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SUSITNA HYDROELECTRIC PROJECT

FEDERAL ENERGY REGULATORY COMMISSION
PROJECT No. 7114

FURBEARER STUDIES PHASE I REPORT UPDATE

ALASKA COOPERATIVE
WILDLIFE RESEARCH UNIT

UNDER CONTRACT TO

HARZA-EBASCO
SUSITNA JOINT VENTURE

FINAL REPORT

OCTOBER 1984
DOCUMENT No. 2329

ALASKA POWER AUTHORITY

ALASKA POWER AUTHORITY

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January 9, 1985
Susitna File No. 1.17.4.2/6.18.4.2

The Honorable Don Collinsworth
Commissioner
Alaska Department of Fish & Game
1255 West 8th
Juneau, Alaska 99802

Subject: Susitna Hydroelectric Project
Document Transmittal

Dear Commissioner Collinsworth:

Enclosed for your use and files is one copy of the following report:

- Alaska Cooperative Wildlife Research Unit, Furbearer Studies Phase I Report Update, October 1984, (Document No. 2329)

Sincerely,

Larry D. Crawford

Larry D. Crawford
Executive Director

csl

Enc: as noted

cc w/ Enc:
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J. Thrall, HE
D. Callesen, HE

Document No. 2329
Susitna File No. 4.3.3.3

SUSITNA HYDROELECTRIC PROJECT

FURBEARER STUDIES
PHASE I REPORT UPDATE

Report by

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Under Contract to
Harza-Ebasco Susitna Joint Venture

Prepared for
Alaska Power Authority

Final Report
October 1984

NOTICE

ANY QUESTIONS OR COMMENTS CONCERNING
THIS REPORT SHOULD BE DIRECTED TO
THE ALASKA POWER AUTHORITY
SUSITNA PROJECT OFFICE

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PHASE I REPORT UPDATE

INTRODUCTION

This document updates the Phase I Report of the Susitna Hydroelectric Project Furbearer Studies (Gipson et al. 1982). Additional studies of beaver and marten have been conducted since the Phase I report was submitted and these are discussed. Studies of foxes and marten conducted in Phase I are reviewed where additional data have been analyzed since the Phase I report was submitted. Recent observations of furbearers, made incidental to other efforts are presented. An informal survey of trappers was conducted in the middle and upper Susitna drainage, and the results of this survey are reported.

Methods were generally the same as described in the Phase I report. Those methods which were not reported in the Phase I report are included in this document.

Long-term monitoring of beaver, marten, and fox numbers and distribution should be considered to help understand the population dynamics and life requisites of these species. Data obtained could be the basis for predicting responses of furbearers to the proposed hydroelectric project.

BEAVER STUDIES

INTRODUCTION

Beaver have been selected as the key furbearer species to study to predict impacts of the proposed Susitna Hydroelectric Project downstream from the impoundments. There are several reasons for selecting beaver:

1. Beavers are tied directly to the aquatic system and changes in water depths and flow rates, water temperatures, and icing conditions will be reflected in changes in beaver distribution and abundance.
2. Beavers are economically and ecologically important.
3. Reliable and practical techniques exist for censusing beaver populations and monitoring their use of habitats.

Our work has focused on determining how beavers use aquatic and adjacent terrestrial habitats; determing numbers of beavers occurring naturally along the river and tributaries; and modeling probable responses of beavers to various management scenarios for the hydroelectric project. This chapter summarizes findings of our beaver studies to date.

HABITAT USE

METHODS

A flight was made on 27 May 1982 along the Susitna River from Devil Canyon to Delta Islands to determine a realistic sampling scheme to assess beaver use of major aquatic and adjacent terrestrial habitats. The river was divided into 3 sampling sections based on river morphology and vegetation: Section I from Devil Canyon to Talkeetna, Section II from Talkeetna to Goose Creek, and Section III from Goose Creek to Cook Inlet.

Each section was divided into linear valley miles of floodplain along the main channel. Each sample unit was a one mile long section from the thalwag to the active floodplain boundary on one side of the river. Sample units were chosen at random within each of the three river sections. The intensity of sampling per river section was weighted to concentrate upon areas likely to be most impacted by the project. The amount of time needed to survey a sample unit in each river section was also considered. Forty-three percent of the sample units in Section I were surveyed, 23% in Section II, and 13% in Section III.

Sample units were surveyed by boat if all water bodies were navigable, and by foot and/or helicopter where water bodies were unnavigable. Sign and predominant vegetation, banks, and water characteristics were noted. Section I was surveyed in June 1982, and Sections II and III were surveyed in August 1982.

Beaver habitats were classified according to the 7 categories developed by the Alaska Department of Fish and Game Aquatic Study Team (ADFG 1983). Although described in terms of water type, habitat also included bank characteristics, water sources, and tree and shrub vegetation. Seasonal changes in water level in the river may alter the habitat classifications. All habitats were classified at the time of beaver surveys.

1) Mainstem Habitat consists of those portions of the Susitna River that normally convey streamflow throughout the year. Both single and multiple channel reaches are included in this habitat category. Groundwater and tributary inflow appear to be inconsequential contributors to the overall characteristics of mainstem habitat. Mainstem habitat is typically characterized by high water velocities and well armored streambeds. Substrates generally consist of boulder and cobble size materials with interstitial spaces filled with a grout-like mixture of small gravels and glacial sands. Suspended sediment concentrations and turbidity are high during summer due to the influence of glacial melt-water. Streamflows recede in early fall and the mainstem clears appreciably in October. An ice cover forms on the river in late November or December.

2) Side Channel Habitat consists of those portions of the Susitna River that normally convey streamflow during the open water season but become appreciably dewatered during periods of low flow. Side channel habitat may exist either in well defined overflow channels, or in poorly defined water courses flowing through partially submerged gravel bars and islands along the margins of the mainstem river. Side channel streambed elevations are typically lower than the mean June, July and August water surface elevations of the mainstem Susitna River. Side channel habitats are characterized by shallower depths, lower velocities and smaller streambed materials than the adjacent habitat of the mainstem river.

3) Side Slough Habitat is located in spring fed overflow channels between the edge of the floodplain and the mainstem and side channels of the Susitna River and is usually separated from the mainstem and side channels by well vegetated bars. An exposed alluvial berm often separates the head of the slough from mainstem or side channel flows. The controlling streambed/streambank elevations at the upstream end of the side sloughs are slightly less than the water surface elevations of the mean monthly flows of the mainstem Susitna River observed for June, July, and August. At intermediate and low-flow periods, the side sloughs convey clear water from small tributaries and/or upwelling groundwater. These clear water inflows are essential contributors to the existence of this habitat type. The water surface elevation of the Susitna River generally causes a backwater to extend well up into the slough from its lower end. Even though this substantial backwater exists, the sloughs function hydraulically very much like small stream systems and several hundred feet of the slough channel often conveys water independent of mainstem backwater effects. At high flows the water surface elevation of the mainstem river is sufficient to overtop the upper end of the slough. Surface water temperatures in the side sloughs during summer months are principally a function of air temperature, solar radiation, and the temperature of the local runoff.

4) Upland Slough Habitat differs from the side slough habitat in that the upstream end of the slough in not interconnected with the surface waters of the mainstem Susitna River or its side channels. These sloughs are characterized by the presence of beaver dams and an accumulation of silt covering the substrate resulting from the absence of mainstem scouring flows.

5) Tributary Habitat consists of the full complement of hydraulic and morphologic conditions that occur in the tributaries. Their seasonal streamflow, sediment, and thermal regimes reflect the integration of the hydrology, geology, and climate of the tributary drainage. The physical attributes of tributary habitat are not dependent on mainstem conditions.

6) Tributary Mouth Habitat extends from the uppermost point in the tributary influenced by mainstem Susitna River of slough backwater effects to the downstream extent of the tributary plume which extends into the mainstem Susitna River of slough.

7) Lake Habitat consists of various lentic environments that occur within the Susitna River drainage. These habitats range from small, shallow, isolated lakes perched on the tundra to larger, deeper lakes which connect to the mainstem Susitna River through well defined tributary systems. The lakes receive their water from springs, surface runoff and/or tributaries.

RESULTS AND DISCUSSION

Habitat use

Section I, Devil Canyon to Talkeetna

There was little sign of beavers along mainstem habitat between Devil Canyon and Talkeetna. A marked exception was fresh tracks made by an adult beaver (along with otter tracks) in sand where Portage Creek enters the mainstem of the Susitna River. Banks were of rocky composition and vegetation graded from predominantly balsam poplar (*Populus balsamifera*) in sample sites near Talkeetna to paper birch (*Betula papyrifera*) and white spruce (*Picea glauca*) in sample sites farther upstream, particularly upstream from Gold Creek.

Side channel habitat was used by beavers more than mainstem habitat in several sites. All side channels which contained dams, trails, caches, lodges, or dens were characterized by silty banks. However, 5 of 6 channels with tracks or cuttings present had rocky banks. Twenty-two of 33 side channels surveyed had no sign of beavers. Rocky banks were present along side channels with no beaver sign.

Side sloughs with silty banks showed high use by beavers. Willows (*Salix* spp.) along with silty banks were present in all 5 sloughs where lodges, caches, or dens were present. Rocky banks along side sloughs were associated with low use by beavers. Upland sloughs sampled in Section I had clear water with silty banks. Five of 7 upland sloughs contained dams, trails, caches, lodges, or dens. Willow was present in 4 of the 5 sections with heavy beaver use.

Section II, Talkeetna to Goose Creek

Mainstem habitat was void of beaver sign. Rocky banks were present along the mainstem channels. Moose sign was found in 1 sampled section. Balsam poplar, willow and alder were common along mainstem channels.

Beaver sign was present in side channel habitat in areas of rocky and silty banks, but caches lodges and dens were found only in channels with silty banks. Abundant beaver sign was associated with moose sign. Balsam poplar was the major tree along channels with heavy beaver use.

Side sloughs were utilized heavily by beaver. Silty banks, willow and balsam poplar were characteristic of sloughs containing beaver sign. Moose sign was commonly present in the habitat.

Upland sloughs and tributary habitats were characterized by silty banks and varied vegetation. Beaver sign including caches, lodges, and dens was present. Moose sign was found in most areas with beaver sign.

Section III, Goose Creek to Deshka River

Mainstem habitat surveyed in this section contained no beaver sign. Fast flow with rocky eroding banks is characteristic of this habitat.

Side channels in the lower section received heavy use by beavers. Of 15 sampled side channels 12 contained sign including dams, trails, caches, lodges, and dens. Silty banks were associated with all of these sections and willow was associated with 6 of them. Moose sign was found in 10 of the side channels which contained intensive beaver sign.

Side slough habitat in this section was characterized by silty banks. Paper birch was present along all sloughs surveyed and beaver sign found in 4 of 5 of the sloughs. Moose sign was also present in those areas.

No upland slough habitat was present in surveyed sites of Section III.

Interactions between moose and beaver and habitats is better viewed over the length of the study area. Out of 33 sampled habitat units which contained moose sign, 25 contained evidence of intensive use by beaver (dams, trails, caches, lodges, dens). Moose and beaver used similar habitats in most sections of the river. Sixteen of the habitat units where moose were found contained willow, a favored food of beaver.

Tributaries

Beaver sign was concentrated along slow flowing sections of most tributaries, particularly Deadman Creek, Portage Creek, Indian River (especially along the tributary to Indian River flowing out of Chulitna Pass parallel to the Alaska Railroad), small streams along the proposed route of the access road between Gold Creek and Devil Canyon, and Prairie Creek. For example, 16 maintained beaver dams were counted on small streams during a flight in July 1981 along the route of the proposed access road and railroad between Gold Creek and Devil Canyon. On the same flight 12 maintained dams and 8 beaver lodges were counted on small streams or lakes draining into Deadman Creek.

Beaver sign on tributaries occurred from the Susitna River to elevations above 3,000 feet MSL. Above timberline beaver appeared to be heavily dependent upon willow and dwarf birch for construction materials and winter food.

General habitat associations

Vegetation used by beaver for food ranged from a variety of herbaceous plants in summer to primarily willow and balsam poplar, and some paper birch in autumn and winter.

Beavers seemed to show specific preferences for the materials used for construction purposes. Unpeeled alders (Alnus spp.) vegetation was the major species utilized for the construction of lodges, dams, and tops or rafts of caches. Peeled paper birch, balsam poplar and willow were also used for construction, but are primarily food items.

Balsam poplar was predominant on islands throughout the sections surveyed with paper birch and white spruce usually dominant on the mainland. Alder and willow were common throughout the 3 sections.

Beaver numbers in Section I appeared to be more limited by a shortage of lodge or bank den sites than in more downstream areas. High water velocities do not appear to prevent foraging in an area, but a moderate velocity flow appears necessary for year-round occupation.

It has been suggested that the high amount of cutting seen in Section III was made by many more beaver than those accounted for by the number of lodges and dens observed. Local trappers report taking beavers at the downstream ends of Section III islands in the winter, a habitat in which we saw no lodges of dens. It is possible that beaver construct dens in the silty banks of islands in Sections II and III, and do not place token sticks on top of the bank as they often do with bank lodges along the mainland in Section I. Fall cache counts should provide helpful information about beaver abundance and they may help locate important bank dens in Section III. Most active dens should have a cache visible from the air (i.e. the caches will project above the muddy Susitna River water). Cache surveys should provide a reasonable index to beaver abundance in all habitats.

We looked for evidence of moose-beaver interactions while surveying and there is a correlation between the presence of both species. Beaver probably have a larger impact on moose than visa versa, since a moose rarely browses a plant beyond useability to a beaver, while a plant cut down by a beaver is unavailable to moose. Both animals seem to prefer the same browse species, feltleaf willow being the most preferred. Openings in closed forest canopies caused by beaver do not appear to allow for increased willow growth, but generally were colonized by balsam or poplar or, more commonly, alder. The latter is of limited food value to either moose or beaver.

POPULATION SURVEYS

METHODS

Autumn Population Estimates

Several techniques have been employed to estimate beaver populations, including direct counts of beavers and indices of beaver abundance such as counts of dams, lodges, and food caches. Many researchers now agree that counts of food caches are the most reliable and practical method of estimating beaver populations over a large area (Hay 1957, Murray 1961, Koontz 1968, Machida 1982). Each active overwintering lodge and/or overwintering bank den is associated with a food cache accessible from the lodge or den under the winter ice. Between 1 and 14 beaver may occupy a lodge with an average of 5 generally used for population surveys in Alaska (Koontz 1968, Boyce 1974).

The population of beaver in an area during autumn may be estimated by counting the number of food caches and multiplying by 5. The preferred survey method is by aircraft after the deciduous leaves have fallen, for increased visibility, and before the winter ice forms.

Our cache surveys were flown in a Bell 206 helicopter at an altitude of 75-100 feet above ground, and a ground speed of 40-60 miles per hour. The survey team included a pilot, navigator/recorder, and 2 observers. The location and number of beaver caches, lodges, and dams were recorded on aerial photos. The area surveyed consisted of the active floodplain of the Susitna River (channels susceptible to hydrologic changes associated with the hydroelectric project) and selected tributaries of the Susitna River.

RESULTS AND DISCUSSION

The floodplain of the Susitna River in Section I, Devil Canyon to Talkeetna, was surveyed for beaver food caches during September 1982 and October 1983 (Table 1). During 1982 we counted 14 caches and estimated that 70 beavers were present. Most caches were located on side sloughs and upland sloughs. Only 2 caches were observed along mainstem habitats and 2 were sighted along side channels. However, during the 1983 survey, we counted 27 caches and estimated that 135 beaver were present. During 1983 use of mainstem habitats increased markedly, with 11 caches counted. The number of caches on side sloughs also increased, but the number on side channels and upland sloughs remained unchanged.

An attempt was made during September 1982 to survey for beaver caches in Sections II and III, but water levels were unseasonally high,

Table 1. Aerial counts of beaver caches in the floodplain of the Susitna River between Devil Canyon and Talkeetna.

15 September 1982 and 18-19 October 1983

Habitat	1982 Caches	1983 Caches
Mainstems	2	11
Side Channels	2	2
Side Sloughs	7	11
Upland Sloughs	3	3
Total Impacted	14	27

due to heavy rainfall. Turbid water had risen above and/or washed away many caches, making an accurate count of caches impossible and the survey was terminated after about 40% of the area was surveyed.

Sections II and III were observed as the study team flew from Anchorage to Talkeetna along the Susitna River during October 1983. Our general impression was beaver numbers in Sections II and III were very high. A number of large caches were sighted and a minimum of 7 individual beavers were observed working on one cache in the Delta Islands.

There are at least 3 explanations for the marked differences in cache counts in 1982 and 1983, particularly in mainstem habitats.

1) Some caches could have been missed during our 1982 surveys due to rapidly rising water immediately before and during the summer. During 1982 the mean daily discharge increased dramatically in mid-September from 13,200 cfs at Gold Creek on 12 September to 32,500 cfs on 16 September. Our cache counts were made on 15 September as the river was rapidly rising. It is possible that some caches along mainstems of the river between Devil Canyon and Talkeetna were covered by turbid water and could not be seen, and/or some caches may have broken loose and floated away. In fact, 1 cache counted on our morning survey flight downriver was observed about 2 km downstream lodged on a gravel bar during our return flight in the afternoon. During our survey flights on 18 and 19 October 1983 the river was relatively low with mean daily discharges of approximately 8,000 to 10,000 cfs at Gold Creek. In 1983 the river dropped steadily through September and early October.

2) Some beavers may have started caches after the survey was conducted in September 1982 but before freeze-up. This does not seem

likely since beavers in most areas of Alaska start cache construction by early September and all caches observed in the 1982 survey were well established.

3) The Section I flood plain populations may actually have increased from about 70 beavers in 1982 to approximately 135 in 1983. A related possibility is that the number of beavers present in 1983 did not differ markedly from the number present in 1982. Rather, high water in 1982 may have caused young beavers to remain in their parent colonies when they would have dispersed under favorable, stable water conditions. Late summer 1983, with its steadily dropping river levels, may have been suitable for dispersal and numerous young beavers may have established new colonies.

The number of beaver actually present could be closely estimated if the number of beaver present in a colony could be related to the size of that colony's cache. Research with beavers at Wood Buffalo National Park in Canada (Novakowski 1967) suggests the amount of food cached for the winter is related to the number of young within the colony, and, generally, the cache size increases with the total number of beavers present. We hypothesize that there is a positive correlation between the number of beavers present and the size of the cache, since all beavers in a colony appear to contribute to construction of the cache. If this relationship appears to be true, we may be able to develop a census guide to permit survey teams to estimate the numbers of beavers present in each colony based on size of the cache.

OVERWINTER AND BREAKUP SURVIVAL

METHODS

The survival of individual families of beavers through the winter may be assessed shortly before spring breakup by examining the area around the lodges and bank dens where food caches were located the previous autumn. During late April beaver along the Susitna River start to forage and move about on top of ice and snow around their winter dens. Emergence holes, where they dig out from beneath the snow and ice, and fresh, muddy tracks are easily sighted around the winter dens. Such signs indicate at least some members of the family survived the winter and the site is still being used.

This technique was used to assess survival of beaver families through winter 1983-1984. The areas immediately around overwintering sites were also checked for fresh signs of beaver shortly after spring breakup in 1984 to establish which families had survived breakup.

RESULTS AND DISCUSSION

Survival of beaver through winter 1983-84 was assessed by aerial surveys on 26 and 27 April 1984 (Table 2). Lodges and bank dens where caches were observed in the autumn of 1983 were examined for signs of beaver activity (large holes where beaver emerged from beneath snow and ice, tracks, trails, fresh cuttings). Calculations of overwinter survival were based on those 27 colonies for which caches were observed during the autumn 1983 survey. Of these 27 colonies, 23 (85%) showed signs of activity in April.

Table 2. Overwinter and spring breakup survival of beaver colonies in the floodplain of the Susitna River between Devil Canyon and Talkeetna. Based on surveys conducted prior to breakup on 26 and 27 April 1984 and following breakup on 23 and 24 May 1984.

		Fate of Colonies				
	1983 Fall	During Winter		During Breakup		
Habitat	Cache Count	Survived	Failed	Survived	Failed	Unknown
Mainstem	11	9	2	7	2	0
Side Channel	2	2	0	2	0	0
Side Slough	11	10	1	9	0	1
Upland Slough	3	2	1	1	1	0
TOTALS	27	23	4	19	3	1

Five additional colonies were discovered for the first time during the surveys in April. All of the new colonies had successfully overwintered, and thus, at least 28 colonies overwintered successfully along this portion of the river (23 of the 27 colonies located during 1983 cache counts plus 5 colonies discovered in spring 1984). By using the approximation of 5 beaver per colony, an estimated 160 beaver overwintered in the river floodplain from Devil Canyon to Talkeetna. Additional colony sites were noted on the spring survey in the lower reaches of tributaries and in lakes near the floodplain, but they were not included in the calculations, since they were outside the immediate impact zone of the proposed hydroelectric project.

Breakup during spring 1984 was apparently mild and few beaver colonies appeared to be impacted (Table 2). Two lodges along mainstems were partially destroyed by ice during breakup in 1984 and there were no signs of beavers in the vicinity of these lodges during our post-breakup surveys during May 1984. One colony along an upland slough may have been displaced or destroyed by ice during breakup and the fate of 1 colony along a side slough could not be determined. The overwintering lodge of the side slough colony in question appeared to be intact when examined in May, but no sign of beavers could be located in the vicinity of the lodge.

RED FOX STUDIES

INTRODUCTION

The red fox was selected as a key furbearing species in Phase I studies. This section updates and revises data on red fox home ranges and food habits presented in the Phase I report. A more detailed analysis of data collected during Phase I was presented as a Master of Science thesis to the University of Alaska, Fairbanks (Hobgood 1984).

HOME RANGE

METHODS

Adult home ranges were assessed during summer and winter. Home ranges were used during the period May 1 to November 15, which extended from the beginning of denning activity to the termination of denning activity. Winter home range was based on the period November 16 to April 30, roughly the period from dispersal of young foxes to the denning season. Summer home range was determined on the basis of radio locations. Winter home ranges were determined by the use of radio telemetry, ground surveys of trails and aerial surveys for trails in snow.

Home range size was determined by the minimum area polygon method (Mohr 1947). Location points outside the normal home range of a particular fox which were excluded in the Phase I report were included in this update.

RESULTS AND DISCUSSION

Twenty-three adult and juvenile foxes were captured and monitored to determine their home ranges from August 1980 to December 1982.

Summer Adults

Summer home range size averaged 39.9 km^2 for 3 adult males and 29.9 km^2 for 3 adult females (Table 3). Five of these adults appeared to be involved in denning activities based on location data and observations at den sites.

Summer home ranges were approximately circular to oval in shape, but this was not consistently the case in winter. Ables (1969b) suggested that circular home ranges require less energy to defend than linear ranges. While this may be true, upper Susitna foxes appeared to experience little intra-specific competition during summer and winter. In summer, food was relatively abundant, home ranges were large, and the primary activity of most adults was care of young, and during winter, many foxes dispersed from the area.

Red fox home range sizes determined by this study are several times larger than are those reported by other investigators in the United States and Europe. Jones (1980) found the largest home ranges, averaging 16.1 km^2 on an alpine-subalpine study area in northwest British Columbia. Ables (1969a) found the largest range of seven foxes on the University of Wisconsin Arboretum to be 1.6 km^2 and suggested that an abundant food supply might explain the small home ranges. Sargeant (1972, p. 229) believed that,"the Arboretum, however, may have

Table 3. Home ranges of adult red foxes in the Susitna study area.

Fox (sex)	Home Range (km^2)	Time Interval
#4021 (female)	28.35	5/13 to 10/30
#4040 (male)	43.67	5/14 to 10/24
#4280 (male)	35.21	6/15 to 10/29
#4181 (female)	37.29	6/16 to 10/29
#4221 (male)	39.40	7/27 to 10/24
#4060 (female)	24.02	6/15 to 10/30
#4132 (male)	(41.40)[a]	6/15 to 7/17

Averages 39.9 males

29.9 females

35.6 both males and females

[a]subjective estimate, see text

represented an island of habitat in a suburban environment that confined the movements of the resident foxes".

Winter Adults

Radio location data were difficult to obtain due to radio transmitter malfunction in the subzero temperatures. For this reason, home range size estimates were based primarily on observations obtained during snow tracking from the ground and air. Adult female 4021 occupied a home range in the vicinity of Watana Camp (Figure 1). Her minimum home range size was 18.3 km^2. Female 4021 moved into this area in late November or early December, 1980. Female 4021 apparently was not drawn to the camp vicinity because of available human food. All garbage and leftover food from the camp was incinerated. Unburned items were compacted and flown by helicopter to the town of Talkeetna. Project personnel were also conscientious about not feeding wild animals and little processed food was available.

An uncollared adult cross fox, 000X, believed to be a male, was seen in the camp vicinity on several occasions in February, March and April, 1981. This fox occupied a territory adjacent to collared female 4021. This fox's minimum winter home range was approximately 20.3 km^2.

Female 4021 and the uncollared adult cross fox, 000X, did not move about their entire home ranges in a given 24 hour period. Rather, they seemed to use a part of the home range for 1 to 4 days and then move to another part. Our impression was that roughly one-fourth to one-third of the home range was utilized in any given 24 hour period.

These data suggest that some foxes in the uplands around the proposed impoundments may maintain smaller home ranges in winter than in

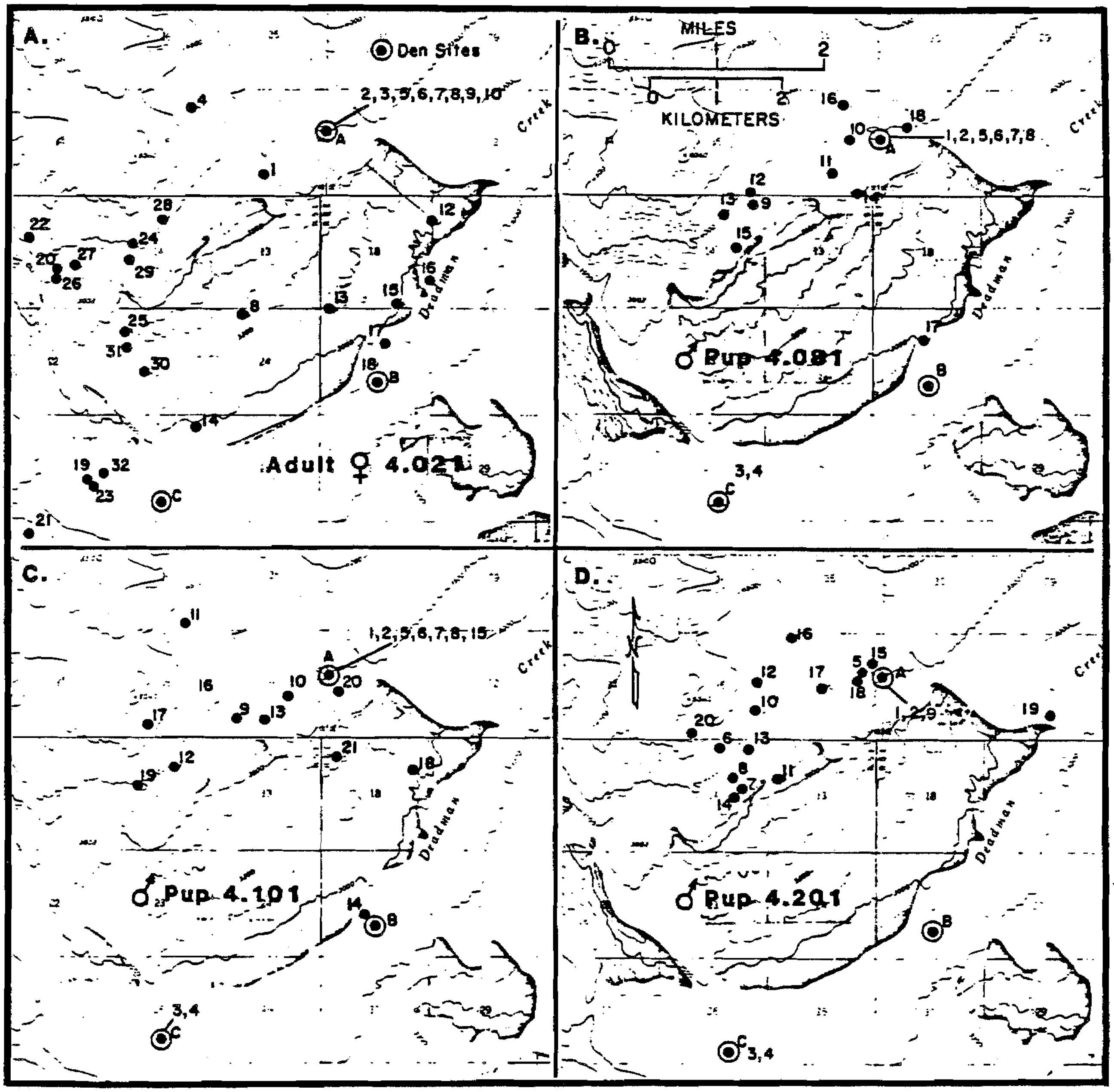

Figure 1. Home range of adult female red fox 4021 and her offspring in 1981.

summer. Storm (1965) and Scott (1943) discussed the importance of food availability in influencing fox movements. McNab (1963) and Jones (1980) suggested that home range size is closely related to food supplies. On the other hand, Ables (1969a) found that, during winter, fox activity was inversely related to atmospheric pressure and snow depth. The upper Susitna basin characteristically experiences many winter snow storms and temperatures may drop to -40°C. Clear days are usually very cold, often with a 30 to 45 kph wind. Foxes utilized single holes or den sites presumably to escape inclement weather. It seems logical that they would not range any further than necessary to obtain food, thus, restricting their range. Large stable winter ranges seem unnecessary in the upper Susitna study area because of the sparse fox population which probably minimizes intra-specific territorial conflicts. A more conclusive study of winter ranges in alpine and subalpine areas of the Alaska Range would be required to establish whether or not fox winter ranges are in fact smaller than summer ranges.

Home Range Shifts - Adults

Red foxes in the upper Susitna basin are strongly dependent upon ground squirrels as a food source in summer.

Female 4021 was located in her usual range on April 29, 1981. She began to move soon thereafter from a home range devoid of arctic ground squirrels to a den site about 13 km north, located in good ground squirrel habitat. On May 2 and May 12 she was located in the general vicinity of this den which she used for the summer. Male cross-fox 000X, the same fox which had occupied a home range adjacent to 4021 for most of the 1980-81 winter, was also seen near this den site on May 12

WATANA ♂ 4132

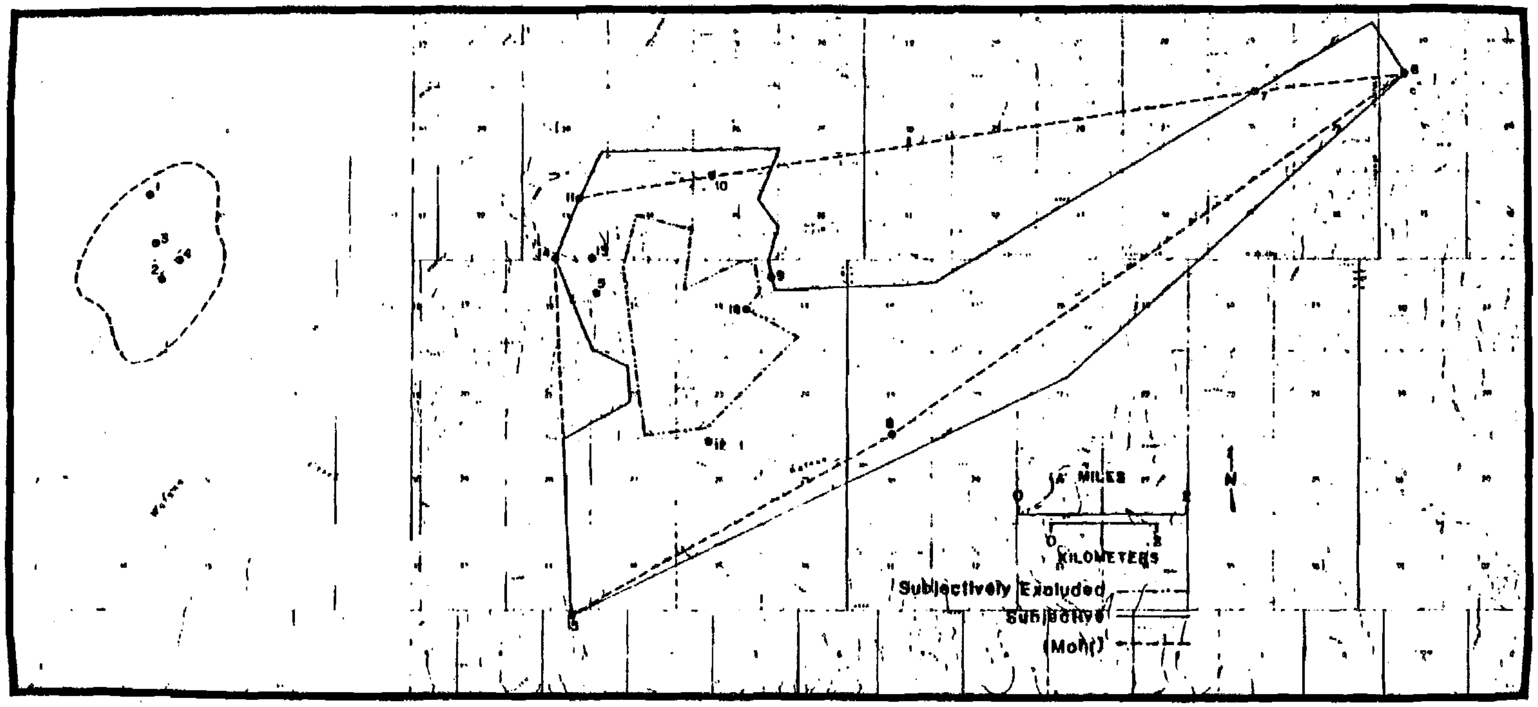

Figure 2. Home range of adult male red fox 4132 in 1981.

and 19 and throughout summer, 1981. In September and October 1981, female 4021 shifted her home range to the east. She could not be located in or near her former areas after November 19.

Adult male 4132 was captured on April 4, 1981. He was seen in the area on three occasions prior to capture. Within a few days of his capture, male 4132 ceased to use the area we believed to be his home range (Figure 2). He was located on May 13, 8 km east of his original range in an area where he remained until his death in July 1981 (Figure 2). It is possible this shift occurred because of the trauma of being trapped. The timing of the shift could also indicate a seasonal home range change between winter and summer that appears to be common for foxes in the study area. This fox utilized two small valleys and a long narrow valley to the east which contained several ground squirrel colonies. He ranged at least 20 km up the valley of the East Fork of Watana Creek and utilized a small pass 1660 m in elevation (near point 9, Figure 2) to cross between the East Fork valley and the two small valleys.

The summer home range size of male 4132 using Mohr's (1947) method is 60.4 km^2 (Figure 2). This seems unrealistic, considering the large high-altitude areas devoid of locations. If the home range is determined using radio locations as a guideline and delineating boundaries in accordance with observed habitat preferences, elevational considerations and known locations, a more realistic minimum home range size of 41.4 km^2 is obtained. Male 4132 was found dead in July, 1981 and was the only male captured who was not observed to have associated with a breeding female.

At about the time of dispersal, adult female 4060 shifted her home range. In late September, 4060 began to move in a more linear fashion up and down the East Fork of Watana Creek, eventually ranging about 25 km along the creek.

It is noteworthy that all except one of female 4060's late fall and winter locations were on the north side (southern exposure) of the creek where small mammals were likely to have been more available. Few fox tracks were observed on the south side of the creek. Hoefs et al. (1975) found aspect to be correlated with the distribution of plants on Sheep Mountain, southwest Yukon Territory.

It is difficult to assign a winter home range size to female 4060 because of the linear nature of the range (16 km in length). The small number of location points do not lend themselves well to existing methods of determining home range size. Female 4060 showed a preference for lower altitudes (near the creek) as winter progressed as well as a preference for southern exposures.

A shift was also observed in the home range of adult male 4040 in November 1981 (Figure 3). On November 10, 1981, 4040 was located near Kosina Creek, 5 km from his summer range. He was located five times from November 10-30 in the vicinity of Kosina Creek, outside his summer use area. However, on December 4, 1981, when he was last located in this study, he was again located in his summer range. A home range size of 71.9 km^2 was obtained for male 4040 (Figure 3) when all location points from May to December, 1981 are used employing Mohr's (1947) method.

An unusual number of fox tracks were observed in snow along creeks, including Kosina, in late october and November, 1980 (early winter) as

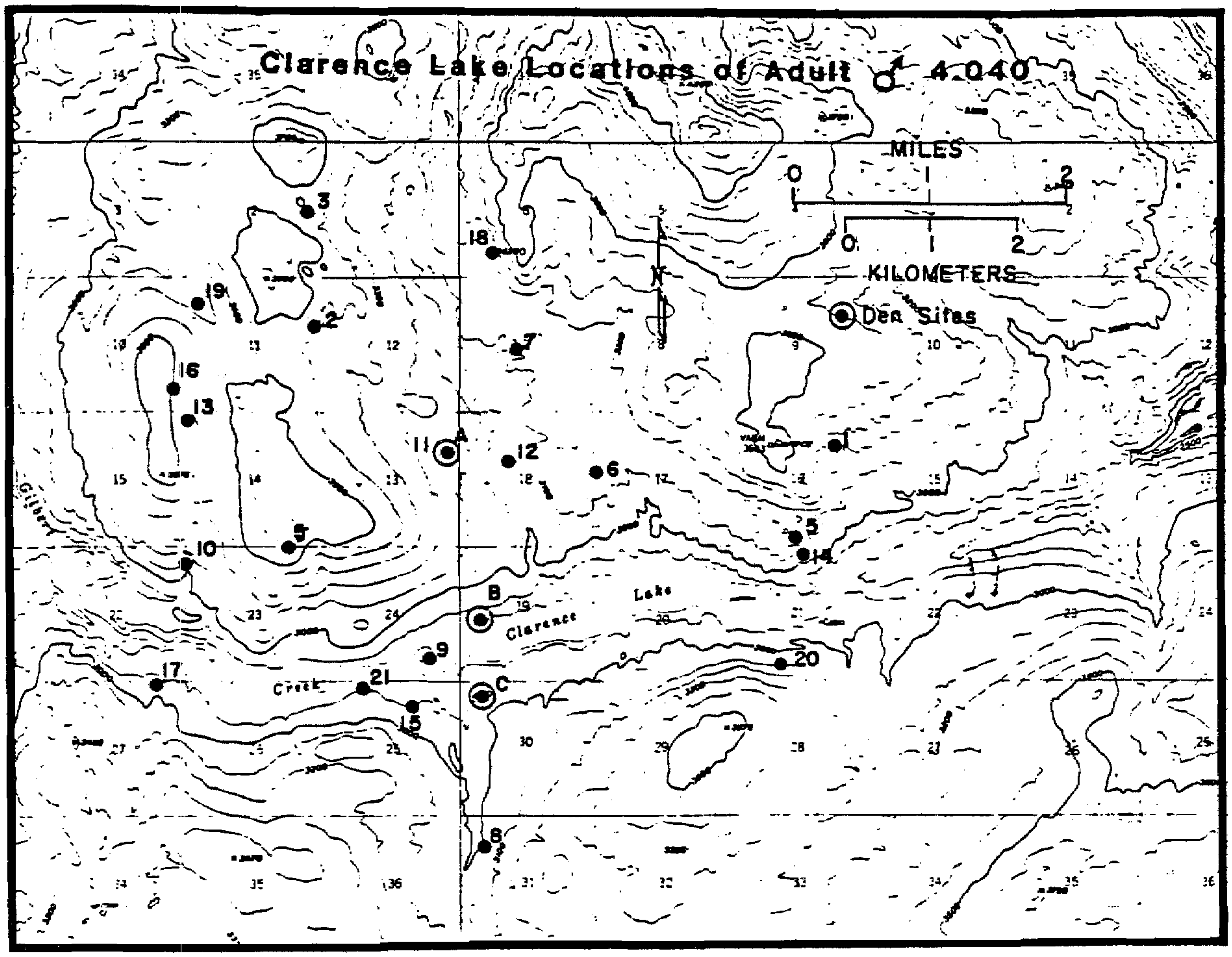

Figure 3. Home range of adult male red fox 4040 in 1981.

opposed to mid and late winter 1980-81. Many sets of fox tracks along creeks were observed again in November 1981-82. Closer investigation of this phenomenon on the ground revealed that the foxes were hunting small rodents. A possible explanation could be that foxes were dispersing in early winter and creek drainages were used as corridors, accounting for the large number of tracks. Although dispersing foxes were suspected of using creek valleys as corridors, we do not believe dispersal alone accounts for the concentrations of tracks observed. The high number of tracks coincided closely with the formation of "aufeis" or overflow on most of the creeks. Large expanses of low lying creek valleys are flooded within a period of a few days to a month, once the creek and surrounding ground freeze. This flooding probably drives resident small rodents from their territories, thus providing easily available prey to foxes. It appears likely that resident adult foxes as well as dispersing juveniles take advantage of readily available rodents displaced by flooding caused by aufeis formation.

Given the unpredictable, often harsh winter conditions in the study area, it would appear that a certain degree of plasticity in the fox home ranges must be maintained. Jim Grimes (pers. comm.), a trapper who operates 48 km from the study site, believes that foxes in the area move 30-50 km in order to find food and/or good hunting conditions. Mr. Grimes cited an example of a fox which he often saw near his cabin. The fox was immediately recognizable to him due to its unusual coloration and markings. This fox did not appear at his cabin for several weeks. He later spotted the animal near his snow machine trail at Deadman Lake, about 50 km away. Mr. Grimes stated there had been heavy snow and wind which he believed made rodents unavailable to foxes due to the depth and hardness of the snow. Mr. Grimes felt that many foxes had left for those same reasons, and that such movements were common when food was scarce.

FOOD HABITS

Many red fox food habit studies have been conducted and most show that foxes feed primarily upon mice and rabbits, followed by carrion, birds and vegetation depending on season and availability.

In this study, fox food habits were assessed by calculating frequency of occurrence of prey items found in scats. Our objective was to determine the relative importance of the prey species utilized by foxes.

METHODS

Food habits of red foxes were determined primarily by analysis of scats collected at dens and along trails from August, 1980 to November, 1981. Scats at dens were collected throughout spring, summer and fall on a monthly basis. Scats were also collected along trails in winter. When trails led to the carcass of a large animal, five scats were subjectively collected at the site.

Individual scats were placed in small paper bags and air dried. In the laboratory, scats were autoclaved to kill the ova of parasites. It appeared that small prey items such as mice were usually ingested whole and they passed through the digestive system as a unit.

Prey items in scats were evaluated by frequency of occurrence. For example, if an individual prey species occurred in five of ten scats, its frequency of occurrence was 50%. Species of prey items in scats were identified by comparison to reference collections of skulls, skins, bones and berry seeds at the University of Alaska Museum. Identification of prey species was most commonly based on teeth. Kessel et al. (1982) conducted a study of small mammal population composition, distribution and abundance in the study area. The results of their study simplified the identification process by providing a list of small mammals that occur in the region.

Scats were divided into two seasons, summer, (May-September) and winter (October-April). The summer and winter divisions corresponded closely to "snow-free" and "snow-covered" periods in the study area. There are several reasons for a two season division. Arctic ground squirrels were observed to be active from May through September and in hibernation from October through April. Spring and fall in the study area were of very short duration and variable in timing. When snow melted to the extent that snow-free areas occurred, plants in those areas immediately began production. In short, two basic seasonal periods occurred in the study area, snow-free and snow-covered. "Summer" and "winter" are used for convenience.

RESULTS AND DISCUSSION

A total of 218 scats from five different areas was examined (Table 4). Scats were collected year-round. Fewer scats (27.5%) were collected in winter than summer (72.5%) because: 1) Scats were more difficult to find during winter because of snowfall and blowing snow, 2) less time was spent in the study area during winter, and 3) scats were concentrated near dens in summer. Frequencies of occurrence of items found in fox scats by season are presented in Table 4.

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Table 4. Percent frequency occurrence of items found in fox scats collected in the upper Susitna drainage, 1980-1982.

	AREA OF COLLECTION														ALL SITES Round
	High Lake		Swimming Bear Lake		Clarence Lake		Deadman Creek		Watana Creek		Miscel-laneous	ALL SITES			
	Summer[d]	Winter[d]	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Unknown Season	Summer	Winter	
Spermophilus Parryli	85.5	0	76.9	75.0	57.1	0	68.1	0	90.0	9.1	55.6	75.5	4.5	34.1
Cleithrionomys rutilus	7.3	0	10.3	25.0	28.6	60.0	27.7	30.0	30.0	27.3	0	15.8	31.4	24.9
Microtus pennsylvanicus	3.6	0	5.1	25.0	42.9	0	12.8	5.0	0	18.2	0	8.3	11.4	10.1
Microtus oeconomus	9.[illegible]	0	0	0	0	10	12.8	0	10.0	0	0	7.1	1.8	4.0
Microtus miurus	3.6	0	0	0	28.6	0	17.0	0	20.0	9.1	22.2	8.3	1.8	4.5
Lemming	1.8	0	0	0	0	0	8.5	0	10.0	27.3	22.2	3.6	5.2	4.5
Unknown Microtine	10.9	33.0	23.1	0	14.3	40.0	19.1	25.0	0	27.3	33.3	15.8	21.6	19.2
Bird	7.3	67.0	7.7	50.0	14.3	30.0	4.3	65	30.0	9.1	22.2	8.2	45.1	29.7
Cervid	5.5	50.0	0	0	0	60.0	4.3	80.0	10.0	36.4	0	3.2	56.8	16.1
Unknown Mammal	5.5	0	2.6	0	0	0	2.1	12.5	0	0	44.4 (Fox remains)[b]	3.2	2.0	2.5
Vegetation	29.1	0	38.5	0	14.3	20.0	27.7	12.5	30.0	18.2	33.3	30.4	9.8	18.4
Number of Scats/ Season/Area	55	6	39	4	7	10	47	20	10	11	-	158	51	-
Total Number of Scats/area	61		43		17		67		21		9	209		218

[a]Summer = May-Sept Winter = Oct-April

[b]Four scats collected at Clarence Lake

[c]Weighted all sites summer/winter, 5:7 respectively.

Microtines and Shrews

Microtine rodents were the most important year-round prey for foxes in the upper Susitna valley (Table 4). Microtines were present in 49.5% of all scats collected. Northern red-backed voles (Clethrionomys rutilus) were the single most important microtine species, occurring in 15.9% of summer scats, 31.4% of winter scats and 24.9% of all scats. Red-backed voles ranked second in importance of all summer prey and third in importance in winter. Red-backed voles were the most abundant small mammal species in the study area, constituting 78.9% of total microtine captures in 16,776 trap nights of effort (Kessel et al. 1982).

Other species found in scats were meadow voles (Microtus pennsylvanicus), tundra voles (Microtus oeconomus) and singing voles (Microtus miurus). Meadow voles were the second most important microtine species in fox diets, with 10.1% year round frequency of occurrence. These Microtus species occurred with varying frequency in scats, depending on the area. Kessel et al. (1982:119) found that these three Microtus species exhibited stronger habitat specificity, as evidenced by their general restriction to open, non-forested sites. "Singing vole colonies were found in open low shrub, herbaceous tundra and mat and cushion tundra above treeline. Captured on only 10 trapline transects, they were most abundant in open low willow-birch shrub on relatively dry soils. Tundra and meadow voles occurred primarily in sedge and grass-forb meadows and bogs. We captured tundra voles on 22 sites (primarily grass-forb, but also sedge-grass), compared to 10 for meadow voles (primarily wet sedge-grass)". Meadow voles and singing voles occurred in scats from the Clarence Lake area more frequently or equally as frequently as red-backed voles. S.O. MacDonald (pers. comm.) reported these species were more abundant than usual in that area. Although Kessel et al. (1982) found temporal differences in population levels, the relative abundance ranking among species remained the same. It appears that foxes were not selecting for specific microtine species in certain areas, rather they were taking them in accordance with local availability.

Two species of lemmings, northern bog lemmings (Synaptomys borealis) and brown lemmings (Lemmus sibericus) were found in the study area in small numbers (Kessel et al., 1982). Brown lemmings were captured in Kessel's study at or above treeline in low shrub and wet herbaceous vegetation. Bog lemmings were captured at lower elevations in mesic sedge-grass/low shrub meadow (2 captures), grass meadow (1 capture) and near a seepage in white spruce forest (1 capture). In 16,776 trap nights of effort, 24 lemmings were taken (1.4% of total microtine captures). Lemmings occurred in 3.6% of summer scats and 5.2% of winter scats indicating that foxes might exhibit a preference for lemmings. However, S.O. MacDonald (pers. comm.) reported lemmings are trap-shy of snap traps and lemming captures were in cone pitfalls rather than snap traps. Further, a large proportion of lemmings occurring in scats came from the Watana Creek area, suggesting the possibility of higher numbers of lemmings in that area.

Murie (1944) found that foxes in Michigan often killed shrews (Sorex spp.), but rarely ate them. In our study, shrews were often found at dens. They were usually chewed, intact, and in various states of decay. Shrews were never found in scats. Possibly they were captured for practice by juveniles and played with until they succumbed. In a food study of captive wild foxes, 14 shrews were offered to a subadult for 24 hours after a 48 hour fast and none of the shrews were consumed. When shrews were offered with microtine rodents, the microtines were selectively eaten and the shrews were not consumed (Hobgood, unpublished data).

Birds

Bird remains, primarily feathers and toes were found in 8.2% of summer scats, 45.1% of winter scats and 29.7% of all scats (Table 4). Birds were the third most important winter prey group. Most of the bird remains were ptarmigan (Lagopus spp.). Ptarmigan were commonly observed in those areas used for denning and winter ranges. Ptarmigan feathers were always found at active dens in summer. It appeared to us that frequencies of ptarmigan found in summer scats might underestimate frequency of consumption. If this is true, the discrepancy probably lies in failure to detect remains in some scats, since most scats with feathers contained a large percent of other prey species' remains.

Most active dens were found near bodies of water large enough to have summer populations of waterfowl and shorebirds. Specific remains attributable to these two groups of birds were not identified in scats. We are confident that ducks, and probably eggs, were taken, although numbers taken appear to have been almost negligible in summer 1981. Duck wings and feathers were found at two den sites inside the study area and at three of four den sites near the area. Most duck remains were from scaup (probably Aythya manila), but one mallard Anas platyrhynchnos wing was also found.

We initially believed that active dens in the study area were probably located near larger bodies of water due to the presence of waterfowl and shorebirds and their potential as prey items. This appears not to have been the case in 1981.

Carrion

Carrion was the most important winter food item, occurring in 56.8% (29) of 51 winter scats and was the third most important year-round food, following microtine rodents and arctic ground squirrels (Table 4).

Carrion was of minor importance in summer scats. For purposes of this study, carrion is defined as the remains of animals, primarily moose (*Alces alces*), caribou (*Rangifer tarandus*) and sheep (*Ovis dalli*), not necessarily killed by foxes.

Schofield (1960) documented the importance of carrion in winter, finding evidence of white-tailed deer (*Odocoileus virginianus*) in 68.1% of 138 red fox scats collected from winter periods, 1955-57. Schofield also found that the carrion resulted from deer killed by hunters. During the years this study was conducted, caribou, an important winter carrion source for Susitna Foxes, were being hunted on a restricted basis, due to low population levels. Most (*Alces alces*) and Dall sheep (*Ovis dalli*) also experienced mild hunting pressure.

It appeared that bear [grizzly (*Ursus americana*) and black (*Ursus arctos*)] and wolf (*Canis lupis*) kills were the primary sources of carrion. Bears have been shown to be important predators of moose (Ballard et al. 1981) in the region. Wolves prey on moose, caribou and Dall sheep. Two Dall sheep were killed by wolves at sites visited in the study area. Three moose kills were judged to have been made by bears. Seveal moose and caribou kills made by wolves were fond. All kills found were utilized by foxes.

Bear populations appeared to be high in the study area. Wolves were controlled in and to the east of the study area by aerial hunting from January, 1976 to July 1978 (Ballard et al. 1982) resulting in 60 killed. Wolf numbers in the area were reduced from one wolf per 157 km^2 in spring 1975 to one wolf per 371 km^2 in spring 1978. Ballard et al.

(1980) concluded that wolf numbers in the area were near precontrol levels in 1980. This may have affected foxes in the region, perhaps to the point of reducing fox numbers by reducing the availability of carrion.

The caribou population was estimated to be 10,000 in 1973 and 22,000 in 1981 (Ballard et al. 1982). At least one, possibly two, new wolf packs were observed in the study area in spring 1982. A new wolf pack would be a boon to foxes, since one pack in the area made a kill every 4.2 days (Ballard et al. 1981). The caribou population in the area has been increasing and more hunters are being allowed to harvest caribou. Wolves occupying areas of food abundance utilize a smaller percentage of kills (R.O. Stephenson, pers. comm.) which means more carrion available to foxes. These factors would, in turn, suggest more fox utilization of carrion and possibly increased winter survival, ultimately resulting in increased numbers.

Arctic Ground Squirrels

Arctic ground squirrels (Spermophilus parryii) were the most important item in the summer diet of foxes, being found in 75.5% of summer scats (Table 4). Evidence of this was found in the location of all active fox dens in or near areas of ground squirrel abundance. Ground squirrels weigh from 454 to 1135 g (Burt and Grossenheider 1976) and carry a notable amount of fat during summer. Foxes appear to capture them without major difficulty.

We found ground squirrel remains in 4.5% of winter scats. Ground squirrels were observed to be in hibernation by October 1. Winter scats containing ground squirrel remains were collected in October and November. These must have been from caches left over from fall. We considered the possibility that ground squirrels might be cached in late fall and used the following spring. Alan Sargeant (pers. comm.) suggested that cache retrieval by foxes is elicited by fouling of the meat. We had thought that fouling might be arrested in late caches until the following spring, at which time retrieval would occur. However, no squirrel remains were found in scats December through April when they were in hibernation nor were retrieved caches found prior to emergence in spring.

Vegetation

A substantial number of summer scats (30.4%) contained vegetation and 9.8% of winter scats contained vegetation (Table 4). Most vegetation found in summer scats was leaves of labrador tea (*Ledum paulstre*) and crowberry seeds (*Empetrum nigrum*), items commonly found in arctic ground squirrel stomachs. To a lesser extent, blades of grass were found. Captive foxes were observed to consume much of ground squirrel stomachs when whole, dead ground squirrels were offered (Hobgood, unpublished data). Foxes did not appear to be able to digest berries very well and complete berries often passed through the digestive system intact. Evidence of crowberries found in scats were often only seeds or pieces of the exocarp. Therefore, we assume that most of the vegetation found in fox scats originated in the stomachs of prey animals.

There was early cold weather during summer 1981 and snow in August. A substantial number of berries on plants such as blueberry (*Vaccinium uliginosum*) and lowbush cranberry (*Oxycoccus palustris*) were killed. This suspected berry crop failure might be responsible for the virtual absence of these fruits in 1981 scats. We found 14 scats at 3 dens in early August 1982 which contained ripe, as well as green unripened blueberries, suggesting that more fruit is consumed in years of higher berry production.

GENERAL

In scats collected during this study, one prey species, muskrat (Ondatra zibethica), was conspicuously absent. Fox tracks were observed between muskrat push-ups and blood on lake ice in winter suggested that muskrats had been taken. Ed Powell (pers. comm.), lodge manager at Stephan Lake Lodge in the study area, reported that "foxes often 'worked the push-up's in winter' and are successful in capturing muskrats". In summer 1981, foxes at the Deadman Creek den moved about 2.5 km to another den after a sow grizzly and two cubs disturbed the natal den. A small muskrat pond and house were located adjacent to the new den. The new site was visited within three days of the move and found the fresh remains of two muskrats. The foxes returned to the natal den about two weeks later and no evidence of remaining muskrats was found. Muskrats may be more important to upper Susitna foxes than this study indicates, especially if muskrats are more abundant in some years.

Other remains found at dens which are of interest are: marmot (Marmota caligata), porcupine (Erethizon dorsatum), beaver (Castor canadensis), pika (Ochotona princeps) and one foot of a raptor, possibly goshawk (Accipiter gentilis). Old remains of a fox pup were found at one site. The cause of death was not determined. Four fox scats collected at this site contained fox remains.

In summary, den site investigations indicated that arctic ground squirrels were important to denning foxes in summer. This was substantiated by scat studies in which ground squirrels occurred in 75.5% of summer scats. In winter, rodents and carrion became important. Some foxes moved from ground squirrel habitat to areas more likely to contain small rodents in fall when ground squirrels entered hibernation. Ptarmigan were preyed upon year-round, but were especially important in winter. Hares (Lepus americanus) were rare and upper Susitna foxes largely exist without this prey item which is important in other regions. Lack of hares in summer was probably mitigated due to the presence of ground squirrels.

PINE MARTEN STUDIES

INTRODUCTION

Marten were selected as a key furbearing species in the Phase 1 studies. This section updates and revises habitat use, food habits and population information presented in the Phase I report. More detailed information on marten is presented by Buskirk (1983).

Marten are generally restricted to conifer-dominated forests or woodland habitats, however, there are many areas of conifer-dominated forests in Alaska in which marten are rare or absent. It has been difficult, with existing knowledge of marten habitat needs, to predict the value of a particular piece of land for marten habitat (U.S. Fish and Wildlife Service 1980) or to make informed statements concerning the effects upon marten of habitat alteration.

Information on the diet of marten in Alaska is meager. Prior to marten studies conducted for the Susitna Hydroelectric Project, the single published account was that of Lensink et al. (1955), who examined 576 scats from the Castel Rocks - Lake Minchumina area. Marten have been characterized alternatively as microtine specialists or dietary opportunists (Strickland et al. 1982). The tendency of marten to prey selectively on some taxa over others has been observed repeatedly (Weckworth and Hawley 1962, Francis and Stephenson 1972, More 1978 and Soutiere 1979). Specific food habits information for marten in Southcentral Alaska is also presented by Buskirk and MacDonald (in review).

A marten population survey based on line-trapping was conducted and data are presented. Marten population estimates were developed using home range data.

Radiotelemetry studies of marten in the proposed impoundment zones in 1980 and 1981 were the basis for the construction of a single population model and estimation of marten numbers (Appendix II). The impoundment zones were considered to be the area of the Susitna River canyon inundated at the high water mark by the proposed Devil Canyon and Watana dams.

In this section, previous marten population estimate efforts are reconsidered and results of the 1980 aerial transect survey are incorporated.

HABITAT USE

METHODS

Data on habitat use by marten were gathered from 3 sources. First, aerial transects were established and flown to record the vegetation types in which marten tracks were observed in a large area of the upper Susitna Basin.

A second source of habitat preference data was snow tracking. From 30 September to 2 December 1981, marten trails in snow were followed on 32 occasions. Vegetation type was recorded every 72 m. Other variables recorded at each vegetation sampling point were snow depth, track depth and track density. Track density was defined as the number of marten strides within a circle 3.2 m in diameter, centered on the vegetation sampling point. Density of marten tracks was assumed to reflect active foraging for mice.

The third type of habitat data dealt with the characteristics of marten resting sites. Resting sites were located by three methods:

1. Radio-tracking collared animals to resting sites.
2. Tracking marten to resting sites in very fresh snow.
3. Searching red squirrel middens for marten scat accumulations.

Variables recorded at resting sites included vegetation type, slope, aspect and elevation. Radiotelemetry was also used to identify resting site distribution within the home range. Autumn radio-locations of marten were plotted on 1:24,000 vegetation maps to determine the manner in which daytime locations were distributed within the home range. The use of this method was based upon the following 2 assumptions:

1. All locations were recorded during daylight hours.
2. Marten are always in resting sites with specific habitat characteristics during daylight hours in autumn.

Previous results showed that marten were found to be active for 28% of the observations made during daylight hours in autumn. Thus, a considerable error is involved in the second assumption.

RESULTS AND DISCUSSION

Fourteen aerial transects were sampled by helicopter from 14 November to 20 November 1980. A total of 1353 marten trails were recorded in the sampling. The distribution of the tracks by vegetation type is presented in Table 5. Of the total number of marten tracks observed, 92.4% were recorded in forest or woodland vegetation types.

Shrub types contained 5.4% of ~~all~~ marten tracks. The coverage of the transect lines by mapped vegetation types is also presented in Table 5. Marten tracks were found to occur more frequently in forest/woodland cover types than forest/woodland cover types occurred on vegetation maps of the transects. Marten tracks occurred less frequently in shrub cover types than shrub cover types occurred on vegetation maps of the transects. No statistical significance was found in these or other differences between observed and expected values in Table 5 because of the high variability observed in marten track densities on specific vegetation types within the study area.

Tracking of marten in snow yielded 499 vegetation sample points in autumn 1981. Evidence of urination was observed 89 times, defecation 42 times, nosing 91 times, digging 74 times, microtine capturing 6 times, capturing of other prey 2 times and resting 6 times in 36.0 km of marten trails.

Track density was assumed to be an index of active foraging by marten for mice. This assumption was based upon observations that marten tended to walk or bound with short strides in areas with high vole densities. Track density may also be correlated with other variables, however, For example, marten appear to leave deeper tracks and take shorter strides when snow is deep and soft. Correlation analysis was conducted to determine whether track density was significantly correlated with snow depth. The two were found to be positively and significantly correlated (P=0.05) over the range of snow depths observed, but that snow depth explained less than 1% of the variation in track density (r=0.09).

Table 5. Habitat use by marten, November 1980, in relation to mapped vegetation types available.

Cover Type	Number of Marten Tracks	% of Total Marten Tracks (Observed)	% Coverage, Vegetation Mapping of Transect Lines (Expected)
Spruce forest	35	2.6	0
Birch forest	3	0.2	2.7
Mixed forest	54	4.0	5.4
Mat-cushion alpine	3	0.2	1.6
Sedge-grass alpine	7	0.5	3.0
White spruce woodland	525	38.8	8.7
Black spruce woodland	605	44.7	32.1
Mixed woodland	29	2.1	5.8
Low shrub	12	0.9	15.0
Medium shrub	35	2.6	17.9
Alder shrub	25	1.9	2.3
River ice	2	0.2	1.8
Lake ice	0	0	0.7
Creek ice	6	0.4	0.1
Marsh	3	0.2	1.6
River bar	9	0.7	1.0
Rock	0	0	0.3
TOTALS	1353	100.0	100.2

The Kruskal-Wallis one-way analysis of variance of track density in three major vegetation types produced no significant differences in track density (P=0.89). This suggests that track denisty is not an appropriate indicator of habitat use for foraging.

A total of 37 marten resting sites were located during the study. These sites were primarily cold season resting sites providing some degree of thermal protection. The characteristics of these resting sites are presented in Table 6. Red squirrel middens and red squirrel grass nests in trees together accounted for 84% of the resting sites observed to be used by marten. Twenty-six sites were active middens, characterized by fresh cone bracts, fresh squirrel tracks and/or a nearby squirrel. Marten entered these underground nests through the same entrances used by the resident red squirrel. The marten remained in the middens for hours at a time, usually all day. The most squirrel middens found to be used by a single marten was 6, (male number 512, spring 1981). Some marten use of red squirrel middens was observed in early autumn and late spring. The earliest observation of marten use of red squirrel middens in autumn 1980 was on 18 October. The earliest observation in autumn 1981 was on 28 September. The latest observation in spring 1981 was on 2 May.

Marten in the upper Susitna Basin were found to use red squirrel middens most heavily in winter. This is suggested by:

1. The dates of observed use of red squirrel middens by marten.
2. Accumulations of marten scats outside the entrances to red squirrel middens in spring. These marten latrines were found to consist of many scats distributed vertically through the winter's accumulation of snow.

Table 6. Characteristics of 37 marten resting sites in the upper Susitna Basin.

Type of Site	Number	% of total
Red squirrel midden, active	26	70
Red squirrel midden, inactive	2	5
Red squirrel grass nest, in tree	3	8
Burrow in ground	6	16
TOTAL	37	
VEGETATION TYPE		
Forest, white spruce	8	22
Forest, mixed (white spruce-paper birch)	17	46
Forest, mixed (white spruce-balsam poplar)	1	3
Woodland, mixed (white spruce-black spruce)	5	13
Woodland, white spruce	4	11
Woodland, black spruce	2	5
TOTAL	37	
ASPECT		
North	1	3
Northeast	1	3
East	2	5
Southeast	4	11
South	10	27
Southwest	6	16
West	6	3
Northwest	1	3
None	6	16
TOTAL	37	

ELEVATION
$\bar{x}$= 564 m ± 61
Range: 451-722 m
SLOPE
$\bar{x}$ = 15.3° ± 11.9
Range: 0-45°

No use of red squirrel middens by marten was observed during the summer months. During this period, marten appear to prefer above-ground resting sites where air temperatures are higher than those of subterranean tunnels.

Attempts to superimpose marten radiolocations on vegetation maps were largely unsuccessful because of the large error in location plotting compared with the size of the smallest vegetation mapping unit employed. The maximum radiolocation plotting error was estimated to be 200 m. The smallest mapping unit employed in the vegetation mapping was approximately 1.5 ha. An exception occurred in the Fog Lakes area, where vegetation was a homogeneous (and nearly pure) stand of black spruce woodland. When radio-locations of marten number 512 were plotted on the 1:24,000 vegetation maps, the daytime locations of this marten during autumn 1981 are clearly not distributed randomly over the home range. The larger area of open black spruce (OBS) comprises most of area of the marten's home range, but is underrepresented in radio-locations during this season. A similar pattern was observed for number 655 during the same season. The plotted locations represent mostly resting sites, which are absent from the large open black spruce stand. Marten 512 and 655 rested primarily in small stands of old-growth white spruce (too small to be mapped), which occurred near the edge of the large stand of open black spruce or within the mapped stands of open birch forest (OBF) and closed tall shrub (CTS).

Other types of marten resting sites located include inactive red squirrel middens and red squirrel grass nests in trees. Marten were found resting in grass nests on four occasions in spring 1981. Three of the four instances were observed between 23 March and 25 March. In each case, an adult male was resting in a nest 3-8 m above the ground in a white spruce during midday, air temperatures were 0 ± 1 C, wind was from the northeast at 2-5 m/sec, relative humidity was 20 ± 2% and sunlight was direct and bright.

Care must be exercised in interpreting data on habitat utilization by marten when a variety of techniques have been employed to gather the data. Data from transects, for example, reflect the distribution of tracks, which is an estimator of habitat use based upon locomotion. Marten may make tracks in the course of a number of activities, including foraging for food, home range exploration/territorial maintenance, dispersal/migration and mate-seeking and reproductive behavior. Vegetation or habitat type is more important to some of these activities than others. It was assumed that at the time of year in question, foraging and home range exploration/territorial maintenance represent the major sources of marten tracks observed and that the closest track-vegetation types associations are due to the behavior of marten foraging for animal foods. Thus, there are probably some tracks which result from activities which are linked to specific habitat types, but other tracks which result from activities which have weak or no habitat links. Of course, the field worker cannot distinguish between the two, and tracks of the second type would tend to obscure relationships which might be apparent from the first. In addition, track-habitat assocations may be further obscured by the use of methods of vegetation classification in transect runs (observed use) different from those used in vegetation mapping (expected use). Although both kinds of classifications were made using the same criteria, one effort (transect runs) was made from a low flying helicopter while the other (vegetation mapping) was based upon high altitude infrared photographs, supplemented by ground truthing. The resulting track-habitat relationships in the data should be used only to identify the most salient and coarse habitat associations.

On habitat data, resting site descriptions, a small bias was introduced by searching red squirrel middens for marten scat accumulations. Because only two marten resting sites were identified in this way, the sample should approximate true winter resting site habitat preferences in the study area.

Data from snow tracking of marten suggest that during autumn of 1981 marten did most of their foraging in stands of black spruce and mixed conifer (black and white spruce). This conclusion is consistent with the finding that marten fed primarily upon tundra voles and meadow voles during that season and the observation of S.O. Macdonald (pers. comm.) that these microtines were most abundant in wet sedge meadows surrounded by black spruce woodlands.

The characteristics of marten resting sites suggest a close spatial and habitat association between marten and red squirrels. Active red squirrel middens appeared to be particularly important to marten during the cold season and a major component of marten winter habitat. A general impression was that there were many more inactive red squirrel middens than active ones in the study area. The preference by marten for active red squirrel middens over inactive middens suggests that maintenance done on the underground nests by red squirrels makes them more suitable for use as marten resting sites. Such maintenance includes carrying in dry nest material such as grass, moss or fur. Johnson (1954) documented that red squirrel underground nests at middens provide a favorable microclimate in winter due to the insulating qualities of snow and the midden material itself. Raine (1981) located three subnivean marten dens in southeastern Manitoba, all of which were renovated (and presumably inactive) red squirrel middens on jackpine ridges. He also found the air temperature in an unoccupied subterranean fisher den to be -11° C when the air temperature at the snow surface was

-26° C. Considering the heat generated by a marten, air temperatures inside squirrel middens occupied by marten may be over 25°C warmer than air at the snow surface during mid-winter cold spells. Use of squirrel middens by marten has been noted by other North American workers (Murie 1961, More 1978, Spencer 1981), however, results indicate a closer ecological association between marten and red squirrels than any yet reported.

Marten use of above-ground resting sites in summer is easy to interpret in terms of soil and air temperatures. Subterranean burrow air temperatures are near 5° C in summer when air temperatures at the soil surface are 15° C warmer (Pruitt 1957).

High quality marten habitat in the upper Susitna Basin appears to be a mosaic of vegetation and topographic types. Vegetation in optimal habitats consists primarily of black spruce woodland, old-growth white spruce forest and woodland and mixtures of white spruce and paper birch. Wet sedge and grassy meadows, highly variable in size and shape, occur within the black spruce woodland. Red-backed voles are common in a variety of vegetation types in the habitat, meadows are productive for lemmings and voles of the genus Microtus and stands of old-growth white spruce support red squirrels which occupy old and well-developed middens.

This habitat satisfies two basic needs of marten during autumn, winter and spring. First, it is productive of the foods, particularly microtines, which marten prefer. Second, it provides suitable resting sites which offer microclimatic protection. The interspersion of these habitat types appeared to be important in the upper Susitna Basin. Active foraging for voles appeared to be more frequent in areas with vegetational heterogeneity. In addition, the occurrence of suitable resting sites close to suitable foraging areas provides energetic savings in terms of reduced daily travel.

FOOD HABITS - AUTUMN, WINTER AND SPRING

METHODS

Collection and analysis of marten scats and gastrointestinal tract contents provided the basis of the food habits studies. The source of the material used for food habits studies is summarized in Table 7. Individual scats were collected from marten trails, resting sites and live traps where marten were captured. Contents of gastrointestinal tracts were taken from the carcasses of marten, purchased, or accepted as donations from local trappers. Gastrointestinal tract contents were divided into stomach and colon contents. Stomach contents were not considered in the analysis. Dried colon contents fell within the weight range of dried scats and were treated as equivalent sampling units in the analysis. All specimens were numbered, assigned codes for date and location and dried at room temperature.

Analysis was done using standard techniques for carnivore food habits studies (Korschgen 1980). Individual scats were weighed and broken apart dry. Food items were identified using reference collections of vertebrate skins and bones and berry seeds. Mammalian hairs were identified by examining medullary hair structure (Moore et al. 1974). Food items were separated and collected in containers by season. The weights of these seasonal food item aggregates were measured with a top loading balance to the nearest 0.1 g. Volumes were measured by the water displacement method (Zielinski 1981). Food items which were suspected of having been ingested incidentally, such as

Table 7. Types of specimens used for determining marten food habits. Seasons are defined as follows: Spring, Mar-May; Summer, Jun-Aug; Autumn, Sept-Nov; Winter, Dec-Feb.

	Autumn 1980	Winter 1980-81	Spring 1981	Autumn 1981	Unknown Season	Totals
Scats from live traps	4	1	2	8	1	16
Scats found on ground	10	5	21	106	5	147
Scats found at resting sites	1	111	78	22	71	283
Colon contents	3	15	0	3	0	21
Totals	18	132	101	139	77	467

leaves, inorganic matter and items ingested in traps, were disregarded in the analysis.

Frequency of occurrence for food item categories above the specific level (e.g., "microtines", "sciurids") was calculated assuming that the occurrence of remains of two species belonging to a higher level taxon in one scat represented only one occurrence of that taxon in scats. For example, a 20% frequency of occurrence value for microtines in marten scats indicates that 20% of the marten scats contained microtine remains, regardless of how much, or from how many species. In addition to percent frequency of occurrence, food item importance is expressed by volumetric percent, the volume of a food item expressed as percent of the total scat remains most accurately approximates the ingested weight of prey of various sizes by a marten-sized mustelid and is the method of choice for indicating the relative importance of mammalian prey remains in marten scats. Seasons were defined as follows:

spring	March-May
summer	June-August
autumn	September-November
winter	December-February

Information on potential prey of marten came from studies of small mammal and bird distribution and abundance conducted by Kessel et al. (1982).

RESULTS AND DISCUSSION

A total of 467 specimens representing scats or colon contents of marten were collected and analyzed. These specimens represented four three-month seasons, however, one of the seasons (summer 1981) was represented by too few scats to provide a basis for analysis (Table 7). An additional group of scats was of "unknown season". These scats varied greatly in age, some of them probably over 1 year. Scats came primarily (60.6%) from latrines at marten resting sites. Another 31.5% were found along marten trails in snow or at other sites. The results of food habits analyses based upon 3-month seasons are presented in Tables 8 and 9.

Microtines

Microtine rodents were the most important class of food during autumn, winter and spring, using either frequency of occurrence or volumetric percent as the index of importance (Tables 8 and 9). This high value and the value obtained by More (1978) in the Northwest Territories of Canada are the highest of any North American studies (Table 10). Microtine rodents have also been found to be the principal food of Old World pine marten (Martes martes) in Finnish Lapland (Pulliainen 1981). Northern red-backed voles (Clethrionomys rutilus) were the most common and important microtine species in marten scats from the upper Susitna Basin (Table 11). They represented 53.8% of the volume of microtine material which could be identified to species. Voles of the genus Microtus collectively comprised 38.7% of the total volume of microtine remains.

Table 8. Food items in marten scats by season, expressed as percent frequency of occurrence.

	Autumn 1980	Winter 1980-81	Spring 1981	Autumn 1981	Unknown Season	
Unknown mammal	0.0	0.8	4.0	0.7	0.0	1.3
Microtine	94.4	78.0	84.2	99.3	84.4	88.2
Soricid	11.1	1.5	3.0	0.0	1.3	1.7
Sciurid	5.6	10.6	15.8	0.0	3.9	7.2
Ungulate	22.2	0.0	2.0	1.4	6.5	2.7
Snowshoe hare	0.0	1.5	0.0	0.0	3.9	1.1
Muskrat	0.0	3.0	3.0	0.0	0.0	1.5
Bird	5.6	18.9	12.9	3.6	5.2	9.7
Fruit	38.9	29.6	28.7	1.4	22.1	20.5
Fish	0.0	0.7	1.0	0.0	0.0	0.4
Human foods	0.0	0.0	0.0	0.0	7.8	1.3
Total Scats	18	132	101	139	77	467
Mean food items/scat	1.7	1.7	1.6	1.1	1.4	1.5

Table 9. Food items in marten scats, by season, expressed as volumetric percent.

	Autumn 1980	Winter 1980-81	Spring 1981	Autumn 1981	Unknown Season	Total
Unknown mammal	0	0	2.8	1.0	0	1.1
Microtine	50.0	66.3	61.5	97.5	67.7	70.4
Soricid	0	0.7	1.1	0	0	0.6
Sciurid	6.7	7.4	17.0	0	6.5	9.0
Ungulate	30.0	0.3	1.1	0	5.4	2.3
Snowshoe hare	0	2.4	2.6	0	2.2	1.9
Muskrat	0	3.7	4.0	0	0	2.3
Bird	0	9.8	3.7	1.5	3.8	4.9
Fruit	13.3	8.8	6.0	0	5.4	5.7
Fish	0	0.7	0	0	0.5	0.4
Human foods	0	0	0	0	8.6	1.5
Total %	100	100	100	100	100	100
Total volume (ml)	30	297	353	202	186	1068

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Table 10. Major food items in the diet of marten from the present study and elsewhere. Values given are percent frequency of occurrence for all seasons sampled.

	Area				
	Northcentral Maine[1]	Southern Northwest Territories[2]	Sierra Nevada Mountains California[3]	Finnish Forest Lapland[4]	Glacier National Park, Montana[5]
Number of scats	412	499	300	2698	1758
Cricetids (except muskrat)	~80	89	~20		73.7
Shrews	7.0	~6	2.2		7.6
Sciurids	~7	6	22	2.8	12.0
Snowshoe hares	1.7	5	4.9	*	2.9
Ungulates	0.7	0	1.2	*	4.7
Birds	18.0	19	8.8	14.5	12.0
Fruits	*	~23	~5	13.5	29.2
Insects	8.3	~14	8.0	*	19.0
Human Foods	*	*	6.0	*	*

	Area				
	Banff and Jasper National Parks, Canada[6]	Interior Alaska[7]	Northcentral Idaho[8]	Southeastern Manitoba[9]	Southcentral Alaska[10]
Number of scats	200	466	129	107	467
Cricetids (except muskrat)	66.0	73	~82	18.6	88.2
Shrews	1.6	0	1	1.9	1.7
Sciurids	10.2	<1	~12	15.9	7.2
Snowshoe hares	1.6	<1	2	58.9	1.1
Ungulates	<1	<1	*	0	2.7
Birds	4.3	10	5	17.8	9.7
Fruits	5.2	17	12	0	20.5
Insects	5.2	0	9	0	<1
Human foods	*	*	*	*	1.3

1 From Soutiere 1979, 67% of material from April-September.
2 From More 1978, material from all seasons.
3 From Zielinski 1981, material from all seasons.
4 From Pulliainen 1981, scats from October-April over 4-year period.
5 From Weckwerth and Hawley 1962, scats from all seasons over 5-year period.
6 From Cowan and MacKay 1950, season unknown.
7 From Lensink et al. 1955, 80% of material from June-August.
8 From Koehler and Hornocker 1977, 63% of material from "winter".
9 From Raine 1981, all winter scats.
10 From present study, scats from autumn, winter and spring (see Table 11).
* Not mentioned or cannot be inferred from data given.

Table 11. Marten use of microtines, by season, based upon percent of total volume of identified microtine material in scats.

	Autumn 1980	Winter 1980-81	Spring 1981	Autumn 1981	Unknown Season	Total
C. rutilus	100.0	64.2	71.0	21.1	44.4	53.8
M. oeconomus	0	18.8	16.7	52.6	14.8	25.5
M. pennsylvanicus	0	10.4	8.6	19.6	21.0	13.2
S. borealis	0	4.6	3.7	6.8	16.1	6.4
L. sibiricus	0	2.0	0	0	3.7	1.1
Total	100.0	100.0	100.0	100.0	100.0	100.0

Strong year-to-year variation was observed in the specific composition of the microtine portion of the diet. In autumn 1980 red-backed voles comprised 100% of the volume of the microtine remains in scats, whereas in autumn 1981 the value was only 21.1% (Table 11). During both autumn trapping periods the proportion of red-backed vole captures to Microtus captures remained essentially the same, roughly 90% red-backed voles and 10% Microtus (Figure 4). This inverse relationship between densities of voles and their importance in the diet of marten in autumn 1981 suggests that marten do not take prey simply in proportion to their relative densities, but that marten adjust their foraging styles in response to prey densities. At low microtine densities marten appear to forage in a wide range of habitats and capture mostly red-backed voles, the most abundant microtine species. At high microtine densities marten seek out locally high concentrations of other species, particularly Microtus. Under the latter conditions marten prey primarily upon species which comprise a small minority of the microtine fauna.

Northern bog lemmings comprised 6.4% of the total microtine remains, a high value considering that MacDonald (pers. comm.) caught only 4 of this species in 1,952 microtine captures. Conspicuous by its absence from the diet of marten was the singing vole (Microtus miurus). MacDonald found this species in moderate numbers in the upper Susitna Basin, but only in areas above the normal elevational range of marten.

Squirrels

Three species of sciurids are found in the study area and were recorded from marten scats - red squirrels, arctic ground squirrels

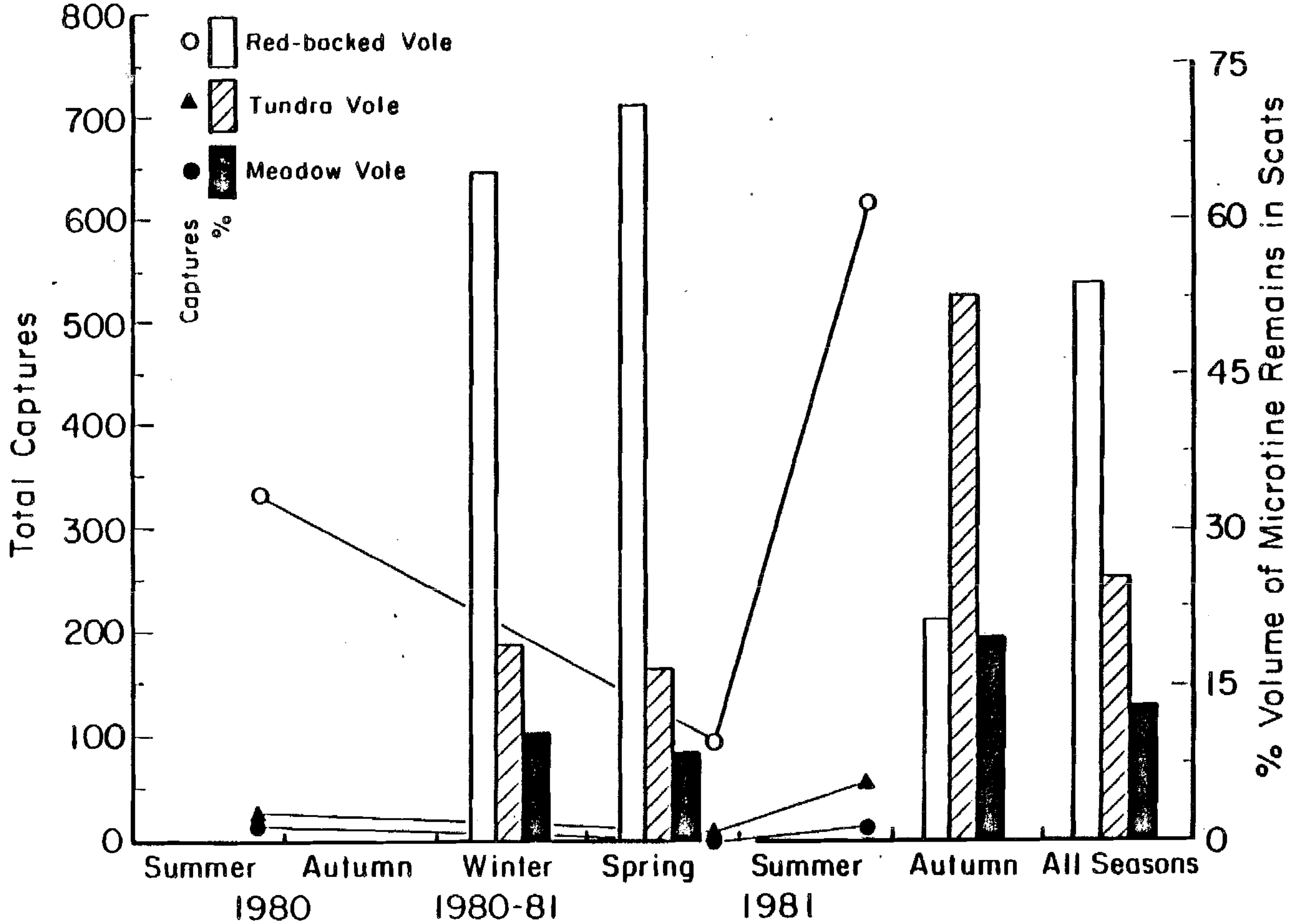

Figure 4 Microtine availability and utilization by marten in the upper Susitna Basin. Connected symbols represent total captures of a species during a trapping session (S. O. MacDonald, unpubl. data). Vertical bars represent volume of microtine remains in scats as a percent of the total volume of microtine material.

Table 12. Sciurid food remains identified from marten scats, by season, expressed as volumetric percent.

	Autumn 1980	Winter 1980–81	Spring 1981	Autumn 1981	Unknown Season	Total
Sciurid, unknown species	0	0	2.3	0	0	0.8
Red squirrel	6.7	2.4	10.7	0	4.8	5.2
Arctic ground squirrel	0	4.4	3.4	0	1.6	2.6
Northern flying squirrel	0	0.7	0.6	0	0	0.4
Total sciurid	6.7	7.4	17.0	0	6.5	9.0

(*Spermophilus parryii*) and northern flying squirrels (*Glaucomys sabrinus*). Squirrel remains were found in 7.2% of all marten scats. The volume of these remains was 9.0% of the total scat volume, making squirrels, as a group, the second most important food class in the diet of Susitna marten (Table 12). Red squirrels were the most important sciurid food item, followed by arctic ground squirrels and northern flying squirrels. The appearance of arctic ground squirrel remains in marten scats from winter and spring poses the question of how the ground squirrels were obtained. Arctic ground squirrels are in hibernacula at the time of year that their remains appeared in marten scats. Thus, marten must have entered the hibernacula and killed the squirrels or eaten cached squirrel carcasses which had been killed in autumn. Very few arctic ground squirrels were observed in areas inhabited by marten in the upper Susina Basin. Those ground squirrels were in gravel bar habitats in various seral stages, adjoined by white spruce forest or woodland. Use of squirrels increased over the winter of 1980-81, from 6.7% (volumetric) in autumn 1980 to 17.0% in spring 1981. Squirrels appeared to be a non-preferred alternative food, used most heavily when microtine numbers were lowest.

Fruits

Berries of 4 species (*Vaccinium uliginosum*, *V. vitis-idaea*, *Empetrum nigrum* and *Rubus idaeus*) and the fruits of wild rose (*Rosa acicularis*) together comprised 5.7% of the volume of all scat material and occurredin 20.5% of the scats. This large difference between frequency of occurrence and volumetric percent results from the high digestibility of berries and/or indicates that marten eat a few berries or hips at a time. Scats containing mostly or entirely berry remains were seldom observed. Frequency of occurrence of fruits in scats showed strong seasonal and annual vairation, ranging from 38.9% during autumn 1980 to 1.4% during autumn 1981. Utilization of fruit decreased over the winter of 1980-81, probably reflecting a decline in availability and preservation of fruit.

The importance of plant fruits in the diet of Susitna marten is difficult to evaluate. Under conditions of high abundance and availability of berries, marten were found to consume large amounts of some species. As winter progressed berry utilization declined, but some use of overwintered berries was noted as late as late April 1980. A berry crop failure was observed in late summer and autumn, 1981. Few berries and hips were observed on plants in early August. A cold snap occurred in mid-month, the temperature at Watana Camp reaching -2.2°C on 16 August. Following this cold snap, virtually no blueberries remained on bushes and other berries and rose hips deteriorated quickly. This berry-hip crop failure is strongly reflected in marten food habits. Only 1.4% of autumn 1981 marten scats contained berry seeds or skins. The volume of these fruit remains was less than 0.5% of the total scat volume for the autumn.

Birds

Birds were the fourth most important food category (volumetric percent). No attempt was made to identify bird remains to species, but our impression is that most bird remains were those of galliform or passeriform species. These two orders comprise the majority of the avifauna found in forested habitats in the upper Susitna Basin. During winter the local avifauna is very limited. It is likely that most birds killed during winter months are spruce grouse (Dendragapus canadensis), willow ptarmigan (Lagopus lagopus) or gray jays (Perisoreus canadensis). It is difficult to compare the importance of birds with other classes of food items in the diet of marten. Bird feathers have high visibility in carnivore scats. Likewise, Zielinski (1981) found a captive ferret to produce more scats per unit weight of bird prey consumed than small mammal prey. Thus, both frequency of occurrence and volumetric percent probably overestimate ingested weight of birds.

Foods of Humans

The remains of foods of humans were found in 1.3% of all marten scats and comprised 1.5% of the total scat volume. These figures probably underrepresent the amounts of human foods consumed because of their high digestibility and resulting underrepresentation in scats. Marten obtained these foods by visiting the field camp used during this study. During March and April 1981, four marten (all radiocollared) frequently visited our field camp in search of food. Items they ate or carried away included a wide range of stored or discarded foods, including meat, cheese, produce and sweets.

General

Several salient similarities in the diet of North American marten can be observed in most or all of the sites where they have been studied.

These include the following:

1. Microtine rodents are the most important food of marten.
2. Marten prefer some microtine genera (e.g. Microtus) over others (e.g. Peromyscus).
3. Shrews, snowshoe hares, porcupines and flying squirrels have low importance in the diet of marten.
4. Squirrels, particularly of the genus Tamiasciurus, are most important during the spring months when microtine numbers and availability are lowest.
5. Utilization of fruits is highest in autumn and declines over winter.
6. Marten utilize carrion and a wide range of human foods opportunistically.

Microtine rodents were found to be the most important food of marten in the upper Susitna Basin. Squirrels were the second most important food type using volumetric percent as an indicator. Other major foods were plant fruits and birds (Table 9). Differences in the relative importance of food types can be attributed to differences in digestibility and patterns of ingestion. The relative importance of four food types as expressed by percent frequency of occurrence and volumetric percent are presented in Table 13.

Strong seasonal variation in diet was observed. Microtines appeared to be most heavily used in autumn and least important in autumn. Plant fruits, particularly ericaceous berries and rose hips, were most important in autumn and declined gradually in importance over the winter, probably reflecting increasing snow depths and decreasing availability of fruits. Shrews were not utilized at all in autumn, but showed slightly increased use as winter progressed and preferred foods became less available. Consumption of carrion and human foods varied strongly, but not along seasonal lines, reflecting the strong contribution of chance to the availability of these foods. During winter and spring, when the availability of natural foods is lowest, human food can prove a powerful attractant to marten. This characteristic of marten has important implications for solid waste disposal.

Northern bog lemmings present an interesting problem with regard to their preference to marten, because of their apparent trap-shyness (M.L. Johnson in Maser and Storm 1979). Of the 4 bog lemming captures made by MacDonald in 1980-81, all were in cone pitfalls rather than snap traps. A small mammal sampling scheme based upon snap trapping may greatly underestimate the abundance of northern bog lemmings and therefore bias interpretation of marten preference for this species.

Marten in the upper Susitna Basin exhibit food habits which are remarkably similar to those of marten elsewhere in North America. Important food items are in many cases the same species or ecological equivalents. Our findings differ in this respect from those of Lensink et al. (1955, p. 364), who reported that, "food habits of marten in interior Alaska are most similar to those reported for Asiatic species". Other comparisons between our findings are difficult to make. The material examined by Lensink et al. came primarily from the summer months. Patterns of seasonal dietary variation appear to have the same explanation in south-central Alaska as they do in areas farther south. During autumn marten utilize preferred prey, particularly habitat specialist microtines. As the cold season progresses and these voles become less abundant and available, marten rely more upon habitat

Table 13. Food item importance based upon two measures of representation in marten scats.

Rank	% Frequency occurrence	Volumetric percent
1	Mircotine	Microtine
2	Fruit	Sciurid
3	Bird	Fruit
4	Sciurid	Bird

generalist microtines, squirrels and shrews and are more strongly attracted to human food sources.

POPULATION ESTIMATES

METHODS

Methods utilized in previous marten population estimates are described in Appendices II and III. Methods used in aerial transect surveys are described in Section 2.13, p. 11 of the Phase I report of the Susitna Hydroelectric Project Furbearer Studies (Gipson et al. 1982).

In brief, the original marten population estimate was based on vegetation associations and average male marten home range size determined by radiotelemetry and determining the amount of marten habitat in the impoundment zones from Phase I plant ecology studies. Verification in July 1982 was attempted by setting live traps along Watana Creek. In 1980, transects 9.6 km apart and 9.6 km long were established from Portage Creek to the Tyone River. Transects were flown at low altitude by helicopter and marten trails intersected by transects were enumerated. Vegetation type at trail/transect intersections were recorded.

RESULTS AND DISCUSSION

Results of Marten Population Estimates (Appendix II) were 0.00847 marten (all age/sex groups) per hectare and a total of 218 marten affected by all components of the Watana and Devil Canyon facility.

In the July 1982 Marten Population Survey (Appendix III) no marten were live trapped along Watana Creek during the 10 day trapping effort (252 trapnights). This area was known to have been trapped independently during the trapping season 1981-82. It is believed that most marten inhabiting Watana Creek were captured which resulted in our failure to livetrap marten on the lower portion of the creek the following July. It is our opinion that industrious marten trappers can signficantly impact local populations in a short period of time.

The aerial transect survey conducted in November 1980 resulted in 1353 marten sample points (tracks) in 15 vegetation types. In reconsidering transect survey results as an estimator of marten numbers, it was determined that any configuration of transects 9.6 km apart crossed an average of 3 of 7 known marten home ranges in autumn 1981. It was further evident that transects 3.2 km apart would be of sufficient density to cross known marten home ranges at least once. Transects 9.6 km apart probably crossed most fox home ranges, which were 4 to 6 times larger than those found for marten.

Using aerial transect marten track counts, assuming that 3 of 7 marten home ranges were crossed, and assuming that all marten make similar numbers of tracks, 3,157 marten tracks would have better reflected the actual number of marten in the area sampled in the 1980 aerial transect survey. If the figure of 218 marten, predicted to occupy the impoundment zones, is correct, each marten in the revised track count (3,157) is represented by about 15 tracks. This seems high to us and we believe that up to twice as many marten may have been present in the impoundment zones than previously estimated.

We found previously (Gipson et al. 1982) that marten in the upper Susitna basin are capable of movements of at least 14.5 km. This suggests that marten occupying home ranges up to 14.5 km from the impoundment zones are susceptible to deleterious effects of the proposed impoundments. Further, tributaries to the Susitna River were generally observed to have larger populations of marten than surrounding areas. Marten sign was also encountered further from the Susitna River along tributaries when compared to non-tributary areas.

We feel that present estimates of marten numbers in the impoundment could be improved. Winter aerial transect surveys, properly tested and interpreted, can be a quick and efficient means of estimating furbearer numbers in Alaska. We suggest that several marten be radio-collared, their home ranges and movements determined and test transects flown over their home ranges under known environmental conditions to determine how many tracks can be expected to be enumerated per marten. This should allow quick, accurate estimates over large as well as small areas. The original transect sampling scheme provided useful data pertaining to distribution of furbearers. When repeated in an area, the original transect scheme should also provide data with which furbearer distribution and relative abundance can be determined.

MISCELLANEOUS OBSERVATIONS OF FURBEARERS

Several noteworthy observations of furbearers have been made incidentally to other work along the Susitna River. These observations are summarized below, by species.

Coyotes

Sightings of coyotes by members of the study team, plus reports from trappers and helicopter pilots, suggest coyotes are more abundant downstream from Devil Canyon than we realized when the Phase I Furbearer Report was submitted. Coyotes appear to be common below Portage Creek and abundant from Gold Creek and Indian River downstream to Talkeetna. It is likely that coyotes are also common to abundant below Talkeetna, but we have no data regarding their occurrence below Talkeetna. Recent sightings and reports of coyotes are summarized below.

27 March 1983. A lone coyote was observed feeding on the remains of a moose carcass, apparently a wolf kill, on the ice on a main channel of the Susitna River. The coyote was sighted by members of the furbearer study team (Gipson and Hobgood) approximately 8 km downstream from Portage Creek. The coyote appeared to have an injured right rear foot or leg.

19 October 1983. A lone coyote was observed along Indian River about 1 km downstream from the railroad bridge. The coyote was dragging what appeared to be the foreleg of a moose. Philip Gipson, Douglas Larsen, and Randy Fairbanks observed this coyote.

Mid-July 1982. Mr. Jerry Dickson, helicopter pilot for Air Logistics, sighted 5 coyotes in a group about 3 km north of Talkeetna and 1 km east of the railroad. Mr. Dickson was the pilot when we sighted the coyote on 27 March 1983, so he was familiar with coyotes.

See the Phase I Furbearer Report (page 68) for additional information about coyote distribution and abundance in the area.

Muskrats

15 July 1982. Trails and cuttings made by muskrats were observed by furbearer study team member Hobgood along small creeks flowing into Deadman Creek. This muskrat sign was observed along 2-3 km of Deadman Creek immediately below the outlet from Deadman Lake.

18 October 1983. Numerous trails, food cuttings and den sites were observed in marshes along the east side of the Susitna River downstream from the village of Susitna.

26-27 April 1984. Four muskrat pushups were counted on upland sloughs incidental to beaver overwinter survival studies. Herbaceous vegetation appeared to have been cut by muskrats at these sites (approximately 3 km downstream from the railroad bridge at Gold Creek, on the northwest side of the river and near Curry, on the west side of the river), and some cut herbaceous vegetation was floating on top of the water.

Foxes

Early April 1983. Mr. Jerry Dickson, helicopter pilot from Air Logistics, observed a red fox feeding on the same moose carcass that a coyote was sighted feeding on about 9 days earlier, 8 km downstream from Portage Creek on ice on the Susitna River.

18 October 1983. A red fox den was sighted on the east side of the Susitna River on the side of a small sandy knoll along the transmission line right-of-way crossing the lower Susitna River. This den was observed by Gipson and Randy Fairbanks.

TRAPPER SURVEY, SPRING 1984

INTRODUCTION

Trappers and other out-of-doors enthusiasts in the Susitna drainage often make observations of furbearers and other wildlife that are valuable to project study teams in documenting wildlife distribution patterns, seasonal abundance and habitat associations. This survey was designed to obtain such information about furbearers from their primary user group - trappers.

METHODS

Trappers and other out-of-door enthusiasts believed to have knowledge of furbearers in the Susitna Valley were interviewed in person on 30 and 31 May, and 1 June. The furbearer study team interviewed residents of the Parks Highway in the Cantwell area, the Denali Highway between Cantwell and Paxson, the Glenallen area, the Edgerton cutoff on the Richardson highway, the Glenn highway, and the Lake Louise area.

During this survey, we stopped at the residences of persons of which we had previous knowledge that they trapped in the area and at lodges and restaurants to ask for names and address of persons in the area that trapped or had knowledge of furbearers.

The questions that were asked of each person surveyed included;

1) Have you trapped in the Susitna River drainage and if so, would the area you trapped be affected by the proposed Susitna River hydro-electric development.

2) If the respondent indicated that they trapped outside of the immediate proposed development, they were asked how they felt the development might affect the area they trapped.

3) What species of furbearers were in the area.

4) What types of furbearers they trapped for.

5) Approximately how many furbearers of each of the different species did they trap each year in each of the last several years. (Note: in some cases, answers were vague and this question was not pursued further.)

6) Whether they felt there had been fluctuations in the furbearer populations in the last few years. If so, which species and how have the populations changed.

7) Names of other trappers or persons knowledgeable of furbearers in the Susitna River area.

8) Whether trapping was a substantial part of their income.

9) General comments, observations and other information about furbearers or the proposed Susitna Hydroelectric Project.

RESULTS AND DISCUSSION

Furbearer Populations and Trapping Activities

A substantial list of persons to contact was available, but only 12 persons with knowledge of the area were available for interviews. Persons in the area said many of those that were not available were already involved in their usual spring-summer jobs such as guiding, commercial fishing, construction, mining and other activities.

Trappers were generally willing to respond to the questions and provided useful information. Persons we interviewed confirmed our earlier conclusions that only a few trappers trap in the immediate vicinity of the proposed impoundments. Responses of trappers that operate in the area around the impoundment zones are included in this report. Summaries of each interview follow. The names of respondents are omitted to protect their desire to remain anonymous.

Respondent. This person has trapped in the Cantwell area, and the Denali Highway area for approximately 55 years. His primary method of transportation in recent years has been by snowmachine. He traps mainly for wolves and foxes and he feels that, overall, furbearer populations in the last few years have been low.

Respondent. The Cantwell area, including sites along the Denali Highway and Parks Highway (North and South of Cantwell) is covered by this trapper. He has trapped this area for approximately 30 years. He has used dogs, trucks and snowmachines as transportation while trapping. He considers trapping a supplement to his regular income. He also reported furbearer populations during the past few years appeared down from several years ago. Wolves, foxes, wolverine, coyotes and mink were trapped. He reported periods of apparent high fox numbers, for example ca. 1955, in the area of Adventures Unlimited Lodge on the Denali Highway and during 1969 and 1970 near the Summit area. He felt that coyotes moved into the Cantwell area about 15 years ago. He also observed that hare populations in 1984 appeared to be the lowest in many years.

Respondent. This person was not actively trapping, but guided in the MacLaren River area. He reported that beavers, mink, otter and fox were plentiful in the MacClaren River area. Few wolves or wolverine occurred in the area and no marten, lynx or coyotes. He observed otters mating in mid-May near on the MacClaren River bridge on the Denali Highway. He indicated that in the last few years, ground squirrel numbers have increased.

Respondent. This trapper has trapped in the MacClaren River drainage since 1969, using airplane and dog team for transportation. Foxes are the primary furbearer trapped, but he also catches mink, otter, wolverine and some beaver. He reported that fox populations appeared stable over the past few years. Beaver and otter were common, but wolves and marten were very low in his area. He attributed the low wolf numbers to the state wolf reduction program. The mink and otter caught are believed by this trapper to be fairly large in size. Trapping constitutes the primary winter income for this person.

Respondent. This trapper has operated in the MacLaren river area since the late 1940's and uses an airplane for transportation when trapping. He reported that he trapped primarily fox, which were one of the most abundant furbearers in the area and some wolves and wolverine. Beavers were very abundant, but because of low pelt prices, were not presently profitable to trap. Otters were also abundant and he trapped several during each of the past few years. He did not indicate what proportion of his income came from trapping.

Respondent. This person trapped by snowmachine in the Susitna drainage in the Slide Mountain area near Glenn Highway for 7 years. Trapping constitutes a minor part of his income. Foxes and marten are the primary animals sought. He reported that numbers of marten appeared to have increased some in the last few years.

Respondent. This person is a fur buyer and he reported that the MacLaren River Valley, Crosswind Lake and Solo Hills were areas of high fur production. He indicated that a substantial proportion of the fur he bought came from these areas. He agreed with many of the respondents that marten numbers in the last few years were up, but he felt that the Susitna Valley River was not a major area for marten. He also agreed with trappers that radio-collaring furbearers decreased the value of the pelts (See Trapper Concerns).

Respondent. This person has not trapped for 5 years, but owns a lodge on the Denali Highway and he was familiar with furbearer populations along the upper Susitna River. He reported that wolves are now at approximately the same level as before a reduction program conducted by the Alaska Department of Fish and Game. He noted that numbers of foxes trapped had remained about the same for the last few years. Beaver were plentiful, but not usually trapped because of low pelt prices. He believed that the impoundments would not greatly affect furbearers, but that increased access for people to the area would.

Respondent. This person has trapped the area east and north of Lake Louise for the past 3 years. He reported several packs of wolves in the area, and high numbers of foxes, beavers and mink. He felt that there might have been more lynx sign during winter 1983-84 than in the last few winters, but lynx were still not abundant. Marten were present, but not abundant. He trapped mainly for wolves, marten and foxes. Weasels were taken incidental to marten trapping. He indicated that trapping did not provide a substantial part of his income. He had mixed feelings about the impacts of the hydroelectric project. He doubted whether the impoundments would have much affect on furbearers, but he felt the increased access for people would.

Respondent. This person trapped for one year in the Black, Oshetna and Susitna Rivers area, using snow machines for access. He indicated that there were a few wolves, numerous foxes, beavers and weasels. He trapped for wolves, but caught none. He reported catching marten, foxes, several beavers and lynx, and weasel incidental to marten trapping. He reported that the pelts of the foxes he caught during winter 1983-84 were in poor condition, but did not speculate as to why. Trapping was not a major part of his income. He had mixed views approximately the same level as before a reduction program conducted by the Alaska Department of Fish and Game. He noted that numbers of foxes trapped had remained about the same for the last few years. Beaver were plentiful, but not usually trapped because of low pelt prices. He believed that the impoundments would not greatly affect furbearers, but that increased access for people to the area would.

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Respondent. This person trapped for one year along the Susitna and Oshetna Rivers, especially near their confluence several years ago. He indicated wolves were plentiful as were foxes, lynx, beaver, and wolverine. He trapped primarily for marten, foxes, lynx and wolverines. During the year he trapped in the area, he felt trapping contributed a substantial part of his income, but during other years, trapping in other areas, trapping income was incidental. He said if he returned to the Susitna River area to trap, the impoundment would adversely affect his income.

Respondent. This person trapped in the Oshetna and Tyone River area for a 10 year period beginning in 1971. The primary method of transportation was snowmachine. His impression was that furbearer populations have generally declined since he first started trapping in the area, primarily, because of the low numbers of snowshoe hares. He reported wolves, wolverines, marten, foxes, beaver and otters were abundant in the past. He felt wolverines were very low last winter, but wolves, marten, foxes, beavers, mink and otters were still plentiful. Muskrats were plentiful in the lakes. He reported that he did not consider the area good lynx habitat. Only when lynx numbers were high in the surrounding areas did they move into the Oshetna and Tyone River areas. He formerly considered trapping to be a major portion of his income, but because of increased human use in the area, and competition with other trappers, he has curtailed his trapping efforts and trapping is no longer an important source of income to him. He felt the increased access provided by the hydroelectric project would be detrimental to furbearer populations.

Trapper Concerns

Several trappers voiced concerns and these are reviewed below. Trappers in the Cantwell area complained about recreational trappers who are employed by the intertie construction contractors. Apparently some intertie workers trap in their spare time and encroach on established traplines in the area. Some trappers around Cantwell believe that the Cantwell vicinity is susceptible to over-trapping due to low furbearer numbers. They also indicated that transient trappers often have little regard for maintaining local furbearer populations because the transient trappers are in the area for only a short time.

Some trappers complained about damage to furbearer pelts resulting from wear caused by radio-collars. Wolves collared by the Alaska Department of Fish and Game were mentioned most frequently. Apparently prices received for pelts from collared wolves are about 30% of the non-collared prices, and trappers received only $25 for the return of the collar, resulting in a net loss per pelt of $150-$200. A local fur buyer substantiated this. The same trappers also felt that too many furbearers were being collared. Several local residents and trappers also complained that many moose, caribou, and bears were wearing collars and ear tags which decreased their value to hunters, photographers, and viewers.

A guide in the MacLaren River area was concerned about possible detrimental effects of the proposed dams to grayling populatons. He reasoned that summer grayling populations would deteriorate if they wintered in segments of the Susitna River which would be inundated by the project.

SUMMARY

It is important to keep in mind that this was a preliminary survey and that many trappers in the region were not available to interview. The results may change markedly when information is obtained from other trappers.

Six of the persons we were able to contact indicated they were trapping or had trapped in the past in areas likely to be affected by the Susitna Hydroelectric Project. These trappers try to catch all species of furbearers present in the area, except for beavers and weasels. Beaver were not usually trapped because of low pelt prices. Some weasels were trapped, but usually incidental to marten trapping. The number of furbearers taken by the trappers fluctuated widely, depending upon area, weather and numerous other factors. Information on fluctuations of furbearer numbers was very hard to interpret. It was subject to personal bias and the information was site specific. There was general agreement that marten numbers appeared to be increasing, foxes were stable and beavers were numerous.

Trapping income was a substantial part of the income of several persons. For the others, trapping contributed to their income which is largely derived from other sources. Snow machines were the primary means of transportation, though several trappers used aircraft or dogteams. In general, most persons contacted indicated that the actual impoundment of water might not greatly affect furbearer, but the increased access allowed by the Project would. Some trappers suggested that establishment of impoundments in the Susitna valley would be beneficial to furbearer populations as well as the economy of the impact region if some means was provided which would allow the expansion of anadromous fish into the upper Susitna River system upstream from Devil Canyon.

LITERATURE CITED

Ables, E.D. 1969a. Activity studies of red foxes in southern Wisconsin. J. Wildl. Mgmt. 33(1):145-153.

_____. 1969b. Home range studies of red foxes (Vulpes vulpes). J. Mammal. 50(1):108-120.

Alaska Department of Fish and Game. 1983. Susitna Hydroelectric Aquatic Studies. Phase II. Basic Data Report. Vol. IV: Aquatic Habitat and Instream Flow Studies, 1982. Parts I and II. Prepared for Alaska Power Authority. Alaska Department of Fish and Game, Anchorage. 367 pp.

Ballard, W.B., S.D. Miller, and T.H. Spraker. 1980. Moose calf mortality study. Alaska Dept. Fish and Game. Final PR report on projects. W-17-9, W-17-10, W-17-11, and W-21-1, 123 pp.

Ballard, W.B., C.L. Gardner, J.H. Westlund and J.R. Dau. 1982. In: Susitna Hydroelectric Proj. Phase I final report, Big game studies, Part 5 Wolf, Alaska Dept. of Fish and Game, Anchorage. 220 pp.

Boyce, M. 1974. Beaver population ecology in interior Alaska. M.S. Thesis, Univ. Alaska, Fairbanks. 161 pp.

Burt, W.H. and R.P. Grossenheider. 1976. A field guide to the mammals. Houghton Mifflin Ca., Boston. 189 pp.

Buskirk, S.W. 1983. The ecology of marten in southcentral Alaska. Ph.D. Thesis. Univ. of Alaska, Fairbanks. 131 pp.

Buskirk, S.W. and S.O. MacDonald. Seasonal food habits of marten in southcentral Alaska (in review).

Cowan, I. McT. and R.H. MacKay. 1950. Food habits of marten (<u>Martes americana</u>) in the rocky mountain region of Canada. Can. Field-Nat. 64:100-104.

Francis, G.R. and A.B. Stephenson. 1972. Marten ranges and food habits in Algonquin Provincial Park, Ontario. Ontario Ministry of Natural Resources, Research Report No. 91. 53 pp.

Gipson, P.S., S.W. Buskirk and T.W. Hobgood. 1982. Susitna Hydroelectric Project Furbearer Studies, Phase I Final Report. Prepared for Alaska Power Authority. Alaska Cooperative Wildlife Research Unit, University of Alaska.

Hay, K.G. 1957. Record beaver litter for Colorado. J. Mammal. 38(2): 268-269.

Hoefs, M., I. McT. Cowan and U.J. Krajina. 1975. Phytosociological analysis and synthesis of sheep mountain southwest Yukon Territory, Canada. <u>In</u>: Syesis Vol. 8, suppl. 1, R.S. Scagel, ed: British Columbia Provincial Museum. Victoria, B.C. Canada. 125-227 pp.

Hobgood, T.W. 1984. Red fox ecology in the upper Susitna basin, Alaska. M.S. Thesis. Univ. Alaska, Fairbanks. 151 pp.

Hobgood, T.W. 1982. Red fox food habits study. Univ. of Alaska, Fairbanks, unpublished data.

Johnson, H.M. 1954. Winter microclimates of importance to Alaskan small mammals and birds. Ph.D. Thesis, Cornell Univ., Ithaca, NY.

Jones, D.M. 1980. The home range, habitat use and diet of the red fox (<u>Vulpes</u> <u>vulpes</u>) in the heterogeneous environments of Northwest British Columbia and southwest Yukon. M.S. Thesis. University of Waterloo, Waterloo, Ontario. 140 pp.

Kessel, B., S.O. MacDonald, D.D. Gibson, B.A. Cooper and B.A. Anderson. 1982. Susitna Hydroelectric Project, Environmental Studies, Subtask 7.11, Birds and nongame mammals. Prepared for Alaska Power Authority. University of Alaska, Fairbanks.

Koehler, G.M. and M.G. Hornocker. 1977. Fire effects on marten habitat in the Selway-Bitterroot Wilderness. J. Wildl. Manage. 41:500-505.

Koontz, K.C. 1968. Small game and furbearers of the Rampart Dam impoundment area. M.S. Thesis. Univ. Alaska, Fairbanks. 165 pp.

Korschgen, L.J. 1980. Procedures for food-habits analyses. Pages 113-127. In: S.D. Schemnitz, ed., Wildlife Management Techniques Manual. Washington, D.C. The Wildlife Society. 686 pp.

Lensink, C.J., R.O. Skoog and J.L. Buckley. 1955. Food habits of marten in interior Alaska and their significance. J. Wildl. Manage. 19: 364-368.

Machinda, S. 1982. Report on Beaver. Annual report of survey inventory progress report. Alaska Dept. Fish and Game. Proj. W-19-1, W-19-2, Job Nos. 7.0, 10.0, 15.0 and 14.0. 115-121 pp.

Maser, C. and R.M. Storm. 1970. A key to microtinea of the Pacific Northwest. O.S.U. Bookstores, Inc. Corvallis, Oregon.

McNab, B.K. 1963. Bioenergetics and the determination of home range size. Am. Nat. 97:133-140.

Mohr, C.O. 1947. Major fluctuations of some Illinois mammal populations. Trans. Illinois Acad. Sci. 40:197-204.

Moore, T.D., L.E. Spence and C.E. Dugnole. 1974. Identification of the dorsal guard hairs of some mammals of Wyoming. Wyoming Fish and Game Dept., Bull. No. 14. 177 pp.

More, G. 1978. Ecological aspects of food selection in pine marten (Martes americana). M.S. Thesis, Univ. of Alberta, Edmonton, Alberta.

Murie, A. 1944. The wolves of Mt. McKinley National Park. Fauna Series No. 5, U.S. Gov't. Printing Office, Washington, D.C. 238 pp.

_____. 1961. Some food habits of the marten. J. Mammal. 42:516-521.

Murray, D.E. 1961. Some factors affecting the production and harvest of beaver in the upper Tanana River, Alaska. M.S. Thesis, Univ. Alaska, Fairbanks. 103 pp.

Novakowski, N.S. 1967. The winter bioenergetics of a beaver population in northern latitudes. Can. J. Zool., 45:1107-1118.

Pruitt, W.O. 1957. Observations on the bioclimate of some taiga mammals. Arctic 10:131-138.

Pulliainen, E. 1981. Food and feeding habits of the pine marten in Finnish Forest Lapland in winter. Pages 580-598. In: J.A. Chapman and D. Pursley, eds. Worldwide Furbearer Conference Proceedings. 2056 pp.

Raine, R.M. 1981. Winter food habits, responses to snow cover and movements of fisher (Martes pennanti) and marten (Martes americana) in southeastern Manitoba. M.S. Thesis. Univ. of Manitoba, Winnepeg, Manitoba.

Sargeant, A.B. 1972. Red fox spatial characteristics in relation to waterfowl predation. J. Wildl. Manage. 36(2):225-236.

Schofield, R.D. 1960. A thousand miles of fox trails in Michigan's ruffed grouse range. J. Wildl. Manage. 24(4):432-434.

Scott, T.G. 1943. Some food coactions of the northern plains red fox. Ecol. Monogr. 13(4):427-479.

Soutiere, E.C. 1979. Effects of timber harvesting on marten in Main. J. Wildl. Manage. 43:850-860.

Spencer, W.D. 1981. Pine marten habitat preferences at Sagehen Creek, California. M.S. Thesis. Univ. of California, Berkeley, Calif.

Storm, G.L. 1965. Movements and activities of foxes as determined from radio-tracking. J. Wildl. Manage. 29(1):1-13.

Strickland, M.A., C.W. Douglas, M. Novak and N.P. Hunziger. 1982. Marten. Pages 599-612. In: J.A. Chapman and G.A. Feldhamer, eds. Wild Mammals of North America. John Hopkins Univ. Press, Baltimore, MD. 1184 pp.

U.S. Fish and Wildlife Service. 1980. Terrestrial habitat evaluation criteria handbook - Alaska Division of Ecological Services, U.S. Fish and Wildlife Service, Anchorage, AK.

Weckworth, R.P. and V.D. Hawley. 1962. Marten food habits and population fluctuations in Montana. J. Wildl. Manage. 26:55-74.

Zielinski, W.J. 1981. Food habits, activity patterns and ectoparasites of the pine marten at Sagehen Creek, California. M.S. Thesis. Univ. Calif. Berkeley, Calif.

PERSONAL COMMUNICATIONS

Jim Grimes, lodge owner, guide, trapper, Cantwell, Alaska.

Stephen MacDonald, museum technician, University of Alaska Museum, University of Alaska, Fairbanks, Alaska.

Alan Sargeant, wildlife biologist, Northern Prairie Wildlife Research Center, Jamestown, North Dakota.

Robert Stephenson, wildlife biologist, Alaska Department of Fish and Game, Fairbanks, Alaska.

Appendix 1. This appendix has been deleted because of its confidential nature.

Appendix 2.

FURBEARER STUDY TEAM REPORT TO LGL

August 2, 1982

MARTEN POPULATION ESTIMATES

(Based largely on home range data)

Data on marten home ranges permit the construction of a single population model for the proposed impoundment zones and estimation of the number of marten presently within the proposed impoundment zones. The model uses the average home range size of radio-collared marten in the study and makes the following assumptions:

1. Marten adult male home ranges are mutually exclusive and adjoin one another so that all marten habitat is utilized within the impoundment zones.

2. Adult marten are those over 1 year of age.

3. Marten habitat consists of vegetation types mapped as forest or wet sedge-grass tundra in Phase I plant ecology studies. Marten home ranges are restricted to these vegetation types.

4. A 100:100 sex ratio exists in all age classes of the marten population within the impoundment zones. (Sex ratio of all marten trapped by local trappers and the furbearer study team during study period was 158 males:100 females, n=93.)

5. The marten population within the proposed impoundment zones shows no effects on density or sex ratio from trapping.

6. Sixty-five percent (65%) of the marten in the impoundment zone population are juveniles (less than 1 yr.). Ralph Archibald (pers. comm.) found that 65.4% of 494 marten taken by trappers in Yukon Territory were less than 1 year of age, using cementum annulations.

7. Juveniles appear in the trapper harvest in the same proportion as in the impoundment zone population.

7. The population is estimated for midwinter, during the trapping season for which Archibald's data are applicable.

8. The mean home range size of adult male marten in the impoundment zones is 682 hectares.

Under these conditions, the population densities for various population components are as follows:

Adult males: 0.00147 marten per hectare

Adults: 0.00293 marten per hectare

All age/sex groups: 0.00847 marten per hectare

Number of marten affected follows:

Watana facility (all facility components): 159

Devil Canyon facility: 59

Appendix 3.

FURBEARER STUDY TEAM REPORT TO LGL

August 2, 1982

MARTEN POPULATION SURVEY

(based on live-trapping)

Abstract

Livetrapping for marten was carried out 10-20 July 1982 along Watana Creek. This was an effort to develop an independent population estimate to be compared with the estimate derived from telemetry studies carried out in the same area in 1980 and 1981. No marten were captured during the July 1982 trapping period. Possible reasons for the lack of captures follow: 1) Marten in the area may have been trapped during the 1981-82 trapping season, 2) trap baits used by the study team may not have been attractive, 3) placement of traps could have been outside of areas used by marten.

INTRODUCTION

Radiotelemetry studies of marten in the Watana Creek basin were carried out in 1980 and 1981 as part of the assessment work for the proposed Susitna Hydroelectric Project. Extrapolation of these data, in conjunction with data on habitat availability and use, lead to an estimate of 205 marten occurring in the combined proposed impoundment areas of the Watana and Devil Canyon reservoirs (see accompanying report - MARTEN POPULATION ESTIMATES).

The furbearer study team attempted an independent test of this estimate by livetrapping portions of the study area used for the telemetry study, enumerating the catchable population. The number of animals captured would provide a conservative estimate of the number present in the study area, and extrapolation to the Watana Creek basin and/or the entire impoundment area, would provide a second estimate of the size of the marten population.

Telemetry studies indicate that Watana Creek is an absolute barrier to marten when not frozen over, so traplines on opposite sides of the creek are independent. The spruce forest habitat preferred by marten lies in a band from approximately .5 to 4 km wide on either side of Watana Creek up to tundra on the surrounding plateaus.

METHODS AND MATERIALS

Trapping was conducted on the lower portion of Watana Creek, with 14 traps spaced about every .4 km along both sides of approximately 5.5 km of the creek's floodplain (Figure 1). Tomahawk brand folding cage

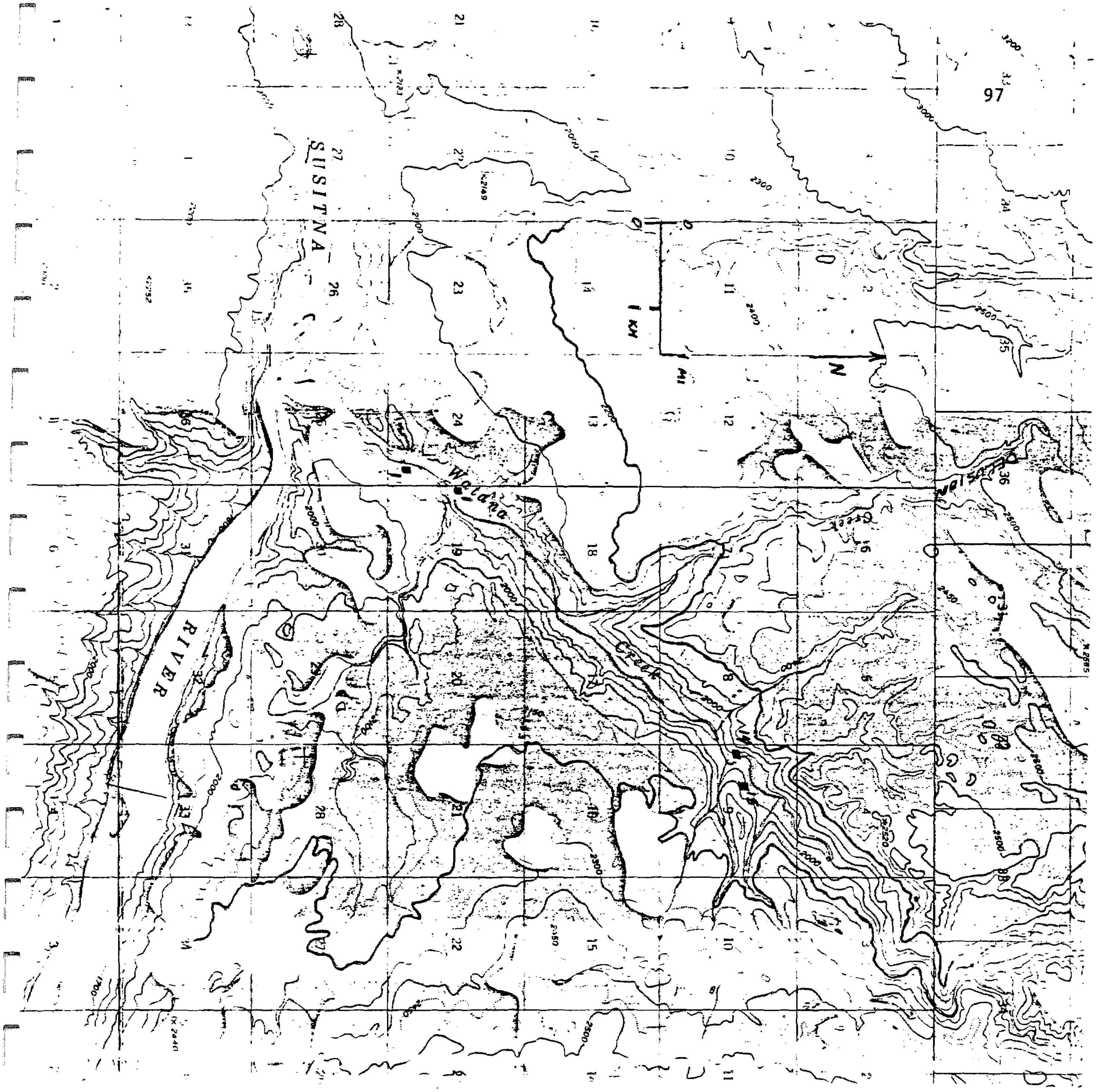

FIGURE 1. Locations of upper and lower trap sets of lines established for marten trapping on Watana Creek 10 - 20 July 1982. The red line at the 2200' contour line represents the approximate shoreline of the proposed Watana Dam impoundment.

live traps were set for the period 10-20 July 1982. Traps were baited with a mixture of sardines, sardine oil, strawberry jam, and oatmeal. On 15 July, liquid carnivore scent lure was placed on a pad of burlap wired to a branch near each trap set to augment the bait. The scent was renewed on 17 July. Alternate baits were tried in some traps after 15 July, including red squirrel, gray jay, and carnivore scent on caribou hair.

Captured animals were to be transferred from the trap to a confinement cone, then drugged with a mixture of ketamine hydrochloride, xylazine, and atropine sulfate. Four adult-size radio collars were available for adult marten, and colored nylon collars were to be used for adult identification after the supply of radio collars was exhausted, and for juveniles. Standard body measurements were to be taken while the animal was immobilized.

RESULTS

In 252 trapnights of effort, total captures were 0 marten, 1 red squirrel, and 8 gray jays. One trap was knocked about by a small bear. Fresh tracks seen in the area included adult and calf moose, brown bear, red fox, wolf, porcupine, and several species of shorebirds.

DISCUSSION

Several explanations have been offered for the lack of marten captures. A trapper active in the study area in January and February may have taken all marten present, and marten in surrounding areas may not have dispersed into the area. Our lures and bait may have been insufficient to entice marten into the traps. The sets may have been too near the creek, and possibly would have taken marten if they were placed on the forested hillsides rising from the floodplain. The latter explanation is probably mutually exclusive with the first, as the trapper's sets were as close, or closer to the creek than ours. In all probability, a mixture of factors probably contributed to our trapping failure with a low marten population in the area not being trappable with our methods.

There are at least four options with respect to marten population estimates:

1. Accept the current (radiotelemetry) estimate, and cease further marten surveys.

2. Retrap the Watana Creek lines in late August, assuming that dispersal into the area will have replaced marten trapped last winter. Use an improved bait and lure.

3. Move trapping effort to Kosina Creek; an area with high marten sign within the Watana impoundment that is untrapped so far as it is known. Trap in late August with an improved bait and lure.

4. Retrap 1 line of 14 stations along Watana Creek, and move the second line to Kosina Creek. Again, trap during late August with improved bait and lure.