SUSITNA HYDROELECTRIC PROJECT

PHASE I FINAL REPORT

BIG GAME STUDIES

Volume VII WOLVERINE

Craig L. Gardner
Warren B. Ballard

Volume VIII DALL SHEEP

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ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the Alaska Power Authority

March 1982

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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. This information, along with information on furbearers, small mammals, birds, and plant ecology collected by the University of Alaska, is to be used by Terrestrial Environmental Specialists, Inc. of Phoenix, New York, in preparation of exhibits for the Alaska Power Authority'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. Little data was available on wildlife use of the immediate project area, although some species had been intensively studied nearby. Consequently, it was necessary to start with fairly general studies of wildlife populations to determine how each species used the area and identify potential impact mechanisms. This was the thrust of the 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 reports are organized into the following eight 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

SUMMARY

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 radiocollared 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.

Loss of habitat by inundation, road and transmission line construction, and associated borrow pits will lower wolverine numbers in the study area. Indirect impacts due to prey reduction could cause wolverine distribution shifts, and may increase competition with other scavengers and resulting in lower wolverine densities.

Some additional data needs for Phase II studies were identified.

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INTRODUCTION

Few studies of wolverine (*Gulo gulo*) ecology have been conducted in North America. Complications inhibiting wolverine research have been related to the species being relatively uncommon, inhabiting remote country and its naturally elusiveness (Van Zyll de Jong 1975). The recent sophistication of radio telemetry equipment has permitted ecological studies in northwestern Montana (Hornocker and Hash 1981) and in northwestern Alaska (Magoun 1979, 1980). Hornocker and Hash (1981) indicated that human disturbances could be detrimental to wolverine populations. Van Zyll de Jong believed (1975) that wolverine populations in Canada declined due to increased influence by man.

The geographic range of wolverine has declined drastically across North America during the past century probably in relation to human encroachment. However, in Alaska, wolverine populations probably have not yet been seriously influenced. Wolverine numbers in Alaska today are probably comparable to what was present a century ago. However, the recent focus on resource development in Alaska may cause significant reductions in wolverine numbers.

Currently under study is a proposal to construct a large hydroelectric project on the Susitna River in southcentral Alaska. The proposed impoundments and the accompanying roads, borrow pits, construction camps and transmission lines are expected to affect over 20,500 hectares. It seems inevitable that disturbances due to construction operations and the inevitable increase in human accessibility will have effects on the area's wolverine population. Therefore, this study was initiated in January, 1980 prior to any substantial impacts of the Susitna Hydroelectric Project on wolverine. Specific objectives included: 1) estimation of wolverine abundance within the vicinity of the proposed impoundments; 2) determination of seasonal movement patterns; and 3) habitat requirements and food habits of this population.

METHODS

Capture efforts were conducted during April and May 1980, and again in February and March, 1981. Helicopter capture techniques (Baer et al. 1978; Ballard et al. 1981) and live traps similar to those used by Hornocker and Hash (1981) and Magoun (in prep.) were used. Initially, a combination of 0.25 cc phencyclidine HCl (100 mg/ml Sernylan Bioceutic Lab., Inc.) and 0.20 cc Xylazine HCl (100 mg/ml, Rompun, Barrett Division of Cutter Laboratories, Inc.) was used to immobilize wolverine. Because Sernylan is no longer commercially available, a combination of 0.4 cc etorphine (1-mg/cc M-99, D-M Pharmaceuticals, Inc.) and 0.5 cc Rompun (100 mg/ml) was used to capture the last 5 wolverine. A technical paper describing the use of M-99 and Rompun to immobilize wolverine is presented in Appendix A. Each captured wolverine was aged, sexed, weighed, measured, ear tagged and radio-collared. In this report each captured or necropsied wolverine is referred to by the last 3 digits of its assigned accession number.

Radio collars (Telonics, Mesa, AZ) were constructed of butyl rubber and had an inner circumference ranging from 29 to 39 cm. Each collar was equipped with a whip antenna which extended 26 cm from the collar. The entire unit weighed 230 g.

Radio locations were made approximately one per week throughout the study period by methods similar to those described by Mech (1974). Radio locations were recorded on 1:63,360 U.S.G.S. maps and the following parameters recorded: date, time, activity, number of associates, topography, and general habitat type. Seasonal and yearly home ranges were delineated by the minimum area method (Mohr 1947).

Habitat classification followed Viereck and Dyrness (1980). However, density and height of the spruce component were estimated and the habitat was classified only to level III. We estimated wolverine habitat selectivity by comparing habitat type availability to actual use determined by relocation data. Vegetation cover type maps (Ag. Exp. Stat. 1981) of the study area were used to estimate availability.

Wolverine habitat was also characterized by available prey species. Known seasonal concentration areas of ungulates and small mammals within the radio-collared wolverine home ranges were compared to the wolverine's movements to determine if these wolverine showed a fidelity toward these areas. Wolverine tracks were followed on the ground during May and December 1980 in an effort to gather information pertaining to food habits and activity patterns. Tracks were initially found by aircraft, then followed on foot.

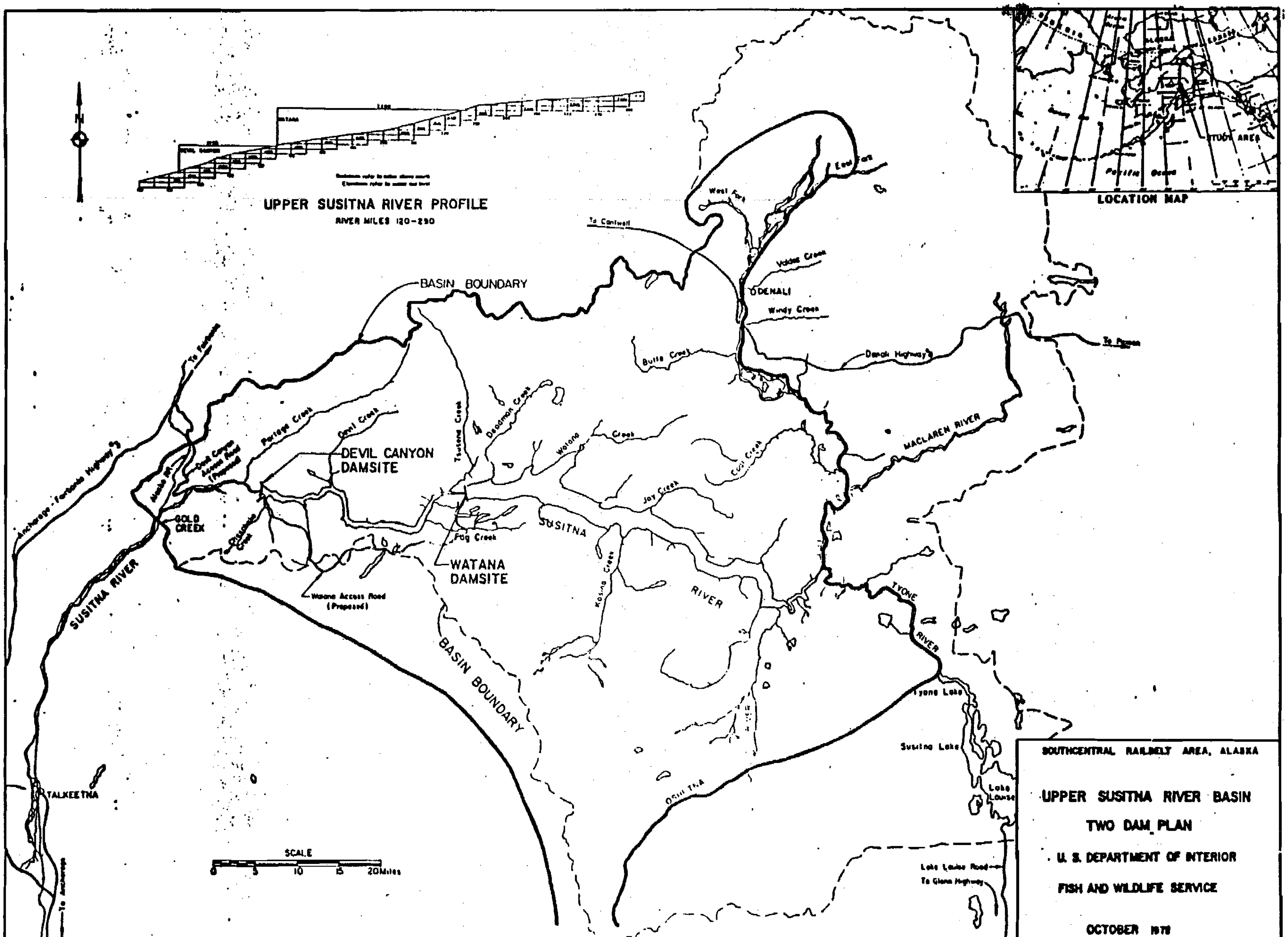
Harvest records, wolverine and wolverine track sightings by project personnel and the public were used to get an indication of wolverine distribution within the study area. Capture locations and sightings were recorded on 1:63,360 scale U.S.G.S. maps.

Wolverine carcasses were purchased from hunters and trappers in Game Management Unit (GMU) 13 for $10.00 per carcass. Each carcass was necropsied in an effort to quantify age structure of the harvest and reproductive status of the area's population. Animals were classified juvenile or adult by the morphology of the canine tooth (Rausch and Pearson 1972).

Study Area

Based upon the boundaries of the proposed impoundments and associated borrow pits and roads in addition to wolverine distribution, the area depicted in Figure 1 is considered the project impact area for wolverine. The study area boundary follows the basin boundary in the west to the base of the West and Middle Fork Glaciers, down the Susitna River to its intersection with the Tyone River, up the Tyone River to Tyone Lake, then a south-

Figure 1. Map of the wolverine study area during Phase I Studies, 1980-1981.



CORPS OF ENGINEERS BASE MAP

west line to the intersection of the Little Oshetna River with the Oshetna River, along the Oshetna River to the peak of the Talkeetna Mountains, follows the upper elevations of the Talkeetna Mountains to the confluence of the upper north and south forks of the Talkeetna River, then northwest to the basin boundary.

Vegetation, topography and climatic descriptions have been described by Skoog (1968), Bishop and Rausch (1974) and Ballard and Taylor (1980), and Subtask 7.12

RESULTS AND DISCUSSION

A total of 6 wolverine (5 males and 1 female) were captured and radio-collared during Phase I studies (Table 1). Wolverine 040 was recaptured once to replace its radio. Fate of the tagged animals during the study period is presented in Table 2.

Induction time for the 2 wolverine immobilized by the Sernylan and Rompun combination were 36 minutes (14.5 kg male) and 11 minutes (9.5 kg female). Induction times for these 2 wolverine may not be indicative of the normal induction times for Sernylan as the drug was outdated. Magoun (pers. comm.) found the Sernylan-Rompun dosage very effective in immobilizing wolverine in northwestern Alaska.

Distribution and Movements

Relocation data for 5 radio-collared wolverine, sightings of unmarked wolverine or wolverine tracks and ADF&G harvest data yielded a total of 144 point locations scattered throughout the impoundment area (Figs. 2 and 3).

Distribution seems to be complete throughout the impoundment area; however, the data indicate that concentrations are centered in generally, hilly topography above treeline. There are

Table 1. Tagging location and physical measurements of wolverine captured in the Susitna River Basin, 1980.

Accession Number	Date	Location	Sex	Age	Weight	Body Length (cm)	Girth (cm)	Neck Circum. (cm)	Head Width (cm)	Head Length (cm)	Canine length (mm)	Canine Width (mm)	Comments
116040	4/10/80	4.8km NW of Clarence Lk.	M	A[1]	14.5kg	87.6	47.9	33.0	11.6	19.4	18.0	10.1	Right eye had microopthelmia
	3/25/81	W. of Goose Ck.	M	A									
116041	4/19/80	5.6km upstream of mouth of Fog Ck.	M	A	15.5kg	87.0	49.8	34.3	11.4	16.5	23.8	9.3	Teeth badly worn
116042	4/19/80	Watana Ck.	F	A	9.5kg	80.0	38.1	27.0	9.8	14.6	21.3	7.6	Lactating slightly, had 2 kits
116043	5/06/80	4.0km SE of of Standing Bear Lk.	M	U[2]	17.7kg	81.9	44.9	11.5	15.9	--	--	--	
116044	5/07/80	Across Susitna River from Stephan Lk.	M	U[2]	--	--	--	--	--	--	--	--	
116050	3/06/81	Clarence Mt.	M	J[3]	17.7	96.0	51.0	34.3	11.3	13.8	23.0	8.0	

1) A = Adult
2) U = Unknown
3) J = Juvenile

Table 2. Status of the radio-collared wolverine captured in the Susitna River Basin Study Area during Phase I Studies, 1980 through 1981.

Accession Number	Collaring Date	Sex	Age	Status
040	4/10/80	M	A[1]	Natural mortality 3/25/-4/15/81
041	4/19/80	M	A	tagging mortality 4/21/80
042	4/19/80	F	A	Unknown - lost contact 8/12/80
043	5/06/80	M	U[2]	Unknown - radio failure 12/04/80
044	5/07/80	M	U	Unknown - lost contact 10/09/80
050	3/06/81	M	J[3]	Unknown - lost contact 3/25/81

1) A = Adult
2) U = Unknown
3) J = Juvenile

Figure 2. Locations of observed uncollared wolverine, wolverine tracks and harvested wolverine within the Susitna River Basin Study Area during 1979-80.

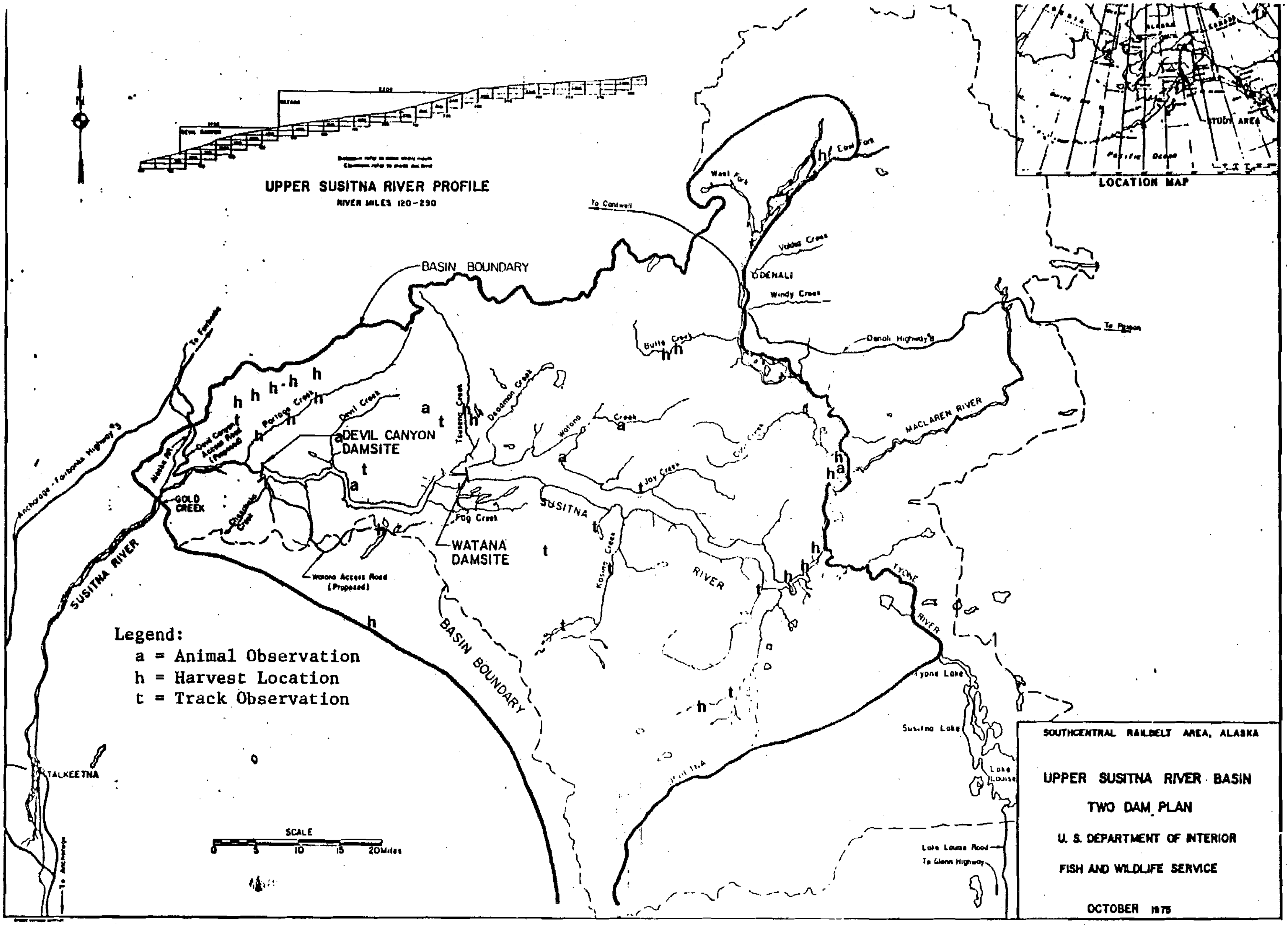
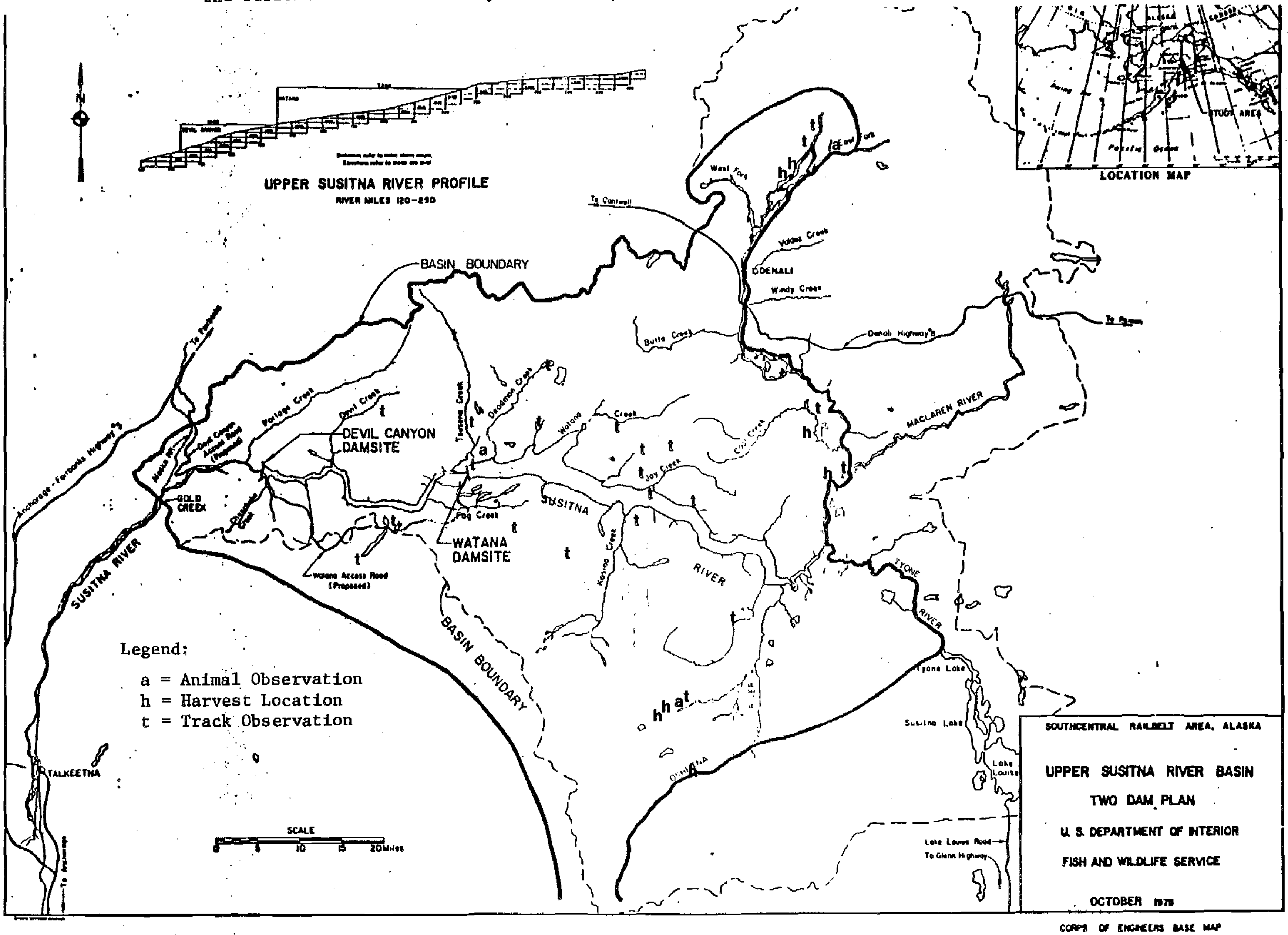


Figure 3. Locations of observed uncollared wolverine, wolverine tracks and harvested wolverine within the Susitna River Basin Study Area during 1980-81.



inherent biases within the data, as most of the track sightings and the commercial harvest occurred during the spring (March-May) when wolverine are generally moving to or inhabiting higher elevations (Hornocker and Hash 1981).

Radio-tracking data suggest that changes in wolverine distribution occur throughout the year. Food availability probably influences these shifts. Van Zyll de Jong (1975) in Canada suggested that food availability influences changes in wolverine distribution. We observed 3 different movements by wolverine which seemed to be induced by food supply. Details of these observations follow:

During 1980, Nelchina caribou (*Rangifer tarandus*) calving extended from 15 May to 10 June (Pitcher 1980). During that period wolverine 040 was located on 6 of 9 (67%) occasions within the calving ground. Although wolverine 040 was never observed with a dead caribou, a number of dead calves were present (unpub. data). The month prior to calving, 040 was observed on the calving grounds 1 of 5 (20%) occasions.

From collaring (April 1980) until mid-December 1980, we observed limited use of the Susitna River by the 3 radio-collared wolverine whose home ranges bordered the river. Only 9 percent (6 of 67) of the relocations were within 1.6 km (1 mile) of the river and only 3 actual crossings were documented. However, from mid-December, 1980 to late March, 1981, wolverine 040 narrowed its activities to 14% of its normal home range and exhibited an increased fidelity to the Susitna River, as 53.8% (7 of 13) relocations were within 1.6 km (1 mile) of the river. This same area had high densities of moose (*Alces alces*) (Ballard et al. 1980). In addition to wolverine 040 at least 4 wolves (*Canis lupus*) and 1 other wolverine (050) were present in the area suggesting concentration of predators and scavengers in this high density moose area.

Wolverine 044 was collared on the Susitna River across from Stephan Lake on 7 May 1980. By 13 June 1980 044 had moved approximately 70 km to the vicinity of Kosina and Tsisi Creek drainages. It remained there until 26 August when it began moving back toward Stephan Lake. On 7 October, 044 was located 6 km east of Stephan Lake. This extensive movement went from a heavily timbered habitat to an upland shrub and tundra habitat. We suspect these movements were correlated to Arctic ground squirrel (*Spermophilus parryii*) emergence and subsequent hibernation. Densities of ground squirrels were more abundant in these higher, more open habitats (McDonald 1980). Ground squirrels and marmots (*Marmota caligata*) were important food species for wolverine in both the Brooks Range (Magoun 1979, 1980) and northwestern Montana (Hornocker and Hash 1981). In addition, moose densities around Stephan Lake and Tsisi Creek were estimated as medium and low, respectively (Ballard et al. 1980).

Magoun (pers. comm.) suggested that male wolverine display an increase in their movement patterns just prior to and during breeding. We were unable to confirm this hypothesis in the Susitna Basin, however, this may be due to sampling biases. We compared percent of home range utilized from May through July to other 3 month blocks and found no significant differences (P 0.05).

Home Ranges

Radio-collared wolverine were located on 104 occasions during Phase I studies. Home ranges were determined for 5 wolverine, however only the home range of wolverine 040 (627 km^2, 242 mi^2) represents an annual home range (Table 3 and Fig. 4).

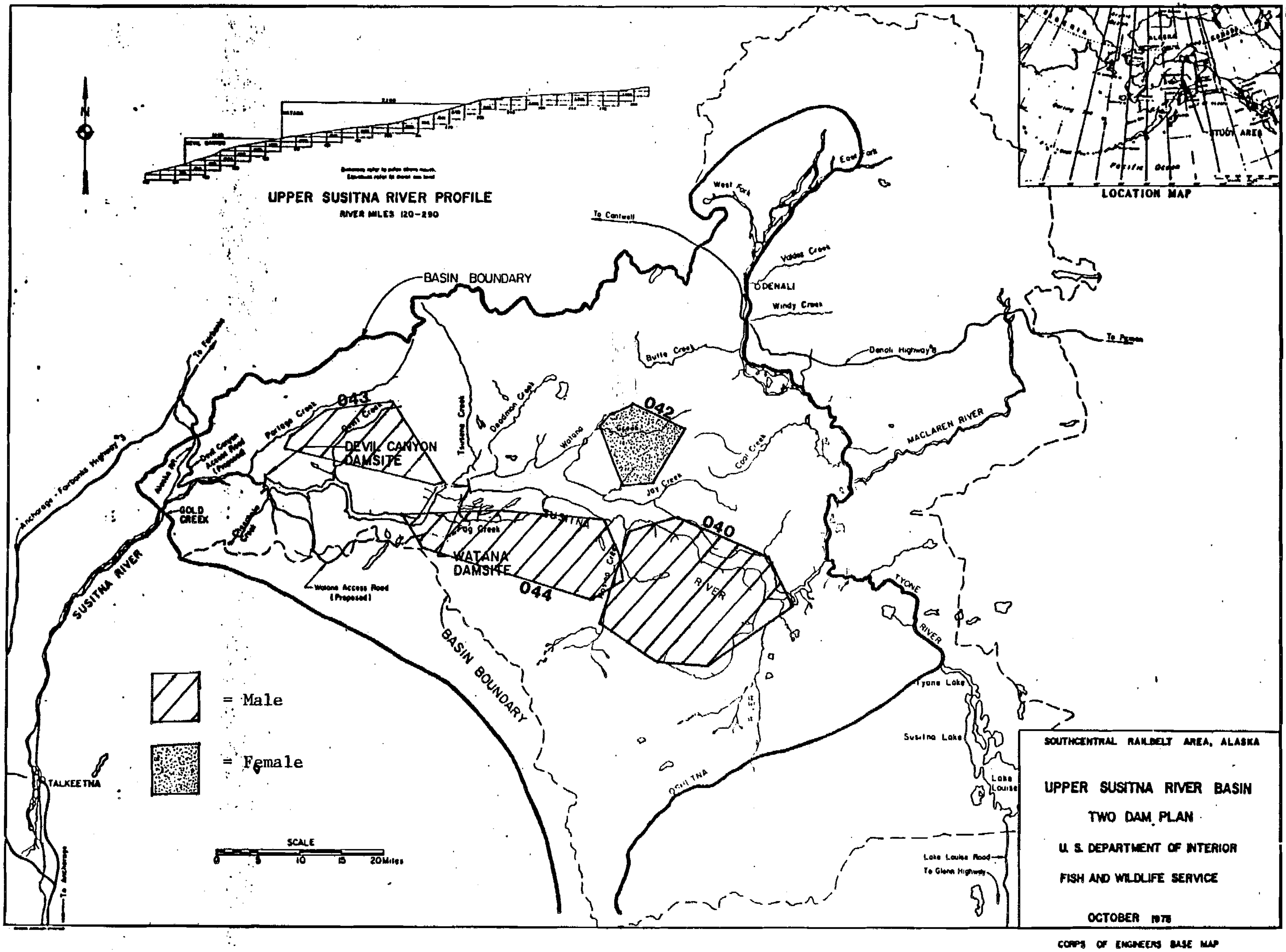
Direct comparison of home range sizes of Susitna wolverine with findings for other radio-telemetry studies is difficult due to the differences in sampling periods. Magoun (1979) reported

Table 3. Summary of home range sizes for 5 radio-collared wolverine in the Susitna River Basin Study Area during Phase I Studies, 1980 through 1981.

Accession Number	Sex	Est. Age	Home Range (km^2)	Period Monitored
040	M	A[1]	627	April, 1980-April, 1981
042	F	A	86	April, 1980-Aug., 1980
043	M	U[2]	272	May, 1980-Dec., 1980
044	M	U	378	May, 1980-Oct., 1980
050	M	J[3]	89	March, 1981

1) A = Adult
2) U = Unknown
3) J = Juvenile

Figure 4. Home ranges of the four radio-collared wolverine in the Susitna River Basin Study Area during Phase I studies.

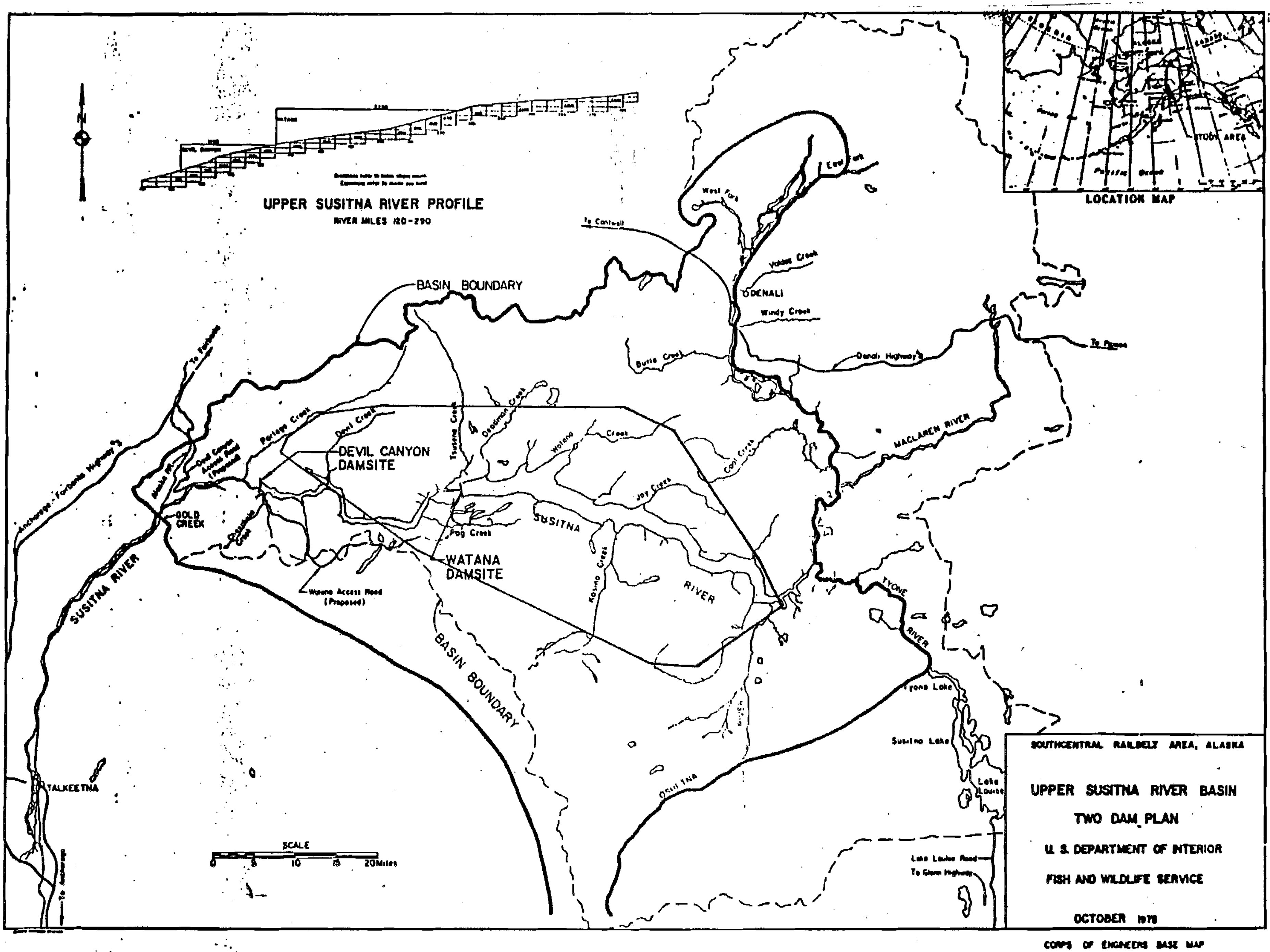


summer home ranges for male and female wolverine in northwestern Alaska as 615 km^2 (237 mi^2) and 187 km^2 (71 mi^2), respectively, while Hornocker and Hash (1981) reported annual home ranges of 422 km^2 (163 mi^2) and 388 km^2(150 mi^2) for males and females, respectively in northwestern Montana. Krott (1959) speculated a male wolverine could have a territory as large as 1,000 to 2,000 km^2 (386 to 772 mi^2) depending on food supply and competition from other species. Comparing home range sizes for males from study areas in northwestern Alaska, the Susitna River Basin and northwestern Montana, it appears that male wolverine in Alaska have a larger home range. However, home range requirements for lactating females were similar between Susitna Basin, Alaska and northwestern Montana. The larger home ranges of wolverine in Alaska are probably related to both lower diversity and density of prey.

Population Estimate

An accurate estimation of wolverine density within the impoundment area is difficult to obtain with the available data. More information is needed on wolverine home range sizes and overlap, habitat utilization, sex and age ratios, mortality, immigration and emigration. Within the 2,727 km^2 (1,052 mi^2) core area where intensive radio-telemetry studies were conducted (Fig. 5), a minimum of 9 adult wolverine occurred providing a minimum density estimate of 1 adult wolverine/303 km^2 (1/117 mi^2). However, we believe a more reasonable estimate might be obtained by utilizing home range data if certain assumptions are made: 1) within sexes, home ranges are essentially mutually exclusive but overlap occurs between sexes; 2) home ranges remain constant all year; 3) equal use of all available habitats; and 4) no significant immigration or emigration. During this study the annual home range for one male wolverine was 627 km^2. Two additional estimates of 272 and 378 km^2 were obtained for 6-8 month periods. Between January and April, the one male wolverine for which annual data exists increased its home range by 228 km^2. This

Figure 5. Boundary of the core area where density estimates were obtained in relation to the entire study area.



increase in home range size during the winter months may have been related to a reduction in food availability. If all male wolverine have similar movements then average annual male home ranges in the Susitna Basin probably range from 500 km^2 to 627 km^2. This estimate appears comparable with the male home ranges found by Magoun (1979) in northwestern Alaska. Both estimates were used for our density calculations. Also, only the home range of a lactating female was determined during this study, which was not representative of a female's annual home range. Hornocker and Hash (1981) reported an annual home range of 388 km^2 for females in northwestern Montana while Magoun (1979) reported female home ranges of 185 km^2 (summer home ranges) in northwestern Alaska. Magoun's estimates are probably not relective of annual home ranges because the data were derived primarily during summer. However, for our density calculations we used a combination of estimates. With the above assumptions and the different estimates of home range sizes we estimated that the study area supported from 11 to 21 adult wolverine, yielding an estimated adult density range of 1/248 km^2 (1/96 mi^2) to 1/136 km^2 (53 mi^2).

Necropsy data from carcasses collected in the Susitna Basin, Alaska and northwestern British Columbia (Liskop et al. 1981) were used to estimate the number of pre-adult wolverine in the study area. Based on Susitna River data, 8 of 15 (53%, similar to Rausch and Pearson 1972) mature females were reproductively active (assuming that pregnant or post-partum females were equally vulnerable to trapping or hunting as non-pregnant wolverine. Liskop et al. (1981), however, determined that in northwestern British Columbia 23 of 26 (88%) mature females were reproductively active. According to Rausch and Pearson (1972) the effective reproduction of wolverine is 2.0 kits/litter. Therefore, the estimated number of kits added annually to the study area's population ranges from 6 to 26. This yields a total population estimate between 16 and 46 wolverine without mortality, immigration and emigration factors included. The above calculations indicate a total density ranging from 1 wolverine/170 km^2

(66 mi^2) to 1 wolverine/59 km^2 (23 mi^2). (Table 4.) Wolverine densities and home range size may be related to food supply (Hornocker and Hash 1981). It is generally accepted that food abundance and diversity normally decrease from southern to northern latitudes (Fisher 1960, Stehli 1968). If wolverine densities are partially related to density of prey, then wolverine densities should be greater Hornocker and Hash's study area in northwestern Montana than in Alaska. Thus, within Alaska, the Susitna Basin should support greater densities than the western Brooks Range. Hornocker and Hash (1981) and Magoun (1979) reported estimated densities of 1/65 km^2 (1/25 mi^2) and 1 adult/149 km^2 (1/58 mi^2) in northwestern Montana and Alaska, respectively. Comparing the density range calculated for the Susitna Basin (Table 4) with these results, the best wolverine density estimate for the core study should be between the estimates for Montana and northern Alaska and probably ranges between 1/75 km^2 (1/29 km^2) and 1/143 km^2 (1/55 mi^2).

The total study area (Fig. 5) encompassed approximate 9,350 km^2 (3,609 mi^2). Using the core area density estimate and extrapolating to the total study area provides a population estimate between 55 and 154 wolverine; however a more reasonable estimate is probably 65 to 123 wolverine.

Harvest

A total of 27 wolverine were harvested from the study area during Phase I (1979-1981) studies; 20 during 1979-80 and 7 during 1980-81. The low take during 1980-81 was probably due to poor weather and snow conditions.

Harvest locations (Fig. 2 and 3) may also provide additional insight into wolverine movements and food habits. A comparison of annual harvests with fall 1980 moose densities and movements (Ballard et al. 1981) suggested that 6 of 8 and 4 of 5 wolverine harvested in 1979 and 1980, respectively, were from areas of medium to low moose density. This suggests that wolverine were

Table 4. Range of density estimates for wolverine in the Susitna River Basin Core Study Area during Phase I Studies, 1980-81.

Estimated # of males	Source	Estimated # of females	Source	Estimated # of reproductive females	Source	Est. # of kits produced	Est. total # wolverine	Density est. (1/km 2/)
5	This study 2/ est. from known animals	5	This study est. from known animals	3	This study	6	16	1/170
				4	Liskop et al. 8/	8	18	1/151
4	Magoun 4/	7	Hornocker 5/ and Hash	4	This study	8	19	1/143
				6	Liskop et al. 3/	12	23	1/119
5	This study	7	Hornocker 5/ and Hash	4	This study	8	20	1/136
				6	Liskop et al. 3/	12	24	1/114
4	Magoun 4/	15	Magoun 4/	8	This study	16	35	1/78
				13	Liskop et al. 3/	26	45	1/61
5	This study	15	Magoun 4/	8	This study	16	36	1/76
				13	Liskop et al. 3/	26	46	1/59

1) Based on 2 kits per litter (Rausch and Pearson (1972).
2) Assumed 1:1 sex ratio.
3) Number of reproductively active females determined by carcass data collected by Liskop et al. (1981).
4) Based on home range data collected by Magoun (1979).
5) Based on home range data collected by Harnocker and Hash (1981).

Table 5. Utilization by wolverine 040 of the different habitats present within its home range.

Habitat Type	Habitat Availability (%)	Expected # of Relocations	Actual # of Relocations	Observed Use (%)
Low shrub	56.4	23	15	37.5
Sedge Grass Tundra	18.5	7	9	22.5
Open Spruce	9.0	4	8	20.0
Mixed Open Spruce	2.7	1	4	10.0
Woodland Spruce	2.4	1	2	5.0
Rock	1.3	1	1	2.5
Willow	0.4	0	1	2.5

probably feeding on moose to an undetermined extent.

Harvest locations may also indicate the degree of trapping pressure in the study area. Only, 2 and 0 wolverine were trapped within the core area (Fig. 5) during 1979-1980 and 1980-1981, respectively. Obviously, the majority of the trapping pressure occurred along the edge of the study area. Harvest occurred near waterways and winter trails. The distance from populated areas, to the core area, the topography and habitats of the core area, and the lack of trails within the core area, probably prohibited this area from being efficiently trapped.

However, with the construction of the Devil Canyon-Watana dam system, there will be an increase in accessibility into the area and correspondingly, a probable increase in wolverine trapping pressure.

If construction occurs, an allowable harvest level should be determined if the area's wolverine population is to remain viable. Van Zyll de Jong (1975) has reported that overharvesting would be detrimental to a wolverine population due to their low intrinsic rate of increase. However, increased trapping pressure, probably would not detrimentally affect the area's population initially, due to the fact that large parcels of wolverine habitat surround the area and therefore emigration into the area may compensate trapping losses.

Habitat Utilization

Within each of the 4 radio-collared wolverines' home ranges, 6 to 11 habitat types were present. All locations were plotted by habitat type to compare use in relation to availability.

Wolverine 040 was observed in 7 of the 11 different habitat types within its home range. By frequency of observation, low shrub (37.5%), sedge grass tundra (22.5%), open spruce (20%) and mixed open spruce (10%) habitats were preferred (Table 5). However, 040 utilized low shrub habitat in a lower proportion than what the habitat was available, (37.5% vs. 56.4%), while 040 utilized sedge grass and open spruce habitats to a greater proportion than the habitat availability, (22.5% vs 18.5% and 20% vs 9%, respectively). Seasonal habitat preferences were also apparent. Seventy-five (6 of 8) percent of open spruce usage occurred between mid-December and 1 April and 67% (6 of 9) usage of sedge grass tundra habitats occurred between 25 May and 1 September.

Wolverine 042, a lactating female with 2 kits, summered in an area of low habitat diversity as three habitat types covered 86% of her home range. The predominant habitat type, mat and cushion/sedge grass tundra, was used in approximately the same proportion as it occurred (Table 6). A cursory examination indicates that the woodland spruce and open tall shrub habitats were preferred and the sedge grass and alpine herbaceous tundra habitats were avoided. However, the small sample size may be a major bias.

Wolverines 043 and 044 displayed preference for ecotone habitats since 37.6% (9/26) and 61.5% (8/13) of their relocations were present in these transition zones. Preference or avoidance behavior toward homogenous habitat types was impossible to separate due to their apparent preference of ecotonal areas (Tables 7 and 8).

All of the radio-collared wolverine displayed an increased use of lower elevation areas during winter and late spring (December through March). The mean seasonal values are 760 m (winter) and 950 m (spring), 940 m (summer) and 950 m (fall). Hornocker and Hash (1981) also reported an elevational decline during winter for wolverines in northwestern Montana.

Table 6. Utilization by wolverine 042 of the different habitats present within its home range.

Habitat type	Habitat Availability (%)	Expected # of Relocations	Actual # of Relocations	Observed Use (%)
Mat and Cushion/ sedge grass tundra	49.7	9	10	55.5
Sedge Grass tundra	21.2	4	2	11.1
Alpine Herbaceous tundra	15.3	3	1	5.5
Open tall shrub	6.5	1	3	16.6
woodland spruce	3.6	1	2	11.1

Table 7. Utilization by wolverine 043 of the different habitats present within its home range.

Distinct Habitat Types # Ecotones	Habitat Availability (%)	Expected # of Relocations	Actual # of Relocations	Observed use (%)
mat cushion/sedge grass tundra	49.1	12	3	11.5
open tall shrub	20.0	5	7	26.9
willow shrub	12.5	3	4	15.3
bush shrub	5.2	1	0	0
open mixed forest	4.8	1	3	11.5
mat cushion/sedge grass tundra/open tall shrub ecotone	--	--	4	15.4
open mixed forest/mat cushion/sedge grass tundra ecotone	--	--	2	7.7
open mixed forest/ open tall shrub ecotone	--	--	1	3.8
birch shrub/mat cushion/sedge grass tundra ecotone	--	--	1	3.8
birch shrub/open tall shrub ecotone	--	--	1	3.8

Table 8. Utilization by wolverine 044 of the different habitats present within its home range.

Distinct Habitat Types & Ecotones	Habitat Availability (%)	Expected # of Relocations	Actual # of Relocations	Observed use (%)
low shrub	21.8	3	2	15.4
sedge grass tundra	20.7	3	0	0
mat cushion/sedge grass tundra	16.6	2	1	7.7
woodland spruce	15.8	2	0	0
willow shrub	6.4	1	1	7.7
low shrub/sedge grass tundra ecotone	--	--	3	23.1
woodland spruce/birch shrub ecotone	--	--	2	15.4
open spruce/open mixed forest ecotone	--	--	1	7.7
woodland spruce/low shrub/sedge grass tundra ecotone	--	--	1	7.7
woodland spruce/birch shrub/closed spruce ecotone	--	--	1	7.7

For carnivores and scavengers it is probably more accurate to classify habitat by available prey species. It is well known that wolverines are well adapted for carrion feeding and also, that it is important in the wolverine diet (Hornocker and Hash 1981, Rausch and Pearson 1972, Pulliainen 1968, Haglund 1966, Krott 1959). However, other authors indicate that wolverine use of smaller prey such as marmot, snowshoe hare (*Lepus americanus*), Arctic ground squirrels, microtine rodents, and birds is extensive, especially in the spring and summer (Hornocker and Hash 1981, Magoun 1979, and Krott 1959). Magoun (1979, 1980) found wolverine feeding on microtines, ground squirrels, marmots and caribou between April and September in northwestern Alaska. In the same report, she speculated that their diet shifts primarily to microtines and ptarmigan (*Logopus* spp.) during the winter due to caribou migration and ground squirrel and marmot hibernation. Scat analysis by Magoun (1980) further exhibits the importance of carrion, ground squirrels, microtines, and birds.

In the Susitna Basin, there is a pronounced movement toward higher elevation areas in the spring, summer, and fall months. During this time, there are an abundance of ground squirrels, pikas (*Ochotona collaris*) and marmots throughout the high country (McDonald 1981). Also present in the tundra habitats are 13 species of ground nesting birds (Cooper, pers. comm.). Within part of wolverine 040's home range, the main summering concentration of Nelchina caribou occurs primarily between 4,000 to 6,000 feet (Pitcher 1980). Sixty-seven percent of 040's locations between 15 May and 1 September were within this tundra habitat. Wolverine 044 moved a straight line distance of 70 km from an open spruce habitat (1400' elevation) to a tundra habitat (3250' elevation) in occurrence with small mammal emergence, caribou inhabitance and bird nesting season. It remained above treeline until 26 September 1980.

The high number of locations of wolverines 043 and 044 within ecotones is probably related to availability of food. It is well known that ecotones are usually high in plant diversity and support a diverse microtine population. Unfortunately, we have no quantitative data on prey densities in these areas.

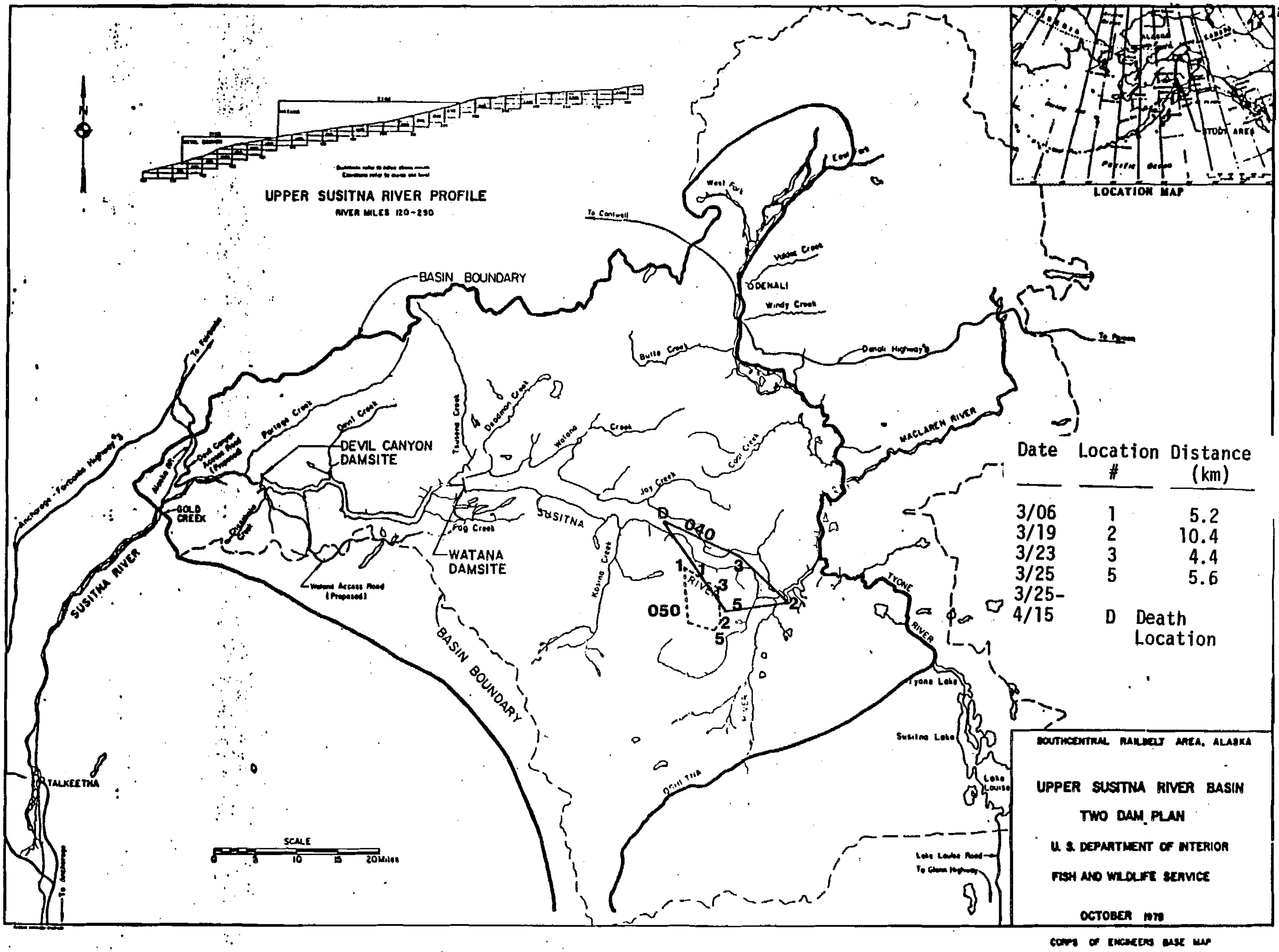
Winter food habits data collected from fixed wing aircraft and from ground tracking indicates the increased importance of lower elevations and forested areas. The Susitna River, from the Gauging Station to the Big Bend (predominately open spruce habitat) supports a high density of moose during the winter (Ballard et al. 1980). Also, microtine rodents were more abundant in the open spruce habitat. From mid-December to 1 April, 75% of wolverine 040's locations were within that area. During March 1981, we knew that at least 2 wolverine were using that area and observed use of 3 different moose carcasses.

Ground tracking during May and November 1980 and April 1981 indicated that wolverine were preying on small mammals. Tracks were followed through a variety of habitats and and it appeared that the wolverine were hunting red squirrels (*Tamiasciurus hudsonicus*), ground squirrels and grouse, (*Canachiles canadensis*).

Social Behavior

There is a discrepancy in the literature concerning wolverine spacing. Koehler et al. (1980) found territorial defense to be nonexistent in Montana wolverines. Magoun (1980), however, documented adult female wolverines excluding other adult females from their home ranges at least from April through September. Both authors concur that there is overlap between sexes. We did not collect adequate data to infer exclusion or overlap of home ranges within sexes. However, during March 1981 we monitored movements of wolverine 040 (adult male) and wolverine 050 (juvenile male), which occupied part of 040's annual home range (Fig. 6). During March we located each wolverine 6 times and found their home range sizes to be comparable, 79 km^2 to 80.6 km^2

Figure 6. Movements and home ranges of wolverines 040 and 050 during March, 1981.



for 040 and 050, respectively. During this time, there was only a small amount of overlap. However, we monitored the 2 wolverine on the same day 4 times and found the distance separating the 2 wolverine ranged from 4.6 to 11.0 km (2.9 to 6.9 mi). During the first week in April we found 040 dead and lost contact with 050.

We investigated 040's death site on 17 April 1981. There were 2 sets of wolverine tracks in the area, both coming from the south side of the river. One of the wolverine had killed and consumed a spruce grouse. Where the trails crossed there was a shallow depression in the snow measuring 0.75 m (30 inches) by 1.0 m (39 inches). Under 15 cm (6 inches) of snow, wolverine 040 was cached. Close examination revealed that the other wolverine had fed extensively consuming all the musculature, internal organs, and genitalia. The head was intact with 040's tongue lacerated.

Where the wolverines made contact, there was an extensive network of tracks but no sign of conflict. Evidence was not adequate to accurately infer if 040 was killed by the other wolverine or had died of another cause and then was fed on and cached by that wolverine. However, we ruled out starvation during March and April, because 040 had been observed feeding on a minimum of 3 moose carcasses during the previous month. There was an increase in spermatogenesis as breeding season (Rausch and Pearson 1972). Magoun (1980) suggests that with the onset of breeding season aggressive behavior by the resident adult wolverine may be related to the dispersal of immature animals (9-14 months). The direction of tracks, the close proximity of previous locations, the loss of contact with wolverine 050 and the onset of breeding season gives circumstantial evidence that the 2 wolverines involved were 040 and 050 and that wolverine 050 possibly killed wolverine 040.

Breeding Behavior

There is limited knowledge concerning breeding behavior of wolverine. Only 3 occurrences of breeding have been witnessed in the wild and these were observed from fixed-wing aircraft (Magoun 1980). On 9 June 1981 a pair of wolverine on Watana Mountain were observed breeding. A description is presented in Appendix B.

Potential Impacts

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.

Recommendations for Phase II Studies

Phase I studies have identified the needs for additional data collection to further assess the impacts of the Susitna Hydroelectric project on wolverine. Additional research should include the following projects:

(1) The segment of the wolverine population which inhabits areas close to Watana Camp and High Lake Lodge should be radio-collared in order to more accurately assess the impacts of human activity on wolverine movements and seasonal distribution.

(2) Establish radio contact with additional wolverine in order to obtain data concerning home range size, habitat use, population dynamics, emigration and mortality.

(3) Monitor radio-collared adult females during late winter-early spring in order to locate any possible dens. Document site characteristics in order to determine any habitat or topographical requirements. Scats should be collected from the den to evaluate a denning female's food habits.

(4) Evaluate winter food habits by ground tracking radio-collared wolverine. Scats should be collected and the location where the scats found recorded. If possible, caches and the food items identified.

(5) Carcasses should continue to be purchased from GMU-13 trappers and hunters. Age, reproductive status and condition of the harvested animal can be determined. Data collected from the harvested wolverine will aid in density estimates and indicate distribution.

(6) Continue to monitor radio-collared wolverine to gather annual home range data, to evaluate seasonal movements and distribution and to determine if any type of territoriality exists within sexes.

(7) Radio-collar wolverine inhabiting the downstream study area. Quantify wolverine harvest mortality, movement patterns and distribution in an area very accessible to human influence.

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Appendix A. Paper describing the use of M-99 and Rompum to immobilize wolverine.

USE OF ETORPHINE AND XYLAZINE TO IMMOBILIZE WOLVERINES

WARREN B. BALLARD AND CRAIG L. GARDNER[1]

Abstract: Seven wolverines were successfully immobilized by darting from helicopter using a mixture of etorphine HCl (EHc) and xylazine HCl (XHCl). No adverse effects were observed following recovery. The major advantage of using EXHCl was that it allowed rapid recovery. A dosage of 9.4 mg EHCl with 50 XHCl was that it allowed rapid recovery. A dosage of 0.4 mg EHCl with 50 mg XHCl was recommended for 12.6-17.7 kg wolverine to be darted from helicopter.

INTRODUCTION

There is a paucity of literature concerning the capture and immobilization of free-ranging wolverine (*Gulo gulo*). Ketamine HCl[2] has been successfully utilized to immobilize wolverines caught in barrel traps but recovery required 3-8 hours.[3] Phencyclidine HCl[3] has also been successfully used by darting from a helicopter[4] but the drug is no longer commercially available. During a study of wolverine ecology in remote southcentral Alaska it was desirable to capture and immobilize wolverine without using time consuming trapping procedures and have rapid recovery so that sedated animals would not be abnormally exposed and vulnerable

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[2] Vetelar[R], Parke, Davis and Co., Detroit, Michigan.

[3] Sernylan[R], Bio-ceutic Laboratories, Inc., St. Joseph, Missouri.

[4] A. Magoun, Personal communication, University of Alaska, College, Alaska.

to extreme air temperatures and hunting and trapping mortality. This paper reports on the successful immobilization of wolverines with a mixture of etorphine HCl[5] (EHCl) and xylazine HCl[6] (XHCl) administered by darting from a helicopter.

MATERIALS AND METHODS

Wolverine were captured in spring and fall of 1980 and 1981 in the upper Susitna River Basin of southcentral Alaska, approximately 230 km northeast of Anchorage. Descriptions of the are have been reported elsewhere.[2,4,5]

Wolverine were located and darted from helicopter[7] similar to methods described for wolves (*Canis lupus*).[1] A mixture of 0.4 mg EHCl (1 mg/ml) and 50 mg XHCl (100 mg/ml) was utilized to immobilize wolverines of both sexes and all ages. Induction time was determined with a stopwatch and was measured from initial injection to when the wolverine became immobile. One wolverine was captured in a barrel trap in Prince William Sound, and was administered mg etorphine with a pole syringe.

After processing, immobilized wolverines were administered an equivalent ml dosage of the antagonist dirpenorphine HCl (2 mg/ml)[8] either intravenously (IV) in the radial or saphenous vein or intermuscularly (IM) in the hip area. Recovery time was also measured with a stopwatch and consisted of the period between injection and regained mobility.

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[5] M-99, The Lemon Co., Inc., Rockville, Maryland.

[6] Rompun, Chemagro Division of Bay Chemical Corp., Kansas City, Missouri.

[7] Bell 206B, Bell Helicopter, Fort Worth, Texas.

RESULTS AND DISCUSSION

Six 14.5 - 17.7 kg male and one 14.5 kg female wolverine were darted from helicopter and one 8.6 kg female was caught in a barrel trap. EHCl dosages delivered from helicopter varied from .02 - .13 mg/kg (x = .05 mg/kg, S.D. = .04) while XHCl dosages varied from 2.74 - 2.83 mg/kg (x = 2.78 mg/kg, S.D. = .05). Induction time ranged from 4 - 19 minutes, averaging 10.0 minutes (S.D. = 6.0). The trapped wolverine was immobilized with 0.6 ml EHCl (.07 mg.kg) and was immobile within 7 minutes. The adult female darted from helicopter also was not administered XHCl but was given 5 mg acepromazine maleate (10 mg/ml).[9] Recovery time for four wolverine which were given the antagonist IV ranged 1-9 minutes (x = 4.8, S.D. = 3.36) while 9 minutes were required for two wolverines when administered IM. No recovery time was available for the female wolverine which received the injection of acepromazine. One wolverine recovered without the antagonist with 25 minutes following induction. All wolverines were subsequently observed from fixed-wing aircraft and no adverse effects were observed.

Results of this study suggest that dosages of 0.4 mg EHCl with 50 mg XHCl are satisfactory for immobilizing wolverines weighing 12.6 - 17.7 kg when darted from helicopter. Although ketamine HCl has also been used to immobilize wolverines from helicopter,[4] the EHCl/XHCl mixture allows rapid recovery from immobilization and therefore wolverines are not abnormally vulnerable to extreme temperatures or hunting-trapping mortality.

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[8] M 50-50, The Lemon Co., Inc., Rockville, Maryland.

[9] Reckitt and Colman Pharmaceutical Div., Hull England.

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Date received ______________________________

Date accepted ______________________________

Appendix B. Report describing the behavior displayed by a pair of mating wolverine.

WOLVERINE BREEDING BEHAVIOR

Breeding behavior of the wolverine (*Gulo gulo*) is not well described in the literature except timing of breeding (Mehrer 1975, Rausch and Pearson 1972) and den ecology (Pulliainen 1968, Myrberget 1968, Krott 1959). Described here are mating behavior and copulation of wolverines observed from the ground on 9 June 1981.

Mating occurred on a north facing slope at 1300 m on Mt. Watana, located in the Susitna River Basin in southcentral Alaska. The site was 9 m^2 with a slope of 0-15°. Vegetation was primarily a boulder strewn heath (*Cassiope tetragona*) mat surrounded by scree.

At 1601 vocalizations ("screams") were heard which resembled the sound of fighting cats (*Felis domesticus*). We approached to within 300 m of a pair of wolverines which appeared to be fighting. The wolverines screamed and wrestled continuously from 1607 and 1609, when they began to vocalize intermittently. At 1612 the wolverines stopped vocalizing, laid down side by side and head to head and began clinching and rolling over each other. Between 1616 and 1617, the male walked behind the female, clasped her back with his forelegs and began to copulate vigorously, pushing the female to the ground. At 1626, the female sat up on her front paws while the male continued to thrust actively. Both animals fell to their right side at 1628; however, the clasp was maintained and thrusting continued. At 1630, the female again lay prone with the male mounted on top. Between 1630 and 1706, the female occasionally sat up. From 1706 to 1755, the male thrusted less frequently, but maintained his clasp and position. No apparent change in behavior was noted when a helicopter landed approximately 600 m north. Between 1755 and 1759, we moved to a better viewing position but lost sight of the wolverines. During that period the male withdrew and the pair left the area together. The total duration of copulation was 102 minutes. Tracks in the snow indicated that they had travelled together a minimum of 2.4 km prior to and 1.6 km after copulation.

The duration and vigor of wolverine copulation is similar to that reported by Enders (1952) and Hatler (1976) for other mustelids. Hansson (1947) found the mean duration of 227 mink (*Mustela vison*) matings to be 64 minutes. Magoun (pers. communication) observed 3 wolverine matings lasting 12 minutes, 20-30 minutes and 54 minutes. An additional mating of 20 minutes was observed for the latter pair. These are minimum times since the entire copulation act was not observed. The matings observed from aircraft occurred on 6 August, 11 June and 5 June, respectively, approximately 300 km SW of Barrow, Alaska.

The apparent aggressiveness exhibited during copulation could be dangerous for either individual. Magoun (pers. comm.) observed agonistic behavior prior to each observed wolverine copulation. Female wolverines, which average 30% smaller by weight than males (Magoun 1979), are probably exposed to greater risk. Females of other mustelid species have died while others have scarred from injuries incurred during mating (Enders 1952, Foott 1970, Hatler 1976). Hatler (1976) observed that male mink on fur farms had to overpower the female even if she was physiologically receptive.

Since the risks and energy demands of wolverine mating appear to be high, especially for the female, it is interesting to speculate upon the evolution of this mating behavior. Asdell (1964) reports that most mustelids are induced ovulators and Hatler (1976) indicates that ovulation follows copulation and/or the stimulus of courtship battle in the mink. However, the aggressiveness during mustelid mating appears excessive to what would be expected for induced ovulation to occur. Therefore, it may serve a specific function. The female invests a considerable amount of energy during gestation, lactation, and kit rearing. If there is intense competition between kits for suitable home ranges and subsequent survival, the aggressive behavior during breeding may constitute a component of epigamic selection. In species exhibiting low population densities such as the wolverine, the female's only cue to a male's fitness may be through the aggressive behavior associated with courting. A male not able to subdue a female would be less fit than one that could. It would then be beneficial for the female to repulse males of low fitness to maximize the perpetuation of her genes through future generations. Therefore, a future benefit of passing on her genes when mated to the more fit male may exceed the immediate cost of physical injury imposed during breeding.

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SUSITNA HYDROELECTRIC PROJECT

PHASE I FINAL REPORT

BIG GAME STUDIES

VOLUME III. DALL SHEEP

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and
Robert Tobey

ALASKA DEPARTMENT OF FISH AND GAME

Submitted to the
Alaska Power Authority

March, 1982

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. This information, along with information on furbearers, small mammals, birds, and plant ecology collected by the University of Alaska, is to be used by Terrestrial Environmental Specialists, Inc. of Phoenix, New York, in preparation of exhibits for the Alaska Power Authority'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. Little data was available on wildlife use of the immediate project area, although some species had been intensively studied nearby. Consequently, it was necessary to start with fairly general studies of wildlife populations to determine how each species used the area and identify potential impact mechanisms. This was the thrust of the 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 reports are organized into the following eight 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

SUMMARY

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.

Impacts of the proposed project on sheep were presented and discussed. The Watana Hills sheep population could be severly impacted by the proposed project. Impacts on sheep in the Watana-Grebe Mountain area and the Portage-Tsusena Creek areas will probably be negligible although additional survey information would be desirable to confirm this conclusion.

Plans for Phase II studies were briefly presented and discussed.

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INTRODUCTION

Prior to initiation of Phase I studies for the Susitna Hydroelectric Project, it was believed that construction and operation of the proposed project would have few adverse impacts on Dall sheep. Identified impacts consisted primarily of harassment and disturbance from construction activities, helicopter traffic, and possible access routes through mountainous habitat. The original study design was limited to determination of seasonal distribution and abundance of sheep close to the proposed impoundments. However, reported observations of Dall sheep near the 2200 foot elevation of Jay Creek during the first year of study suggested the possibility that critical habitat might be inundated by the proposed Watana impoundment. As a result, the scope of study was expanded to document use of the Jay Creek site.

The study area includes all drainages flowing into the Susitna River from Gold Creek to Kosina Creek on the south and to the Denali Highway on the north. Survey efforts were confined to areas of known or suspected Dall sheep habitat within this area (Fig. 1).

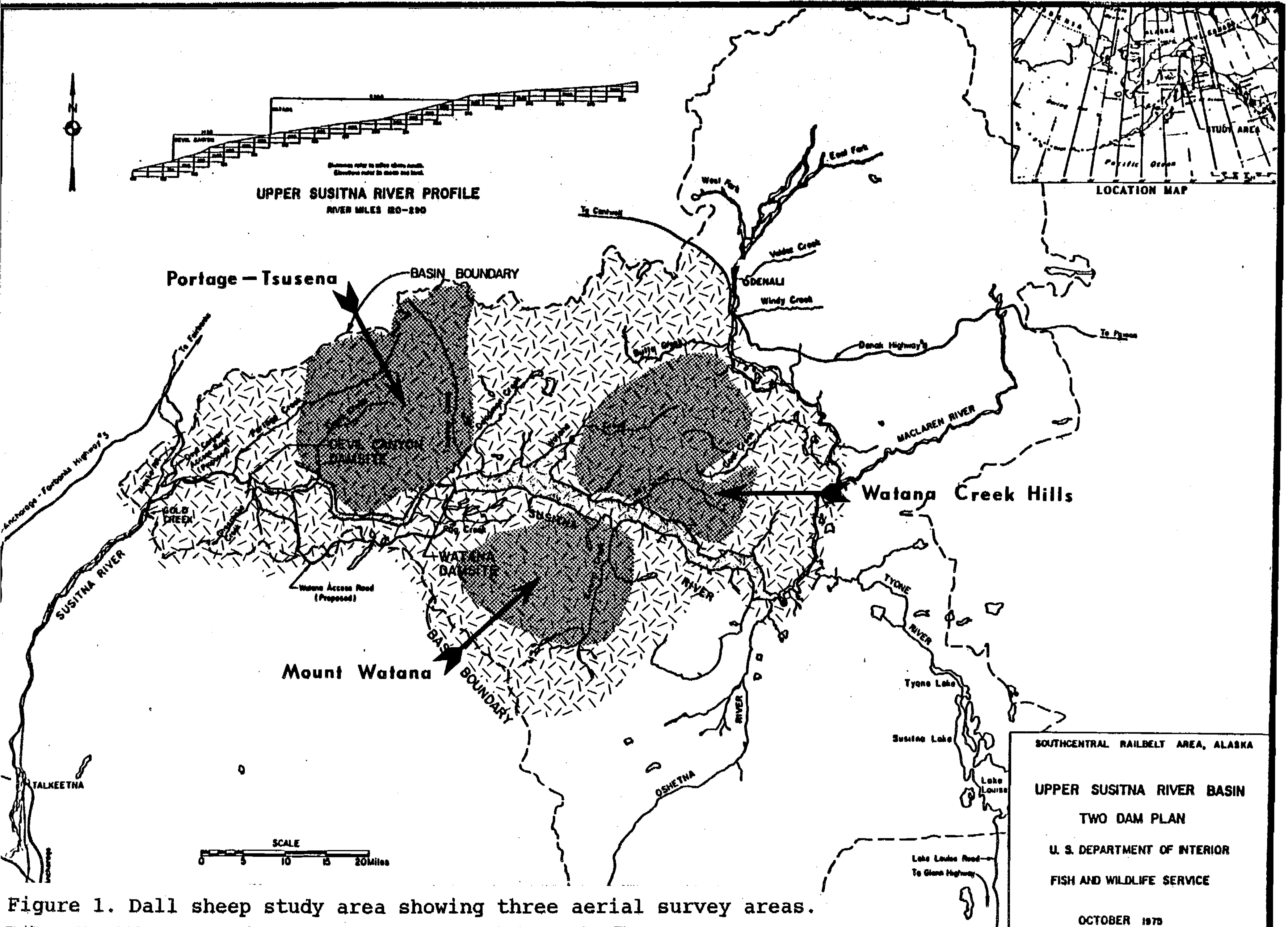

Figure 1. Dall sheep study area showing three aerial survey areas.

METHODOLOGY

Sheep observations were recruited from all Susitna study participants. Date, location, number, sex and age of all sheep observed and subsequently reported were recorded on 1:63,360 USGS topographic maps. winter and spring observations were especially requested because they show seasonal distribution and in some instances habitat use.

An aerial survey was conducted with a PA-18 Super Cub, on 22 and 23 July 1980, in an effort to determine sex and age composition and summer distribution of Dall sheep. Sixteen hours were spent surveying sheep in 3 areas; Portage-Tsusena, Mt. Watana, and Watana Hills. (Fig. 1). All observed sheep were identified as to number, sex, age class and locations were plotted on 1:63,360 maps.

Sheep aerial surveys were conducted with a PA-18 Piper Super Cub on 13 and 25 March 1981, to determine sex and age composition and winter distribution. Approximately 6 hours were spent surveying sheep in 2 areas; 3 hours in the Watana Hills count area, and slightly less than 3 hours in the Mt. Watana-Grebe Mountain count area. All sheep observed were identified by sex and age class. Their numbers and locations were marked on either 1:250,000, or 1:63,360 scale on U.S.G.S. maps.

On 9 May 1981 a helicopter transported ADF&G biologists to the lick near Jay Creek where Dall sheep had been observed. Ground examination of the area was made & photographs were taken showing use of the area by sheep and moose. Preliminary altitude measurements were taken with a hand held altimeter. Soil samples were collected from 4 different locations, and placed in plastic bags for future analysis.

Beginning on 13 May 1981 and continuing to 24 June 1981 aerial observations of the area were made from a Piper Super Cub. All sheep observed were counted and identified by age and sex. Their activities were recorded, and their location relative to the mineral area was plotted.

On 28 July 1981 an aerial survey of summer sheep distribution was conducted with a PA-18 Piper Super Cub. Approximately 3 hours were spent surveying sheep in the Watana Hills count area. All sheep observed were identified by sex and age class.

RESULTS AND DISCUSSION

Watana Hills

The Watana Hills count area was established as a population trend area for Dall sheep by ADF&G in 1967, and since that time has been surveyed 8 times (Table 1). The July 1980 count of 174 sheep was higher than the 7 year average of 163. However, if the 1974 survey of 76 sheep is eliminated, the average is 175 sheep. Thus, the 1980 survey suggests that the population has remained stable.

The July 1981 count of 209 sheep was the 2nd highest number of sheep recorded for this area. The percentage of lambs was similar to past years, and suggests that productivity and early survival are remaining constant. The small number of legal rams counted could reflect the rather high (13) sport harvest taken from this area in 1980 (Tobey, pers. comm.). Although the 1981 count was relatively high it is suspected that the population has remained stable or perhaps increased slightly. Some yearly variation is expected in count data because of differences in observers and counting conditions and minor population fluctuations.

Table 1. Compilation of highest yearly counts completed in Watana Hills sheep trend count count area.

	Legal Rams*	Lambs	Total	% Legal Rams	% Lambs	Surveyor	
1950			0			Scott	
1967	--	--	220	--	--	Nichols	
1968	--	--	183	--	26.6	Nichols	Aug.
1973	10	40	176	5.6	22.7	McIlroy	Aug.
1974	6	18	76	7.9	23.7	Harnkess	April
1976	4	30	130	3.1	23.0	Eide	Aug.
1977	4	33	152	2.6	21.7	Spraker	July 11
1978	5	34	189	2.6	18.0	Eide	July 23
1980	9	42	174	5.1	24.1	Tobey	July 22
1981	2	43	209	1.0	20.6	Westlund	July 28

* A legal ram is defined as having a 3/4 curl or greater horn.
Beginning in 1979, a legal ram is defined as having a 7/8 curl or greater horn.

The winter distribution of sheep was determined during March 1981 and is presented in Table 2 and Figure 2. It is of interest that all sheep observed were on south facing slopes, suggesting that these areas are a very important part of Dall sheep winter range (Geist 1971). South facing slopes provide maximum exposure to the winter sun, and frequently have snow depths less than adjacent slopes with different aspects (op. cit.).

Table 2. Number of Dall sheep observed in the Watana Creek sheep count area of the Susitna River Basin during a survey on 3 March 1981.

Observation # for Fig. 2	No. of Sheep	Observation # for Fig. 2	No. of Sheep
1	2	9	16
2	13	10	7
3	5	11	1
4	5	12	2
5	3	13	2
6	6	14	2
7	3	15	16
8	4		
		TOTAL	87

Figure 2. Distribution by observation number (see Table 2) of Dall sheep observed on 3 March 1981 in the Watana Hills count area of southcentral Alaska.

Differences in total numbers of sheep observed between the winter survey and the summer survey were probably the result of poor observability due to snow cover during the March survey and/or movement of some segments of the population from the area.

The mineral lick at Jay Creek was visited by staff biologists on 9 May 1981. Portions of the lick extend below the 2200 ft. elevation. Therefore, at least a portion of the lick area will be inundated by the Watana impoundment. Sheep usage of the area ranged from the Jay Creek streambottom to the top of the bluff and for an undetermined distance away from the bluff.

Soil samples collected at the Jay Creek lick will be analyzed for chemical content during Phase II Studies. This analysis will determine the types and concentrations of minerals and/or salts that might be the main attractant of the area to sheep and other ungulates.

On the day of examination (9 May), four Dall sheep were observed actively scraping and eating dirt from this area. This further suggests that minerals are the main attraction.

Numbers of sheep observed from the air at the Jay Creek mineral area during late May and June 1981 are presented in Table 3. Classification of age classes often was not possible because either sheep were located in thick fringe vegetation or weather conditions caused poor visibility. A total of 34 separate sheep observations were made over a 50 day time period, starting 6 May and ending on 24 June 1981. The largest single group observed at the Jay Creek site was 15, on 8 May. The observation represents approximately 7 percent of the observed Watana Hills summer population, and approximately 17 percent of the observed Watana Hills winter population.

Table 3. Number and age-sex classification of sheep observed at the Jay Creek Mineral lick located in th Susitna River Basin of Southcentral Alaska from 6 May through 24 June 1981.

Date	Time	Total # Sheep	# Ewes	# Yrlgs.	# Lambs	# Rams	Comments
5/06		5					At edge of mountains and flat area.
5/08		15					
5/09	A.M.	4	2	2			Soil samples collected.
5/13	1645	2					Bedded on top near right edge.
5/14	0900	4					2 pairs standing along right edge.
5/18	1355	4					2 sheep standing along right edge and 2 sheep standing on 1st small hill to NW between lick and mountains.
5/21	---	8	1	1		6	
5/22	1700	8	1	1		6	Rams feeding on bushes around edge at Lf. center.
5/23	1145	9	2	1		6	Rams feeding on E. side of Jay Cr. in cave on ridge.
5/24	1840	9	1	2		6-7	
5/25	1152	14	1	1		12	Rams in 2 groups on E. side of Jay Cr.
5/26	1808	0					
5/27	2225	0					
5/30	---	5					
6/02	---	0					
6/03	1405	1				1	E. side of Jay Cr. 2 miles NE of lick.
6/03	1408	9				9 (?)	Bedded on cliff 2 miles upstream from lick on west side.

Table 3. (Cont'd)

Date	Time	Total # Sheep	# Ewes	# Yrlgs.	# Lambs	# Rams	Comments
6/04	1926	0					Overcast w/ heavy rains, winds SE at 30-40.
6/05	1900	9				9 (?)	E. side of creek.
6/06	2146	9				9 (?)	Probably same group as on 6/05.
6/07	2025	9					E. side.
6/08	2115	10					E. side.
6/09	---	7	7				W. side.
6/10	0955	4	2	2			W. side.
6/11	---	4	3		1		W. side.
6/12	1939	10					Mostly ewes on upstream lick - 2 miles up.
6/13	1154	8	5		3		1 single on E.side of lower lick. 3 & 2 on W. side upper lick
6/14	0933	0					
6/15	1509	7	6		1		4 on lower lick. 2 & 1 on upper lick.
6/16	1102	4	3		1		W. side upper lick.
6/17	1155	1	1				E. side upper lick.
6/19	1000	2	1			1	Ram on upper lick. Ewe on lower lick.
6/21	1545	14					Lower lick - W. side.
6/24	0847	7				7	Lower lick. - W. side.

Sheep were observed frequenting other locations adjacent to the Jay Creek mineral site. On 23 and 25 May 1981 groups of 6 and 12 rams, respectively, were observed scraping and eating soil on the ridge located on the east side of Jay Creek, directly opposite the main lick area. Since only rams were observed on these 2 occasions, the observation could represent a preferential use of certain areas by sex or age class. Also, on June 3, 12, 13, 15, 16, 17 and 19, sheep of different age classes were observed at an area approximately 2 miles upstream from the main mineral area. This area also appears to be mineralized. Further investigation is necessary to determine the extent of mineralization and if there is any preferential use of these areas by sex or age class.

An aerial summer distribution survey was conducted on 28 July 1981, and no sheep were observed at the Jay Creek area. However, a group of 10 ewes and yearlings were observed actively utilizing a known mineral lick in the drainage of the E. Fork of Watana Creek, approximately 7 miles to the North of the Jay Creek site.

Mount Watana

During July 1980 only eight sheep (1 ram, 7 unidentified) were observed in the Watana Mountain-Grebe Mountain area (Fig. 3). Earlier observations in 1977 suggested that at least 34 sheep were present on Mt. Watana. Numerous observations exist of sheep in the Terrace Creek-Tsisi Creek area but no sheep were observed during the 1980 survey. Either the sheep migrated from the area or they were missed during the 1980 survey.

On 25 March 1981 a winter distribution survey was conducted in the same area surveyed in July 1980. A total of 28 to 30 sheep were observed (Table 4, Figure 4). If data collected during the summer 1980 survey and this survey were representative of the sheep population, they would indicate that sheep were migrating into the area during winter. All sheep observations, however,

Table 4. Number of Dall sheep observed in the Watana-Grebe Mountain area of the Susitna River Basin on 25 March 1981.

Observation # for Fig. 3	# of Sheep
1	3
2	5
3	10
4	3-4 tracks only
5	3-4 tracks only
6	4
	TOTAL 28 - 30

Fig. 3. Areas surveyed and distribution of Dall Sheep observed on 22-23 July 1980 aerial survey.

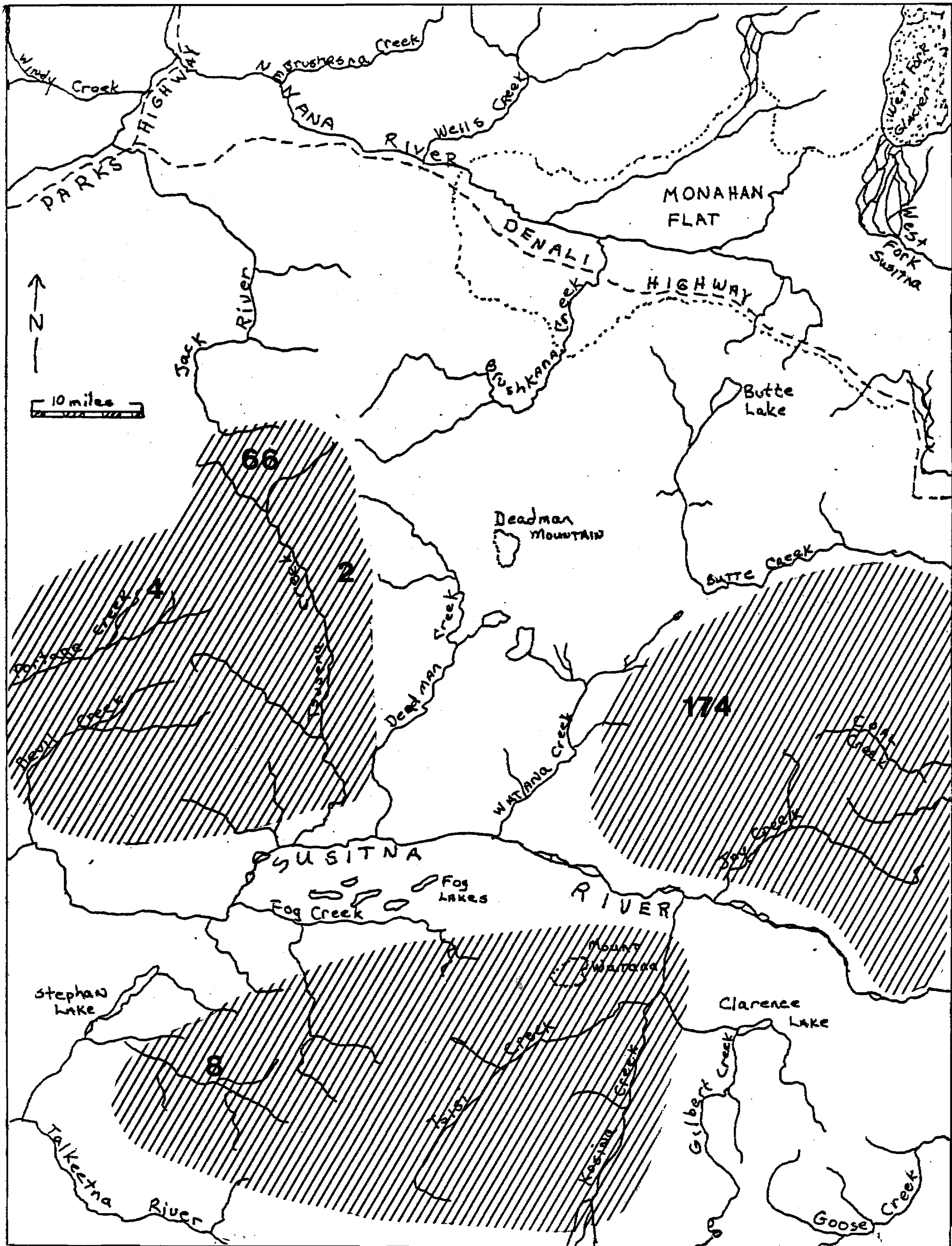

Figure 4. Distribution by observation number (see Table 4) of Dall sheep observed on 25 March 1981 in the Mount Watana - Grebe Mountain count area of southcentral Alaska.

were located on the southern extreme of the count area, well away from the impoundment and therefore, impacts of the impoundments on these sheep populations would appear to be minor.

Portage - Tsusena Creek

A total of 72 sheep (7 legal rams, 12 lambs and 54 unidentified) was counted in the Portage Creek and Tsusena Creek drainages during July 1980 (Fig. 3). The only previous ADF&G survey in this area was a 1977 count of 91 sheep (8 legal rams, 18 lambs, 65 others). The 1977 survey included the Jack River drainage which was not surveyed in 1980. The sheep sighted were located fairly high up in the drainages and relatively far from the proposed impoundments. Sheep may concentrate closer to the Susitna River in winter and may occupy habitat close to potential access routes. No surveys were conducted in 1981. The single distribution survey would suggest that the impoundment would have little effect on these sheep populations.

Hunter Use

The 1980 harvest within the Susitna sheep study area was 13 sheep. Eight of these were considered to be trophy quality with horn lengths greater than 35 inches. Most of the harvest occurred in the Watana Creek Hills.

The 1981 sport harvest from the study area was 2 sheep, also taken from the Watana Hills area. This small harvest could indicate a reduced number of available legal rams, or simply less hunting pressure in the area.

Potential Impacts

At the time this study was designed it was assumed that the only significant impact of the Susitna Hydroelectric Project on Dall sheep would be from disturbance from construction activities, helicopter traffic, etc. Such impacts could be moderated by avoiding areas used by sheep or scheduling activities at seasons when sheep use of an area was reduced. However, sightings of sheep along Jay Creek indicate a possibility of direct loss of habitat.

The Portage - Tsusena Creek sheep are likely to be impacted only by disturbance. With adequate data on seasonal distribution serious disturbance probably can be avoided. 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 (Heimer 1973), 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 (Geist 1971).

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.

Plans for Phase II Studies

TITLE

Dall sheep movements and habitat use patterns in relation to mineral lick habitat that will be impacted by the proposed Susitna Hydroelectric Project.

OBJECTIVES

To determine the size and sex and age composition of subpopulations of Dall sheep utilizing the Jay Creek mineral lick.

To determine the time of travel and travel routes of those populations to and from the lick site.

To determine the timing and degree of dependence of sheep subpopulations on habitat that will be impacted by the Susitna hydroelectric project.

To identify habitat critical to sheep subpopulations in the vicinity of the proposed impact area.

To intensively assess winter distribution of three populations to determine possible impact by proposed borrow pits and access routes.

PROCEDURE

1) Approximately 25 animals will be captured and fitted with radio-collars and visible ear tags. Most of these will be captured during late spring when they are on their winter range. Standard helicopter capture techniques will be utilized. The sex and age ratio of animals captured will approximate the ratio observed in the population.

2) The remaining animals to be fitted with radio-collars not captured by helicopter will be captured at the lick site, with the use of a cannon net. Procedures will follow those used by Heimer. Capturing animals with this method will allow personnel to mark individuals in the ratio at which they visit the lick area. Animals captured but not fitted with radio-collars will be marked with high visibility ear tags and visual collars.

3) Aerial location and observation of radio-collared animals will occur twice a month during spring and fall, and once a

month during the remainder of the year. Information to be gathered during these flights will include: number, sex and age composition, location, aspect of the location, altitude, snow depth, and vegetation type.

4) Seasonal range use and distribution will be determined by radio-collar locations, and visual ground observation of tagged animals. Ground observations will be attempted during the summer months.

5) Critical south slope habitat will be identified during winter months. Snow conditions will be monitored, and their effect on sheep noted.

6) A literature search will be conducted to locate information regarding micro-climatic changes involving large bodies of water. Climatic changes producing greater snow depths could be detrimental to the sheep populations, if it falls on critical south slopes.

7) Additional sheep will be marked by spraying from fixed-wing aircraft (Nichols pers. comm.).

8) Ground observations will be conducted at both the Jay Creek and Watana Creek mineral licks to determine use by number, sex and age of sheep. Exchange of sheep between the two licks will be determined by observations of dyed and radio-collared animals.

9) Chemical analyses will be performed from soil samples collected at both lick sites.

10) Aerial surveys will be conducted to monitor winter distribution and abundance of the Tsusena-Portage Creek sheep.

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