of the existing habitat, by overuse of the range, and ultimately, a reduction, through winter kill, of the moose population. Should this scenario happen, there would probably be an increase in wolverine numbers for a period of 3-5 years, followed by a substantial reduction in the population because of a lack of winter carrion. (2) Moose will migrate out of the Basin in search of better range. This would probably result in lower wolverine densities, as winter carrion would not be as available. (3) Massive dieoffs of moose would occur during inundation and immediately after maximum pool level is attained, mainly from accidental deaths (i.e. shifting and thin ice, drownings, concentration of individuals with increased predation resulting). Should this occur, wolverine numbers will probably increase for 1-3 years following inundation, with subsequent reduction in numbers when carrion is no longer available in such quantities.

During Phase 1 studies, a mineral lick used by Dall sheep was discovered in a location adjacent to the proposed Watana impoundment. The lick use area occurs on a steep bluff on the west bank of Jay Creek, from creek bottom (2000 ft/610 m in elevation) to the rim (2450 ft/747 m). The Watana impoundment normal maximum operating level is designated as 2185 ft/666 m with an average annual drawdown of 120 ft/36.6 m, which will cause inundation and erosion of some of the lick use area. Also, the lick's close proximity to the impoundment will make the sheep seasonally vulnerable to disturbance from construction, transportation and recreational activities. During 1982, aerial and ground observations were made of this site (Table 3) and other licks to observe sheep use. However, due to a lack of personnel, observations were infrequent and not sufficient to adequately determine the extent of lick use. Aerial sex and age composition surveys of the Watana Hills sheep population were conducted on 23 March and 3 August 1982. During the August survey, another possible lick was located approximately 4 mi/6.5 km northwest of the Jay Creek lick. Four legal rams were reported taken from the Watana Hills population during the 1982 hunting season.

Project Impacts

Impacts of Watana Impoundment

The Watana Hills sheep population appears to be vulnerable to severe impact from the proposed Watana impoundment because of disturbance to the Jay Creek lick area. This lick, adjacent to the proposed Watana impoundment, is used by sheep in early summer. A group of 15 sheep (7.5% of the surveyed summer population) was the largest seen using the lick during 1982. Up to 23 sheep (13% of the observed 1980 population) have been seen at the lick at one time (Tobey 1981), indicating that a significant portion of the population uses this lick. It is likely that sheep travel some distance to use this lick as both winter and summer surveys have located most of the population 7 or more air mi/11.3 km from the Jay Creek lick. The Jay Creek lick area and much of the terrain traveled from observed summer and winter range is atypical sheep habitat, being relatively flat with shrubland and trees and little rocky cliff escape habitat. This indicates the importance of the Jay Creek lick, especially when the East Fork lick is so much closer to the majority of sheep sightings and in more typical sheep habitat.

The cycle of filling and draining in the Watana impoundment will subject the lick area to flooding and erosion and possibly will leave ice shelves on portions of the lick area during the peak lick use season. Together, the mineralized lick substrate, rock

Table 3. Observations at the Jay Creek lick during 1982.

Date	Time	Total Sheep	Rams	Unclassified	Observer
23 March		0			J. Westlund (aerial obs.)
27 May	1600-2000	0			J. Westlund (ground obs.)
28 May	0600-1000	0			J. Westlund (ground obs.)
29 May	0900-1100 1600-2000	0			J. Westlund (ground obs.)
30 May	0700-1300	0			J. Westlund (ground obs.)
8 June	1530	12	12		J. Whitman (aerial obs.)
10 June	1400	15	15 (3 at lick, 12 0.6 km south)		J. Whitman (aerial obs.)
17 June	1030	15	9	6	R. Fleming (aerial obs.)
24 June	1539	1		1	St. Miller (aerial obs)
29 June	1400	0			St. Miller (aerial obs.)
8 July	1533	2		2	St. Miller (aerial obs.)
3 August		0			J. Westlund (aerial obs.)
14 October	1200, 1700	0 (no tracks seen either)			J. Whitman (aerial obs.)

outcrops providing escape cover, other resting areas, and trails are used by the sheep. Flooding, erosion and ice shelves on portions of these components may lessen or destroy the value of the lick to the Watana Hills' sheep. In addition, sheep attracted to the lick area may be seasonally vulnerable to disturbance and habitat degradation from timber harvest in the impoundment and other human activities.

The Watana Hills is a small isolated sheep population, used by local guides and sheep hunters (see also Ballard *et al*. 1982). The nearest additional sheep habitat occurs southwest across the Susitna River around Mt. Watana, and also farther northeast in the Clearwater Mountains across a larger valley. Aerial surveys, other sightings and the distances involved suggest that the Watana Hills sheep may have more interchange with the Talkeetna Mountains population to the southwest. This interchange may provide the opportunity to maintain a viable sheep population in the Watana Hills, by emigration from the larger Talkeetna Mountains population. The Watana impoundment, with seasonal hazards of a large width of open water, ice shelving and unstable ice conditions and mud shelving may depress or eliminate sheep immigration from the southwest. This would make any detrimental impacts of the project on the Watana Hills sheep population even more serious, as population recovery from a project impact could be greatly slowed or made impossible by loss of immigration opportunities.

Climatic Impacts

A delay in spring plant growth in areas near the Watana impoundment (Exhibit E, FERC License application) may degrade some of the Watana Hills and Mt. Watana sheep habitat. If the Watana impoundment causes additional snow accumulation in nearby areas, important south-facing slopes in the Watana Hills may become poorer winter habitat.

Increased Human Access

The project development will undoubtedly increase fixed-wing and helicopter traffic. Low-flying aircraft, especially helicopters, are known to disturb Dall sheep (Linderman 1972, Nichols 1972, Lenarz 1974). Groups of ewes and lambs (possibly including young rams) react most strongly to helicopters (Lenarz 1974). The dangers of aircraft disturbance include injuries sustained by sheep while fleeing (Linderman 1972), wasted metabolic energy expense (which could become critical if the disturbance is repeated during stressful winter or lambing periods) (Geist 1971b), and abandonment of habitat (Linderman 1972), which could lower the population size. However, some sheep show habituation to aircraft that maintain regular flight patterns and do not approach sheep closely (Lenarz 1974, Summerfield 1974, Reynolds 1974). MacArthur *et al*. (1982) found no cardiac or behavioral responses by unhunted adult bighorn sheep to helicopters and fixed-wing aircraft flying 400 m or more away.

Roads and reservoirs developed by the project will allow increased access by vehicles and hikers who can also disturb sheep (Tracy 1976, MacArthur 1982). One area where the Denali National Park road was built directly through sheep habitat receives less use by sheep now than in the early 1940's, but the exact cause of this apparent abandonment is not clear (Tracy 1976). Tracy (1976) also reported that a few Dall sheep (mostly ewe and lamb groups) in Denali National Park were disturbed while crossing a small valley with a road when vehicles were present. Tour buses stopping, people exiting and making loud noises increased (respectively) the disturbance to the sheep (observed by their behavior). Reactions of sheep to moving vehicles more than 200 m away were minimal (Tracy 1976). These sheep were habituated to traffic and not hunted. Among unhunted sheep populations, sheep may habituate more readily to human presence (Geist 1971b).

MacArthur *et al.* (1982) documented relatively few cardiac responses (8.8% of trials) and fewer behavioral responses (0.9% of trials) of bighorn sheep to vehicle passes. Most of these responses (73.7%) occurred when the vehicle passed within 25 m. Humans approaching on foot, especially accompanied by a dog, elicited stronger responses (MacArthur *et al.* 1982). These sheep were living in an unhunted sanctuary and had been regularly exposed to humans and vehicles along a nearby road. No ewes with lambs were monitored, which are more sensitive to disturbance (Murie 1944, Smith 1954, Jones *et al.* 1963).

MacArthur *et al.* (1982) recommended restricting human activities to roads and established trails, and discouraging dogs in areas of sheep habitat.

Population Distribution

The difference in sheep numbers between the winter and summer surveys in the Watana Hills may be due to the poorer observation conditions during the winter survey or because fewer sheep inhabit the Watana Hills during winter. Future surveys and scrutiny of sheep movements may help clarify this discrepancy.

The few observations of sheep in the Mt. Watana-Grebe Mountain range do not indicate that these sheep will be directly affected by the impoundments or other ground construction activities. However, sheep have been observed in the past on Mt. Watana near the proposed impoundment (Tobey 1981) and may continue to do so. More surveys and observations of sheep in this area are needed to delineate seasonally important range.

The few observations of the Portage-Tsusena Creeks sheep also indicate that they do not occupy areas close to the impoundments, Denali access route or the northern route of the transmission lines. However, more complete seasonal surveys are needed to confirm this.

Mitigation Recommendations

Lowering Watana's maximum reservoir level to 2000 ft/609.6 in elevation would eliminate much of the physical disturbance to the Jay Creek lick. Also, certain methods and scheduling of construction activities and access would reduce the impacts of the Susitna Hydroelectric project on sheep.

Timber harvest within 2 air mi/3.2 km of the Jay Creek lick should be restricted to the months of September through April. The area within a 0.5 mi/0.8 km of the lick should remain untouched by clearing activities, including roads, logging equipment and debris, except for those portions below the minimum operating level (2065 ft/629.4 m). Any clearing within 2 air mi/3.2 km of the lick should be delayed as long as possible until just before the reservoir begins filling. This will condense the physical effects of the Watana development into a shorter time period.

Access for project personnel and recreational users should be restricted to minimize disturbance in areas of sheep habitat. Limiting off-road access to certain trails (away from lambing areas and mineral licks) should be considered. Air traffic should be prohibited below 1000 ft/304.8 m above ground level in areas of sheep habitat. Helicopter landings within 1.0 mi/1.6 km of mineral licks should be prohibited during 1 May - 15 July or later, depending on the results of seasonal lick use studies. Boat and ground access within 1.0 mi/1.6 km of the Jay Creek lick and other mineral licks should be prohibited from 1 May - 15 July, or later, if lick use continues through the summer.

If the project substantially reduces availability of mineralized substrate at the Jay Creek lick, options of mining or blasting the lick area to expose additional substrate, or supplying appropriate mineral elements near the Jay Creek lick or other areas could be considered.

Belukha surveys were flown in Upper Cook Inlet between May 17 and Aug. 27, 1982. A concentration area was identified nearshore from the mouth of the Little Susitna River to the mouth of the Beluga River (Fig. 7). Exact timing of use of the area has not been determined, however, the concentration appeared to build up in late May and lasted through mid-June. It is probable that this concentration was in part associated with calving and breeding although no calves were positively identified because of generally poor viewing conditions. The concentration appeared to involve 200 to 300 animals, however accurate counts were not possible because of, again, poor viewing conditions. The Belukha concentration near the mouth of the Susitna River appeared to coincide with the arrival of large numbers of eulachon which spawned in the lower Susitna River in late May and early June. This run of eulachon was estimated to total several million fish. King salmon are probably not particularly important to this concentration of belukhas although large male belukhas probably do take some king salmon. Probably the only other salmon species from the Susitna River system available in sufficient numbers to be considered significant prey to the belukhas concentrated in late May and early June would be the sockeye. No information is presently available which would allow conclusions on belukha predation on salmon smolts from the Susitna River.

Given the present state of our knowledge, we cannot accurately predict impacts on Cook Inlet belukhas from the proposed dams on the Susitna River. It is possible that the overall population could suffer reduction in numbers both directly by alterations in the habitat, particularly the concentration area near the mouth of the Susitna River and indirectly by reduction of available food species.

Potential Impacts

Quantification of impacts of the Susitna hydroelectric project on belukhas at the present time is not possible. This type of project has the potential for reducing the numbers concentrating near the mouth of the river by reducing the available food or by altering the heat budget of the river. However the overall effect on the availability of anadromous fish to belukhas is predicted to be small. There may be no alteration of the heat budget of the river realized by the belukhas at the mouth of the river although very little data are available to prove this.

Approximately 5 to 8% of the total adult salmon returning to the Susitna River system spawn in the area from Talkeetna to Devil Canyon; the area which is predicted to be the most heavily impacted by dam construction. The slough habitat in this area is predicted to be completely lost, thereby eliminating approximately 5% of the chum salmon from the system as well as a small

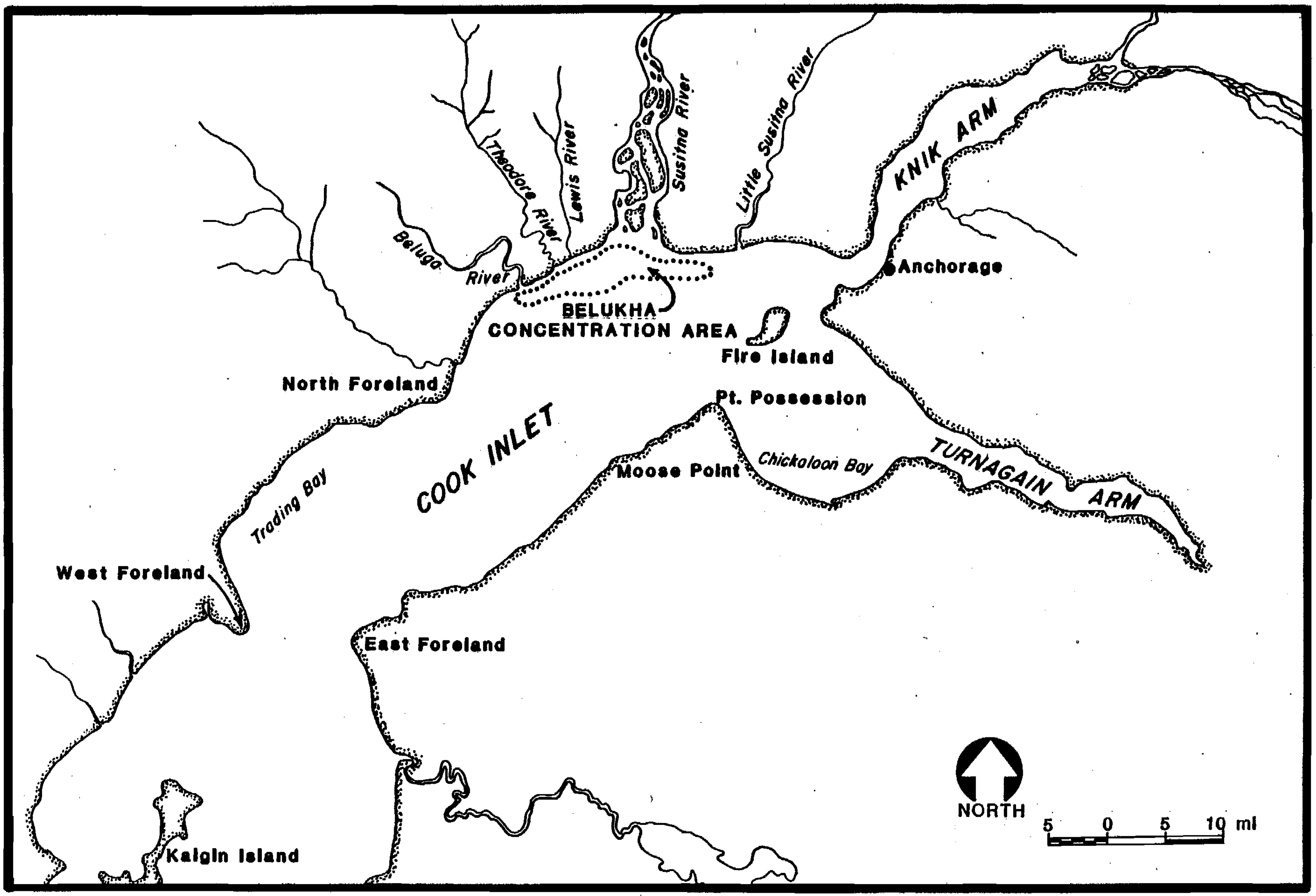

Figure 7. Upper Cook Inlet Belukha study area.

number of sockeye. This means that a small amount of food in the form of adult chum and sockeye will no longer be available to the belukhas after dam construction. Since we have no quantitative measure of the importance of these species to the belukhas, no estimate of impact can be made except to guess that it will probably be slight.

Impacts on the eulachon runs which enter the Susitna River are assumed to be slight as they remain in the lower reaches of the river (Bruce Barrett ADF&G pers. comm.). This species may be extremely important to the belukhas and it is possible that <u>any</u> reduction of eulachon could severly impact the belukhas.

Although most impacts from either heat budget alteration or food reduction are likely to be slight, we cannot accurately predict the overall effect on the belukhas. If any environmental perterbations effect the belukhas in upper Cook Inlet, it is likely these effects will take the form of a reduction in the population in Cook Inlet. Given our present state of knowledge, a reduction in the belukha population of upper Cook Inlet would not be detectable unless it were greater than a 50% to 75% reduction in the entire population. Even a reduction of this magnitude could go unnoticed for several years as no systematic monitoring of the population is planned.

LITERATURE CITED

Ballard, W. B., A. W. Franzmann, and C. L. Gardner. 1982. Comparison and assessment of drugs used to immobilize Alaskan gray wolves (*Canis lupus*) and wolverines (*Gulo gulo*) from a helicopter. J. Wildl. Dis. 18(3):339-342.

Ballard, W. B., J. H. Westlund, C. L. Gardner, R. Tobey. 1982. Susitna Hydroelectric Project, Phase 1 Final Report, Big Game Studies, Vol. III Dall Sheep. Alaska Dept. Fish and Game. 21pp.

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

Geist, V. 1971. A behavioral approach to the management of wild ungulates. pp 413-424 in Duffey, E. and A. S. Watt, eds. The scientific management of animal and plant communities for conservation. 11th Symp. Brit. Ecol. Soc., Blackwell Sci. Publ.

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

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

Hornocker, M. G. and H. S. Hash. 1981. Ecology of the wolverine in northwestern Montana. Can. J. Zool. 59:1286-1301.

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

Jones, F. F., R. F. Batchelor, H. R. Merriam, and L. A. Viereck. 1963. Sheep and goat investigations. Vol. III, Alaska Dept. Fish and Game, Ann, Proj. Seg. Rep. Fed. Aid. Wildl. Rest. Proj. W-6-R-3, Work Plan E.

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

Lenarz, M. 1974. The reaction of Dall sheep to an FH-1100 helicopter. Chapt. III in Jakimchuk, R. D., ed. The reaction of some mammals to aircraft and compressor station noise disturbance. Can. Arct. Gasline Stud. Biolog. Rep. Ser. Vol. 23.

Linderman, S. 1972. A report on the sheep study at the Deitrich River headwaters. Appendix III in Nichols, L. and W. Heimer. Sheep Report, Vol. XIII, Proj. Prog. Rep. Fed. Aid Wildl. Rest. Proj. W-17-3, W-17-4.

MacArthur, R. A., V. Geist, and R. H. Johnston. 1982. Cardiac and behavioral responses of mountain sheep to human disturbance. J. Wildl. Manage. 46:351-358.

Murie, A. 1944. The wolves of Mount McKinley. Fauna of the Nat. Parks of the U.S. Fauna Ser. 5 238pp.

Nichols, L. 1972. Productivity in unhunted and heavily exploited Dall sheep populations. In Nichols, L. and W. Heimer. Sheep Report, Vol. XIII, Proj. Prog. Rep., Fed. Aid Wildl. Rest. Proj. W-17-3, W-17-4, Job No. 6.4R.

Reynolds, P. C. 1974. The effects of simulated compressor station sounds on Dall sheep using mineral licks on the Brooks Range, Alaska. Chapt. II in Jakimchuk, R. D., ed. The reaction of some mammals to aircraft and compressor station noise disturbance. Can. Arct. Gasline Stud. Biolog. Rep. Ser. Vol. 23.

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

Smith, D. R. 1954. The bighorn sheep in Idaho--its status, life history, and management. Idaho Department of Fish and Game, Wildl. Bull. No. 1, Boise.

Summerfield, B. L. 1974. Population dynamics and seasonal movement patterns of Dall sheep in the Atigun Canyon area, Brooks Range, Alaska. M. S. thesis, Univ. Alaska. 109pp.

Tobey, R. W. 1981. Susitna Hydroelectric Project Annual Progress Report, Big Game Studies, Part VIII Sheep. Alaska Dept. Fish and Game. 12pp.

Tracy, D. M. 1976. Reactions of wildlife to human activity along Mount McKinley National Park road. M.S. Thesis, Univ. Alaska, Fairbanks.

van Zyll de Jong, C. G. 1975. The distribution and abundance of the wolverine (*Gulo gulo*) in Canada. Canadian Field-Nat. 89(4):431-437.