SUSITNA HYDROELECTRIC PROJECT

ENVIRONMENTAL STUDIES

SUBTASK 7.11: FURBEARERS

PHASE I REPORT

APRIL, 1982

ACRES

Terrestrial Environmental Specialists, Inc.

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

FURBEARER STUDIES

PHASE I REPORT

To:

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SUMMARY

During 1980 and 1981, a variety of methods were employed to assess furbearer populations in the vicinity of the proposed impoundments and also downstream. Foxes and marten were equipped with radio collars and relocated at frequent intervals. The diets of foxes and marten were studied by following trails in snow, collecting food remains at dens and gross analysis of scats and stomach contents. Furbearer populations were also assessed through the use of 14 aerial snow transects. Beaver and muskrats were surveyed in the upper basin in 1980 by the use of helicopters and from a river boat along the lower river.

The fox population in the study area was low during 1980 and 1981. Fox numbers have been low in this area since the mid-1970's and it is felt that their numbers remain consistently low. The population of red foxes generally increases from Devil Canyon upstream to the mouth of the Tyone River. Harvests of red fox pelts have generally been highest upstream from Vee Canyon. Fox dens typically occur between 1,000 and 1,200 m elevation in areas of rolling hills adjacent to mountains.

Pine marten are locally abundant in the vicinity of the proposed impoundments and have historically been important to trappers. Marten are restricted to elevations below 1,000 m, probably due to the corresponding restriction of forested vegetation communities. Preliminary estimates indicate approximately 150 marten are present in the Watana impoundment area and approximately 55 are present in the Devil Canyon impoundment area.

Populations of beavers and muskrats are present along slow-flowing sections of most larger creeks, particularly where lakes drain into streams. Of the 103 lakes and ponds surveyed in the upper basin during 1980, only 27 showed evidence of muskrat overwintering. The farther downstream from Devil Canyon one moves, the greater is the beaver and muskrat use of riparian habitats along the Susitna River. As the river becomes more braided the greater is the abundance of beavers.

In the upper basin, mink tracks were observed along all major tributary creeks below 1,200 m in elevation and near some streams and lakes. Tracks of river otters were sighted along the Susitna River, on tributary creeks to 1,200 m elevation, and around Stephan and other large lakes.

Coyotes occur in the study area, but their distribution is generally restricted to areas downstream from Devil Canyon. No coyotes or their tracks were observed by the furbearer team. Lynx occur in the study area but their distribution is very limited. Lynx tracks were only found near the mouth of Goose and Jay creeks and along portions of Goose Creek. The distribution of lynx was probably limited by, and restricted to, pockets of snowshoe hares. Short-tailed weasels are locally abundant in the study area. Observations also suggest that least weasels occur sparsely throughout the study area.

The two impoundments will eliminate a large amount of terrestrial furbearer habitat. The species that will be most severely impacted from this loss is the marten due to their high dependence upon forested habitats along the Susitna River and its tributaries. Flooding may also reduce the carrying capacity of the region for foxes. Flooding may eliminate the few lynx that are present along the Watana impoundment. Other project components will also reduce the habitat available to furbearers. Some species could be negatively impacted by improper disposal of garbage and illegal feeding by workers. Projected changes in the flow rates of the Susitna River downstream from the Devil Canyon impoundment could result in marked changes in aquatic furbearer habitat. Reduced circannual water level fluctuations could conceivably create a water flow regime more favorable to muskrats and beavers.

In general, little can be done to directly mitigate the habitat losses that will take place. Due to the nature of the vegetation communities that will be lost, there are no management options available to create suitable compensatory habitat. Some mitigation options such as restoration of temprary use areas and prevention of illegal feeding can be employed to avoid or minimize the negative consequences of these aspects of the project.

PROPOSED DEVELOPMENT

In the proposed plan for full basin development, two major reservoirs will be formed. The larger reservoir extends 48 miles upstream of the Watana site and has an average width of about one mile and a maximum width of 5 miles. The Watana reservoir has a surface area of 38,000 acres and a maximum depth of about 680 feet at normal operating level.

The Devil Canyon reservoir is about 26 miles long and one-half mile wide at its widest point. A surface area of 7,800 acres and a maximum depth of about 550 feet represent conditions at normal operating level.

Staged development is planned. An initial installation of 680 MW of capacity at Watana will be available to the system in 1993 and 340 MW will be added in 1994. If the mid-range forecast in growth in energy demand is realized, Devil Canyon will be completed by 2002 with an installed capacity of 600 MW.

The Watana dam will be an earthfill structure with a maximum height of 885 feet, a crest length of 4,100 feet, and a total volume of about 62,000,000 cubic yards. During construction, the river will be diverted through two concrete-lined diversion tunnels, each 38 feet in diameter, in the north bank of the river. Upstream and downstream cofferdams will protect the construction area. The power intake includes an approach channel in rock on the north bank. A multi-level, reinforced concrete, gated intake structure capable of operating over a full 140-foot drawdown range will be constructed.

The Devil Canyon dam will be a double-curved arch structure with a maximum height of about 645 feet and a crest elevation of 1463 feet. The crest will be a uniform 20-foot width and the maximum base width will be 90 feet. A rock-fill saddle dam on the south bank of the river will be constructed to a maximum height of about 245 feet above foundation level. The power intake on the north bank will include an approach channel in rock leading to a reinforced concrete gate structure which will accommodate a maximum drawdown of 55 feet. Flow construction will be diverted through a single 30-foot diameter concrete-lined pressure tunnel in the south bank. Cofferdams and the diversion tunnel provide protection during construction against floods.

About 2 1/2 years of average streamflow is required to fill the Watana reservoir. Filling will commence after dam construction proceeds to a point where impoundment concurrent with continued construction can be accommodated. Post-project flows will be lower in summer and higher in winter than current conditions. As one proceeds downstream of the project, differences between pre- and post-project flow conditions become less pronounced, as the entire upper basin contributes less than 20% of the total discharge into Cook Inlet.

The selected access plan consists of a road from a railhead at Gold Creek to Devil Canyon on the south side of the river. At Devil Canyon the road crosses the Susitna and proceeds east to the Watana site on the north side of the river. The plan also includes access by road connecting Gold Creek to the Parks Highway. Limited access between Gold Creek and the Watana site by way of a pioneer road will commence in mid-1983. Road access from the Parks Highway will be deferred until after award of a federal license for the project, and the pioneer road will be rendered impassable if the project does not proceed.

The selected transmission line route associated with the Susitna project roughly parallels, but is not adjacent to, the access route between Gold Creek and the Watana dam site. At Gold Creek, it connects into the Railbelt Intertie. Between Willow and Anchorage, the route extends in a southerly direction to a point west of Anchorage, where undersea cables will cross Knik Arm. Between Willow and Healy, the route would utilize the transmission corridor previously selected by the Power Authority for the Railbelt Intertie.

1 - INTRODUCTION

This report summarizes the progress made during Phase I investigations of furbearers.

Phase I studies were designed to determine probable impacts of the proposed Susitna Hydroelectric project upon the following species of furbearers: red fox, Vulpes fulva; coyote, Canis latrans; lynx, Lynx canadensis; mink, Mustela vison; pine marten, Martes americana; river otter, Lutra canadensis; short-tailed weasel, Mustela erminea; least weasel, Mustela nivalis; muskrat, Ondatra zibethica and beaver, Castor canadensis.

1.1 Objectives for Phase I

The specific objectives of Phase I studies were as follows:

(a) Determine general abundance of each species in the study area.

(b) Assess habitat preferences of each species.

(c) Analyze seasonal use of habitats and degree and type of utilization of habitats for each species.

(d) Project the probable impacts of the proposed development on each species.

- (i) Assess likely changes in habitats from the proposed action.
- (ii) Project changes in abundance of furbearers in response to habitat changes.
- (iii) Predict other, non-habitat related impacts upon furbearers.

1.2 Tasks performed during Phase I

(a) Reviewed literature.

(b) Familiarized the study team with the study area.

(c) Designed a sampling scheme for the impoundment zones, areas adjacent to the impoundments, and downstream areas.

(d) Conducted baseline surveys of furbearer populations and furbearer and habitat relations.

- (i) Generated information on activity patterns and home ranges of furbearers.
- (ii) Provided information on furbearer distribution and general movement patterns.

(iii) Determined seasonal use of habitats by furbearers.

(e) Consulted with residents, trappers, scientists, government officials and others who were knowledgeable of the Susitna area or similar areas, or knowledgeable in disciplines pertinent to our research.

(f) Developed close working relations with other teams conducting studies related to probable impacts of the hydroelectric project upon resources.

(g) Provided information as needed to aid in developing recommendations for mitigation and development proposals including alternative access routes, borrow sites and transmission line corridors.

(h) Participated in public meetings and provided information to the media as appropriate and as approved to inform the public about progress of the study.

2 - METHODS

The study area for this project was defined as the proposed impoundment zones, land and water areas within 12 kilometers (7.5 miles) of the impoundment zones and the downstream flood plain to Delta Islands (Figure 1). Aerial surveys of furbearers were conducted downstream to Cook Inlet.

2.1 Literature Review

Literature searches were conducted throughout Phase I studies. Computer bibliographic searches as well as manual searches of literature, indices and private reprint libraries were employed.

2.2 Personal Interviews and Special Site Surveys

Interviews were conducted with trappers, fur buyers, agency officials and residents of the upper Susitna basin to gather information on present and past furbearer population levels and harvests. Trappers in the area provided information on the trapping history of the area and supplied carcasses for studies of food habits and age structure. Emphasis was placed on verifying reports of furbearer den sites and reports of furbearers known to be uncommon in the area such as lynx and coyotes. Special surveys were conducted of areas where local concentrations of furbearers were suspected or where project construction activities such as borrow site excavation or access corridors could cause severe localized impacts.

2.3 Fox Den Surveys

Aerial surveys were conducted, primarily early in the study, to locate fox dens. Dens located were classified according to size and apparent or actual use. Orientation of the den, number of entrances and proximity to water were noted. Locations were recorded on USGS 1:63,360 scale maps.

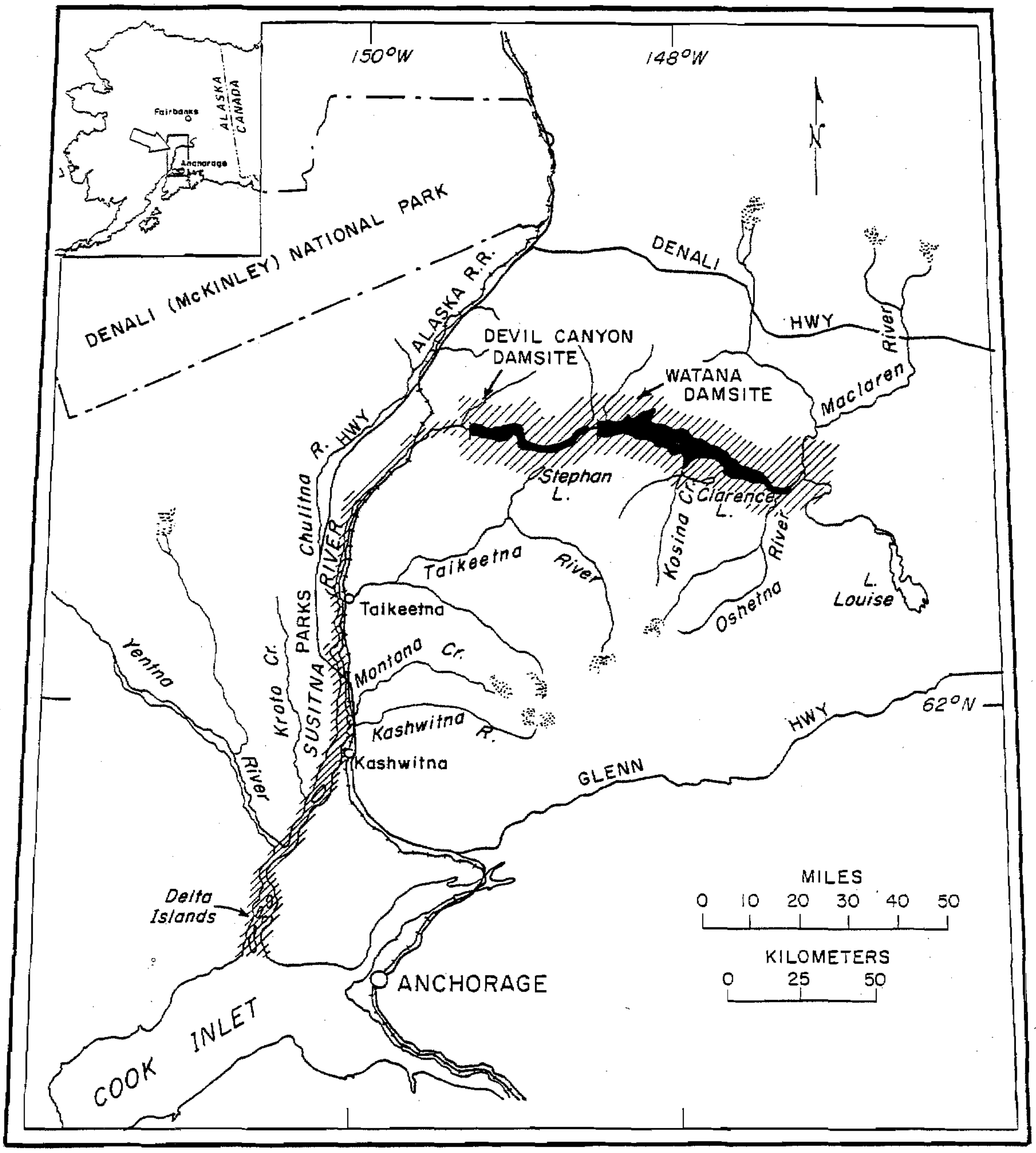

Figure 1. Susitna Hydroelectric Project with the furbearer study area indicated by hatching.

In addition, locations of fox dens reported by other TES and ACRES researchers were verified and plotted on maps.

Active and inactive dens, other than study dens, were surveyed periodically throughout the summer months for changes in activity patterns. Use patterns of dens in 1980 and 1981 were recorded. Dens were classified according to the type of use by foxes (Table 1).

2.4 Live Trapping and Radio-telemetry Studies of Foxes

Red foxes were trapped with #1 or #0 single long spring traps or #1 jump traps. A variety of sets were utilized, primary of which was an unbaited, unscented "blind" set. Captured foxes were anesthesized with 1/3 to 3/4 ml of hetamine hydrochloride, depending on size. Standard measurements were taken and each fox was fitted with a radio-transmitting collar of either Telonics or AVM manufacture and released. Five small pups were fitted with AVM expandable collars which allow for growth of the animals.

Radio-collared foxes were located from the ground using hand-held yagi antennas and from the air with a four-element yagi mounted on a Bell 206 Jet Ranger helicopter. Date, time, elevation, and vegetation type were recorded for each location. A Telonics TR-2 receiver with scanner was used in both instances. Radio-collared foxes were sighted in most cases.

Fox locations were plotted on 1:63,360 scale USGS maps. Minimum home range sizes were determined by connecting outer-most location points with straight lines. Area was then obtained with a compensating polar planimeter.

2.5 Tracking Foxes in Snow

Snow tracking was initiated in order to determine fox habitat relationships as well as the importance of snow cover characteristics in influencing fox movements and hunting activities.

Fox trails in the snow were followed in the winters of 1980-81 and 1981-82. When fresh snow was present, trails were followed on foot or from snowmachine or helicopter. When followed on foot or snow shoes, each fox trail was sampled every 150 paces for snow depth, snow hardness, vegetation, elevation, physiography, activity of the animal and proximity to water bodies. Other noteworthy activities of the animal were recorded, for example, kill sites or scent posts (Table 2 is a sample trail data sheet).

2.6 Fox Food Habits Studies

Food habits of red foxes were investigated by examining field sign at feeding sites, such as dens, by collecting scats at dens and along fox trails, by examination of food remains in stomachs of carcasses collected from trappers, and by correlating habitat preferences of small mammals with habitat utilized by foraging foxes. Scats collected were identified

TABLE 1. RED FOX DEN CLASSIFICATION SYSTEM.

Importance Ranking	Den Type	Description
1	Primary	Active or believed to have been active in 1979, 1980 or 1981. Natal den. Multiple burrow system. Believed to have traditional use. Large dirt mounds at burrow entrances and wear patterns. Five or more entrances.
2	Secondary	Not active in 1980 or 1981. Multiple burrow system. Large dirt mounds at entrances. Wear patterns but obscured to various degrees by recent vegetative recolonization. Probable natal den when in use. May be used as a resting site. Five or more entrances.
3	Primary Alternative	Found near primary or secondary sites. Signs of recent or present use. Two to five entrances usually. Probably occupied and used primarily by pups. First pup movements away from natal den are usually to these sites. Presence of digging activity.
4	Tertiary	Usually two to five entrances. Old food remains and/or scats present. Probably not used in recent years. May be used as a resting site.
5	Shelter	One burrow. Probably used for shelter only.

Table 2. Sample Fox Trail Data Sheet.

Name of Observer: W. Hobgood   Date: 10/11/80   Altitude: 3200 MSL   Sample Interval: 150 paces
Weather: Partly cloudy   T°: 20°F   Location: Swimming Bear Lake   Date of last snow: 10/11/80
Collared Fox? Yes ___ No X   Band ___ Channel ___

Sample Point	Snow Depth	Vegetation	Physiography	Within 50 Yds Prey Species?	Lake or Stream?	Activity	Comments
1	2.5"	Lake shore/bog	Lake shore rock morph	No	Edge of Lake	Wandering by edge of lake	
2 65p.	2.5"	" " "	" "	No	" " "	---	Scent post
3 150	2.5	" " "	" "	No	Lake within 100 yds	Walking	In areas of deep snow he avoided it by bounding from tussock to tussock
4 w/in 12p.	2.5"	" " "	" "	No	Lake within 100 yds	Investigating ground sq den	
5 150	2.5"	" " "	" "	No	Within 50 yds	Walking	---
6 150	2.5"	Mat cush exposed boulders/rocks	" "	No	Within 50 yds	Coming down hill along edges	Backtracking snow drift
7 w/in 38p.	2.5"	" " "	" "	No	Within 50 yds	Coming down hill along edges	Urine post
8 150	2.5"	Mat cush exposed field of boulders	" "	Yes	Within 75 yds	Coming down knob	Investigated squirrel hole at 144p.
9 150	Deep snow	" " "	" "	Yes	Within 100 yds	Hopping along in deep snow	---
10 150	Deep snow	Tussocks, some rocks	" "	Yes	125 yds away	Investigating grass clump	Tracks of ptarmigan within 20 yds
12 150	Deep snow	Mat cush and shrubs	" "	Yes	125 yds away	Running	Determined this fox observation Oct. 10 from helicopter

by day, month, year and location to allow for categorizing in order to detect possible monthly, seasonal, or location anomalies. For the most part, only fresh scats were collected.

2.7 Reactions of Foxes to Human Disturbances

The study team noted reactions of red foxes at dens to overflying aircraft and to the presence of people on the ground.

2.8 Live Trapping and Radio-telemetry Studies of Marten

Marten were trapped on an opportunistic basis using live box traps (models 203, 205 and 206) supplied by the Tomahawk Live Trap Company, Tomahawk, Wisconsin 54487. Traps were placed at irregular intervals at sites accessible on foot, by snow machine or helicopter. A variety of baits and lures were used, most commonly canned sardines and oil of anise or wintergreen. The floors of traps were covered with polyethylene padding to prevent fraying and loss of trapped animals' claws. In wet or windy weather traps were covered with various material to reduce heat loss of trapped animals. Traps were checked once per day (in morning) at air temperatures above 0°C. Between temperatures of -10°C and 0°C traps were checked twice daily (in morning and late evening) and traps were sprung when temperatures fell below -15°C. Captured animals were maneuvered into a wire holding cone and immobilized with a mixture of ketamine hydrochloride, xylazine and atropine sulfate. The animals were then measured, examined, weighed and affixed with radio collars (AVM Instrument Company, Advanced Telemetry Systems).

Radio locations of marten and mink were obtained by helicopter or from the ground as often as aircraft support and available manpower would permit. Due to the relatively short life of these small transmitters an intensive effort was made in the weeks following collaring to determine home range size and shape, habitat preferences, resting site locations and activity patterns. Radio-tracking was conducted using an AVM LA-12 and a Telonics TR-2 receiver, the latter equipped with a TS-1 scanner-programmer. Three- and four-element AVM yagi antennas were utilized for both aerial and ground locations. Radio locations were recorded on 1:24,000 or 1:63,360 maps. A location error of 200 m was considered acceptable for marten radio locations. For each marten radio location made, data on date, time, vegetation types, elevation and visual contacts were recorded.

Home range sizes were calculated using the minimum area polygon method and comparing paper range map weights with a paper weight standard. Seasonal ranges were determined for each animal for which a sufficient number of locations had been obtained.

A preliminary estimate of marten numbers in winter in areas that would be inundated by the Watana and Devil Canyon impoundments was made. The estimate was based on home range sizes we determined for adult males (0.147 per km^2), an assumed 100:100 sex ratio, and the assumption that 65% of the marten present are less than one year old (Archibald 1980).

The location of marten resting sites was accomplished by three different means: 1) radio-tracking collared animals to their resting sites; 2) searching red squirrel middens for marten scat accumulations; and 3) by tracking marten to resting sites in very fresh snow. For each resting site found, data recorded were date, time, location, resting site type (midden, nest, etc.), vegetation type, elevation, slope, aspect, number of marten scats found, and air temperature.

2.9 Activity Patterns of Marten

The activities of free-ranging marten were monitored using radio transmitter signals. Transmitters which were moving varied their signal strength erratically while stationary collars produced a signal of constant strength at the receiving antenna. For the purposes of activity pattern description, telemetry signals were received by a stationary yagi or whip antenna. Observers either listened to the signals and interpreted activity, or signals were recorded automatically on a chart recorder. Signals were sampled for 60 seconds out of fifteen minutes and were interpreted as either active, inactive or unknown (no signal). During activity monitor sessions, air temperature was recorded hourly. Activity data were grouped into one-hour segments and tabulated using the Statistical Package for the Social Sciences (SPSS) (Nie et al. 1975) crosstabs program.

2.10 Tracking Marten in Snow

Snow tracking of pine marten was undertaken to discern microhabitat preferences and to correlate specific activities with habitat types. Fresh marten trails were selected at random and followed. Sample points were placed at 90-meter intervals. At each sample point the data recorded were: snow depth, track depth, slope, aspect, vegetation type, track density in 3.2 m-diameter circle, activity, microvegetation type (3.2 m-diameter circle).

2.11 Marten Food Habits Studies

Food habits data for marten and other mustelids were gathered from scats and gastrointestinal tracts, the latter gathered from trapper-taken animals. A total of 608 mustelid scats and digestive tracts were collected and dried.

2.12 Muskrat and Beaver Surveys Upstream from Gold Creek

In spring 1980, just prior to break-up, a survey of lakes and ponds in the study area was conducted to determine the presence and relative numbers of muskrats and beavers during the previous winter. Aerial searches for muskrat push-ups and beaver sign were conducted on three dates in spring 1980. An initial survey was made on 10 March. Forty-five lakes and ponds were surveyed on this date, requiring 6.0 hours of flying time in a Bell 206 helicopter. The snow cover on many lakes was still too deep to permit positive identification of muskrat push-ups. A second attempt was made on 24 April, however, deep snow was still present on some lakes. A third attempt was made on 9 May. On this date the weather was clear and the melt of snow and ice had progressed to a point that permitted optimum sightings of push-ups. Ninety-seven lakes were surveyed in 6.9 hours. Lakes surveyed were below 850 meters (2800 feet) in elevation and they were either within the proposed impoundment zones or 4.8 km (3 miles) thereof. Lakes within 4.8 km (3 miles) of the Susitna River were surveyed as far downstream as Gold Creek.

Aerial surveys of muskrat and beaver sign were flown throughout the upper basin during July 1981.

2.13 Aerial Transects

A system of snow transects was developed to provide a broad overview of furbearer distribution and habitat preference. The transects are 9.6 km (6 miles) long and perpendicular to the river (Figure 2). The transects extend 4.8 km (3 miles) south and 4.8 km (3 miles) north of the Susitna River. Fourteen transects at intervals of 9.6 km (6 miles) from Portage Creek to the Tyone River were surveyed (Figure 2).

To survey the transects, a helicopter carrying two observers and a person to record observations is flown along the transect at 24-32 kmph (15-20 mph) at treetop level or the lowest possible altitude, generally 10-20 m (30-60 feet). Tracks of furbearers are observed and counted as crossed along the flight path. The following are recorded each time the trail of a furbearer is crossed: the species of the furbearer, the vegetation type and the 100 foot elevation contour in which the trail was found. To determine accuracy of track identification, ground truth checks were conducted on three transects. Team members walked along transects shortly after the transects were run by helicopter. Data recorded were the same as those recorded from aircraft.

2.14 Furbearer Surveys Downstream from Devil Canyon

Furbearer sign and habitat use preferences were inventoried along the Susitna River from riverboat, during August 1980 from 3 km (1.9 miles) above the confluence with the Indian River to 4 km (2.5 miles) below the confluence with the Kashwitna River (Figure 1). This survey included portions of three major river sections below Devil Canyon, including:

(a) Section I. - Devil Canyon to confluence with Talkeetna and Chulitna Rivers. Characterized by rapid flow, usually single channel, narrow floodplain with occasional islands covered by stands of mature forests.

(b) Section II. - Confluence with Talkeetna and Chulitna Rivers to confluence with Montana Creek. Characterized by meandering channels, broad floodplain with forested shores and islands.

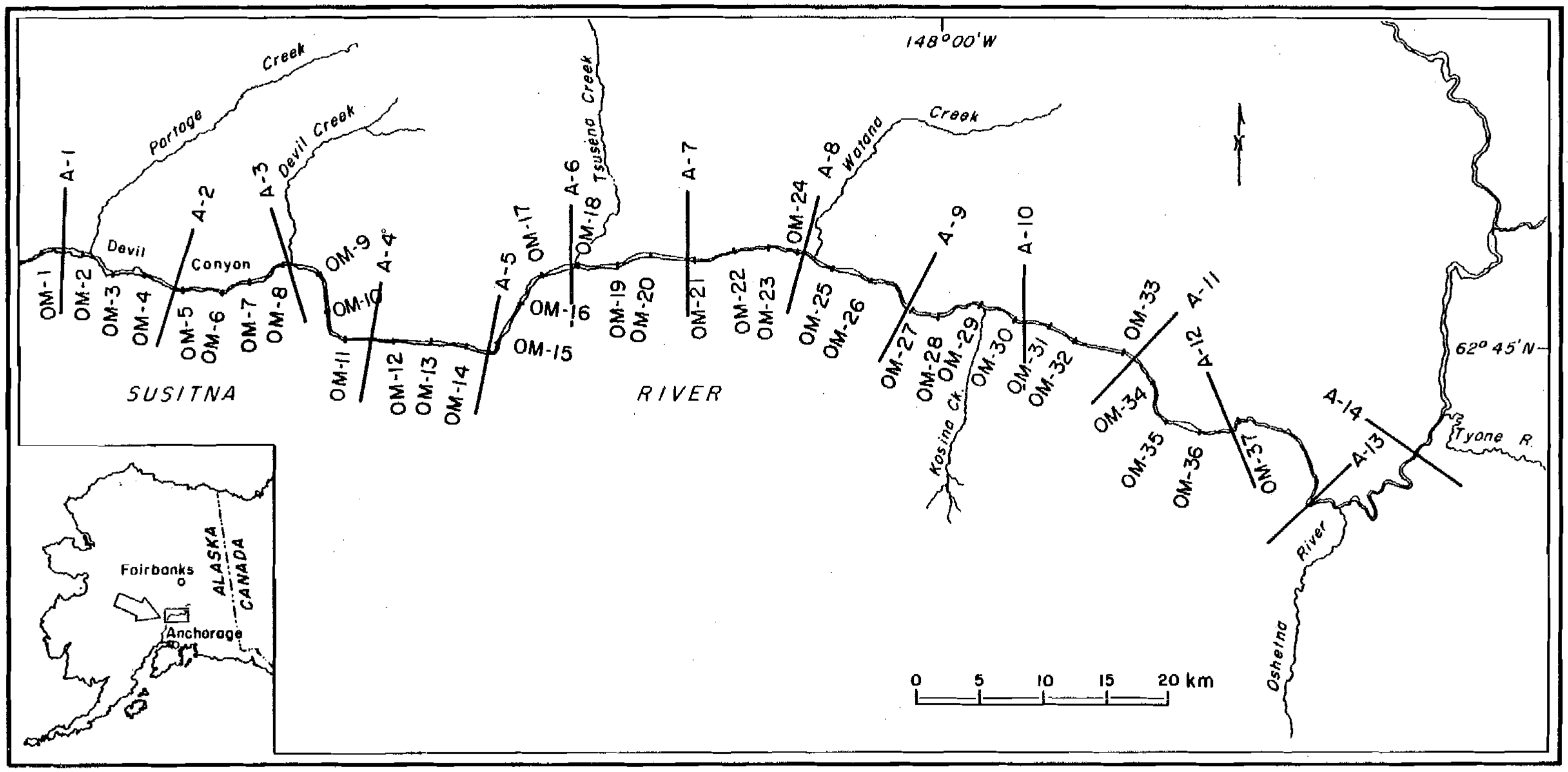

Figure 2. Location of aerial transects for furbearers (A) and checkpoints for signs of otter and mink (OM).

(c) Section III. - Confluence with Montana Creek to Cook Inlet. Characterized by broad meandering and braided channels, numerous sloughs and oxbow lakes, broad floodplain with heavily forested shores, islands and tributary deltas.

The above sections of the Susitna River were also surveyed from fixed-wing aircraft during July 1981.

3 - RESULTS AND DISCUSSION OF BASELINE STUDY

3.1 Literature Review

Over 350 references relating to furbearers and hydroelectric development have been collected and reviewed. Only a small portion of this literature treats impact assessment in northern regions. A symposium in Ottawa, Ontario on 7 and 8 January 1974, reviewed major hydroelectric projects in Canada and the impact assessments made for these projects. Proceedings of this symposium were published in the Journal of Fishery Research Board of Canada, Volume 32, number 1. Baxter and Glaude (1980) also reviewed environmental effects of dams and impoundments in Canada. Probably the most extensive study of impacts of a proposed hydroelectric project in Alaska was directed at the Rampart Canyon Dam on the Yukon River (Spurr 1966, Leopold 1966). Recently the Arctic Environmental Information and Data Center (1980) reported their assessment of probable environmental effects of constructing and operating the Terror Lake hydroelectric facility on Kodiak Island. A team working with Konkel (1980) modified a widely used terrestrial habitat evaluation system for Alaska and developed a handbook to be used in assessing the importance of habitats for some Alaskan wildlife species.

Published accounts treating the life requisites of furbearers in Alaska and probable effects of environmental alterations upon furbearers are reviewed in the discussion sections of this report treating particular furbearers.

3.2 Fox Dens

Nineteen fox dens were located and six of these were active during summer 1981 (Figure 3). Sixteen dens were located north of the Susitna River. Several dens were concentrated in the Upper Watana Creek and upper Deadman Creek drainages. There are probably more dens south of the Susitna River than we located, however, extensive searches were conducted and no other dens were found. The Stephan Lake - Prairie Creek area appears to be particularly well suited for red fox dens. Aspect, physiography and vegetation are more favorable for denning and hunting on the north side of the river. Fox dens were classified according to size (number of entrances) and apparent or actual use. This classification system and description is presented as Table 1. Fox dens located during this study and their classification are presented in Figure 3.

Den sites discovered in the Susitna area are characterized by south-facing slopes, sandy soil, offering a good view of the surrounding area and by being near water, in most cases adjacent to a lake. Dens of red foxes typically occur between 1000 m and 1200 m elevation in areas of rolling hills adjacent to mountains. A lake covering four ha or more or a creek is usually located nearby. Stanley (1963) discussed the presence of water as a governing factor in den selection. All active dens located were in or near areas of medium to high ground squirrel density. Vegetation surrounding den sites includes alpine tundra (Dryas-lichen), shrub tundra (medium and low shrub with tussocks, spagnum dwarf birch, low willow and ericaceous shrub-sedge) and mat and cushion tundra (Dryas-sedge, willow and ericaceous shrubs).

Murie (1944) reported that:

> "Red fox dens in McKinley Park were in the open and in the woods, on sunny knolls far up the slopes, and on the flats. Most of them were dug in sandy loam..."

His findings are similar to ours except that ground and air searches have thus far failed to produce fox dens in the woods. Allison (1971) working in Mt. McKinley National Park recorded dens in habitats similar to the dens we observed. Allison made no mention of woody plants near dens over 1.2 m in height, except alder. Steve Buskirk (pers. comm.), a Park Ranger for several years in McKinley National Park, stated that some fox dens did occur in the woods in the Park.

Dens of red foxes usually have a complex of burrow entrances which are predominantly oriented to the south but some entrances face west. The number of entrances present per den ranged from three to 27. Murie (1944) found typical red fox dens in Alaska to have six to 19 entrances. Dens are found on prominences up to 5 m higher than the surrounding area which offer a good view of the surrounding area. The soil type is usually silt and relatively rock-free. One alternative den is generally located within 200 meters of the main den.

Fox pups remained at den sites into October on our study site. Present information indicates that foxes in the study area utilized den sites much later than in other areas of Alaska. The latest data reported for foxes at dens in Alaska are August 11 (Magoun, pers. comm.). Allison (1971) reported that fox families vacated dens by mid-August in Mt. McKinley National Park. Storm (1972) reported fox families utilized den sites until late July in the midwest. Storm (1972) found that foxes in Iowa and Illinois remained together as a family unit into October. Sheldon (1950) observed that some fox families stayed together until September and that the latest data of an occupied den were recorded on July 10, 1947. Sheldon's study area was in central New York. Our findings in the Susitna area suggest that a period of roughly one month may pass between abandonment of the den site and dispersal of young. A period of about three months passed between abandonment of the den site and dispersal in Storms' (1972) study area in Iowa and Illinois.

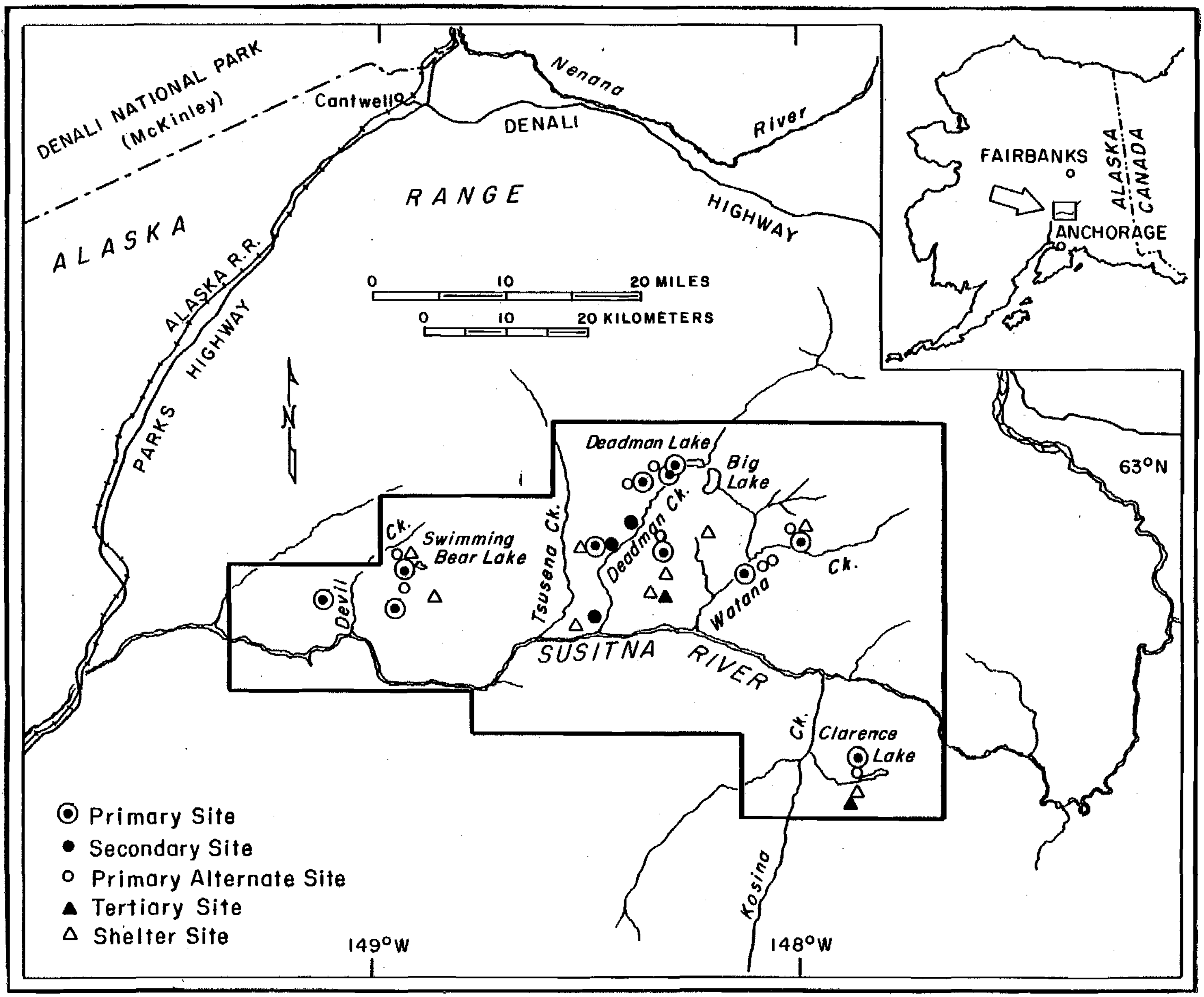

Figure 3. Location and classification of fox dens. Primary study area is denoted by heavy black line.

TABLE 3. BACKGROUND FOR CAPTURED FOXES.

Fox identification number	Date Captured	Location Captured	Sex	Age	Total length	Weight
4567	8/10/80	Swimming Bear Lake	F	Juvenile	88.0	3.1
4615	8/10/80	Swimming Bear Lake	M	Juvenile	89.0	3.3
4667	8/10/80	Swimming Bear Lake	M	Juvenile	42.0	3.5
4XXX	9/2/80	High Lake	-	Adult	-	6.4
4590	9/4/80	High Lake	M	Juvenile	105.0	4.3
4641	11/10/80	Watana	F	Juvenile?	101.0	5.0
4021	4/1/81	Watana	F	Adult	99.1	4.4
4130	4/4/81	Watana	M	Adult	110.5	5.6
4040	5/2/81	Clarence L.	M	Adult	114.3	6.0
4280	6/12/81	Swimming Bear Lake	M	Adult	120.6	6.4
4181	6/13/81	Swimming Bear Lake	F	Adult	98.7	4.6
4060	6/15/81	E. Fork Watana	F	Adult	81.9	4.4
4545	7/15/81	E. Fork Watana	M	Juvenile	8.4	2.7
4221	7/17/81	Deadman L.	M	Adult	113.7	5.9
4493	7/17/81	Deadman L.	F	Juvenile	88.9	2.9
4442	7/17/81	Deadman L.	M	Juvenile	89.5	3.1
4515	7/17/81	Deadman L.	M	Juvenile	86.4	3.3
4641	8/5/81	Swimming Bear Lake	M	Juvenile	87.9	2.9
4471	8/5/81	Swimming Bear Lake	F	Juvenile	81.6	2.9
4132	8/6/81	Swimming Bear Lake	M	Juvenile	85.0	2.9
4100	8/6/81	Deadman Cr.	F	Juvenile	89.5	3.0
4080	8/6/81	Deadman Cr.	M	Juvenile	91.4	2.9

Allison (1971) noted that :

> "...red foxes use homesites only during the small part of each year when the young are being raised".

This is not the case in our study areas where fox tracks were often seen during the winter at or near den sites. In most cases, at least one entrance was kept clear of snow and showed evidence of being entered by a fox throughout the winter.

3.3 Radio-telemetry Studies of Foxes

1980

Five foxes were fitted with radio collars (Table 3): three juveniles from the Swimming Bear Lake site, one juvenile from the High Lake site, and one adult-sized fox from Watana Creek.

Two juveniles dispersed from the Swimming Bear Lake site during the period 20, 21, 22 September 1980. One juvenile established a territory in the vicinity of its den. Another established a territory in an adjacent drainage 2.4 km (1.5 mi.) north of its den. A cross-color phase juvenile dispersed out of the area. He was last seen at 1:40 p.m., 22 September 1980, about 2.4 km (1.5 mi.) southeast of the den site.

In 1980, the Swimming Bear Lake area was occupied by a red female adult and three juveniles, two of which were the red color phase and one a cross-color phase. When the den was initially discovered in late July, an adult cross fox was observed on two occasions at the den site. This fox was believed to be the adult male.

An active den site 2.4 km (1.5 mi.) north of High Lake was discovered in early September 1980 (Figure 3). On 2 September 1980, at least three separate foxes were seen at the den: one red, one light red, and one cross. At 9:30 p.m., 2 September 1980, a red adult was captured (fox No. 4XXX). It weighed 6.4 kg (14 lbs.) and escaped while being measured. This appeared to be an adult female. Juveniles and adults were difficult to distinguish due to the large size of the juveniles. It also seems likely that there were at least two foxes at this site which had almost identical coloration. Based on observations at that time, it appeared that one red female and three juveniles (one red, one light red, and one cross) were occupying the den.

On 4 September 1980 a cross juvenile weighing 4.3 kg (9.5 lbs.) was captured about 1.6 km (1 mi.) east of the den. This animal had lost its milk canines and the carnassials were erupting. No new tracks or activity at the den were observed on 3 September or 4 September 1980 and when no fox signs were observed after subsequent visits to the site, it was assumed that the den had been vacated. Sheldon (1950) suggested that dens are abandoned about the time the pups lose their lacteal dentition.

1981

Seventeen foxes, seven adults and 10 juveniles were captured in the study area and radio-collared in 1981. Four of the adults were males and three were females. Of the pups captured and collared, seven were males and three were females. Standard measurements, capture dates and locations and background data are presented in Table 3.

Collared foxes were located as often as possible from the day of capture to late November when aircraft support became unavailable. Activity patterns of adults and juveniles at den sites were monitored in late July, August, September, and October 1981.

Radio locations of 16 foxes collared in 1981 are shown in Figures 4-9. Denning activities and birth of foxes occurred in May. Use areas of juveniles, with the den site as its center, increased from mid-June, when they appeared above the surface of the den, until late October when dispersal took place. All juveniles collared are thought to have dispersed completely out of the area. Searches up to 80 km (50 mi.) away from den sites in late November failed to locate any subadults that had dispersed.

Two subadults, #4545 male and #4080 male, were tracked 37 km (23 mi.) and 64 km (40 mi.) respectively as they were dispersing (Figure 9). Subadults, for the purpose of this study, are defined as foxes less than one year old which have abandoned the natal den. Contact with these two animals was lost shortly after 24 October 1981 and it is assumed that they dispersed even farther. Most of the subadults were located up to 10 km from their natal dens when dispersing. In one case, a subadult (#4492) dispersed about 10 km (6.4 mi) and then returned to the den area before dispersing completely out of the area a few days later (Figure 6).

On 14 January 1982, a trapper reported catching a radio-collared fox 12.8 km (8 mi.) west of Chelatna Lake which lies between the headwaters of the Kahiltna and the Yentna Rivers, about 32 km west of Petersville and the Kahiltna glacier region. This fox was #4641, a subadult male from the Swimming Bear Lake den. He was captured about 173 km (108 mi.) southwest of his natal den.

Subadults #4545 and #4080 dispersed across the Susitna River at a time when freeze-up was in progress and the river was running approximately 50% slush ice. Although #4641 did not necessarily have to cross the Susitna in order to reach the area where he was killed, he had to cross the Parks Highway, the Chulitna River and many smaller rivers and creeks. Storm (1972) felt that large rivers were a barrier to dispersing foxes. The Susitna River does not appear to be a barrier to dispersing foxes. However, an impoundment might very well be a barrier and might funnel dispersing foxes along its shores to the east (Tyone region) and to the west (Talkeetna area).

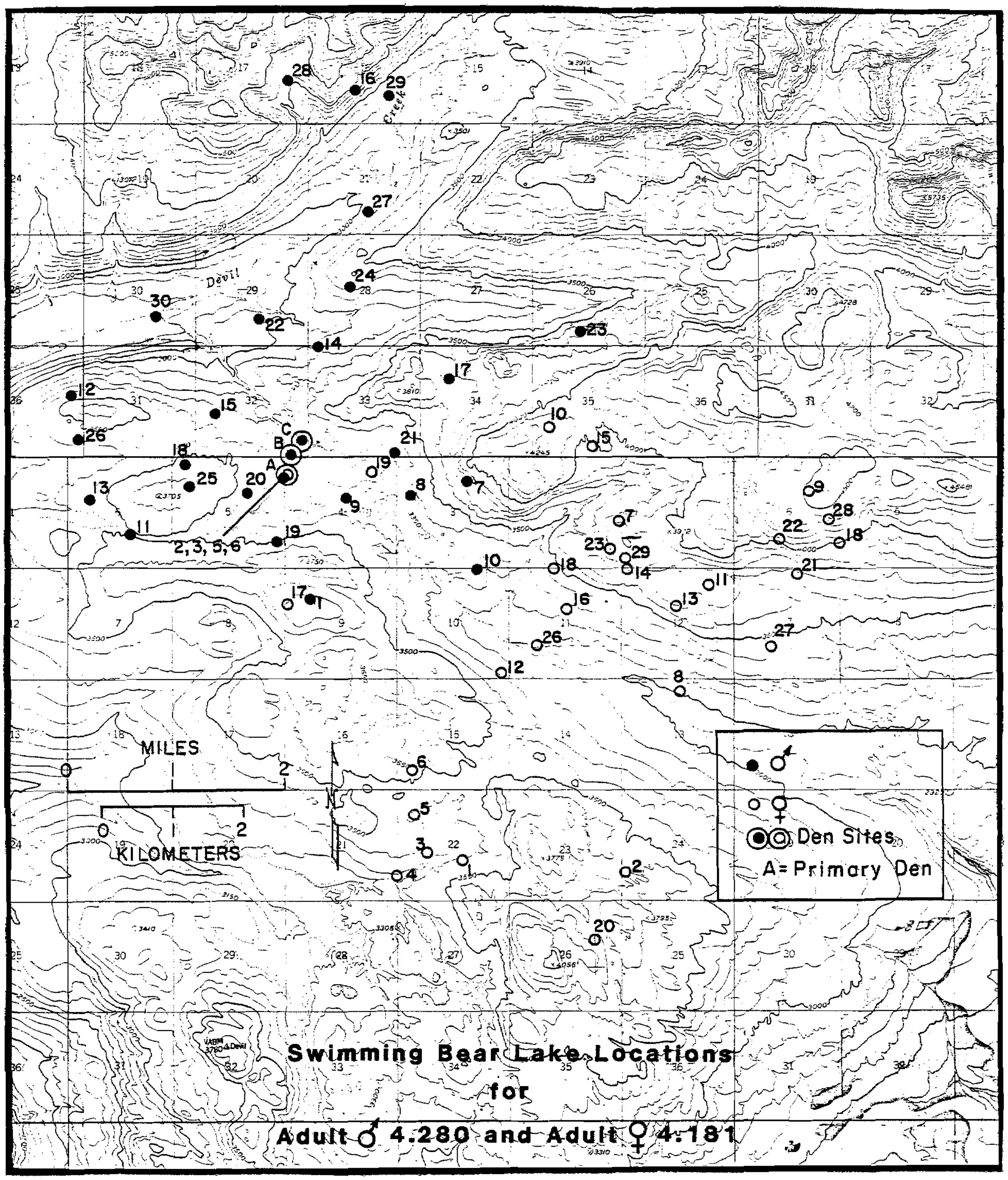

Figure 4. Radio locations of foxes captured at the Swimming Bear Lake den, 1981. Location dates corresponding with numbered locations appear in Appendix I. Locations are numbered chronologically.

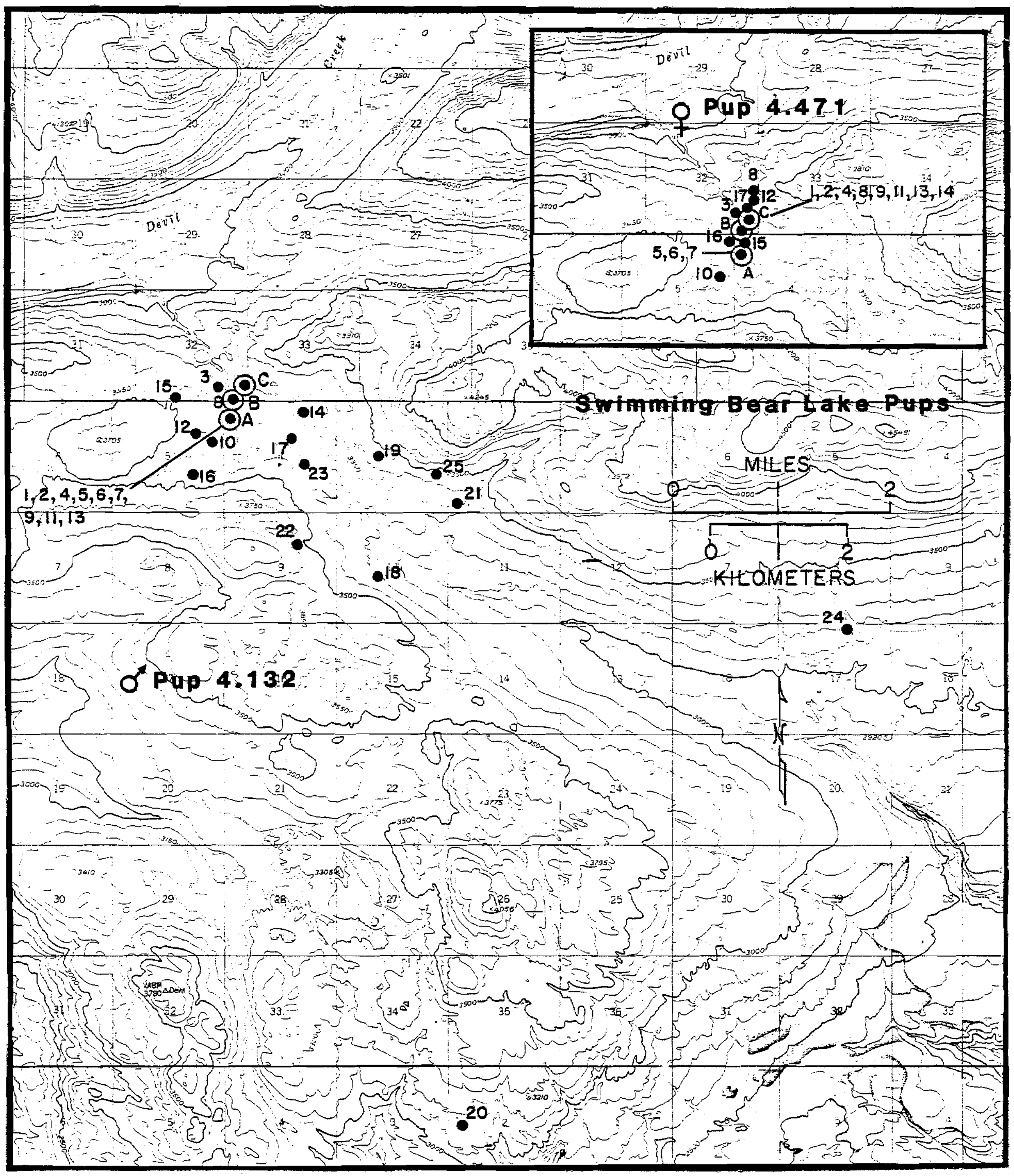

Figure 4. Continued.

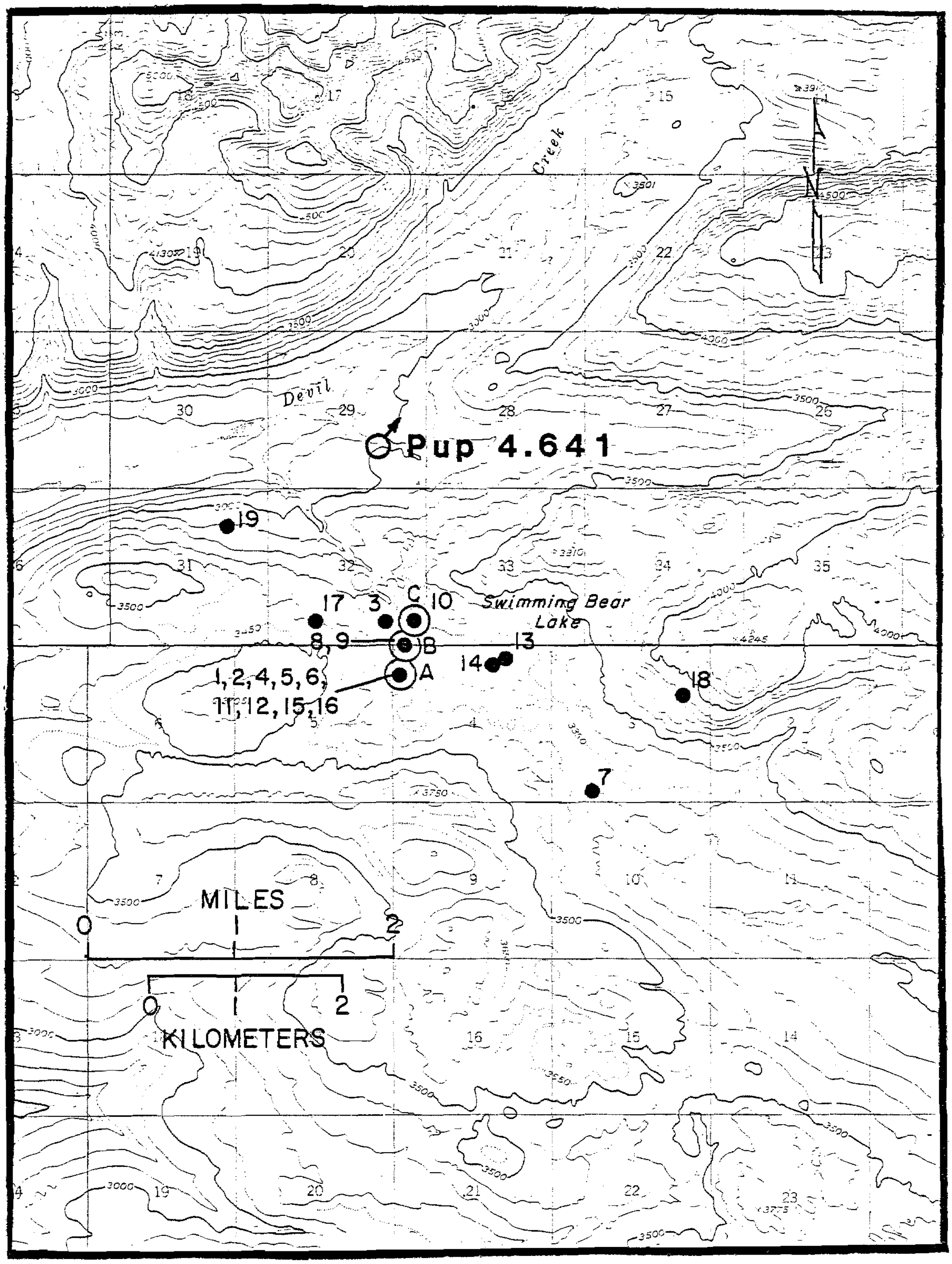

Figure 4. Continued.

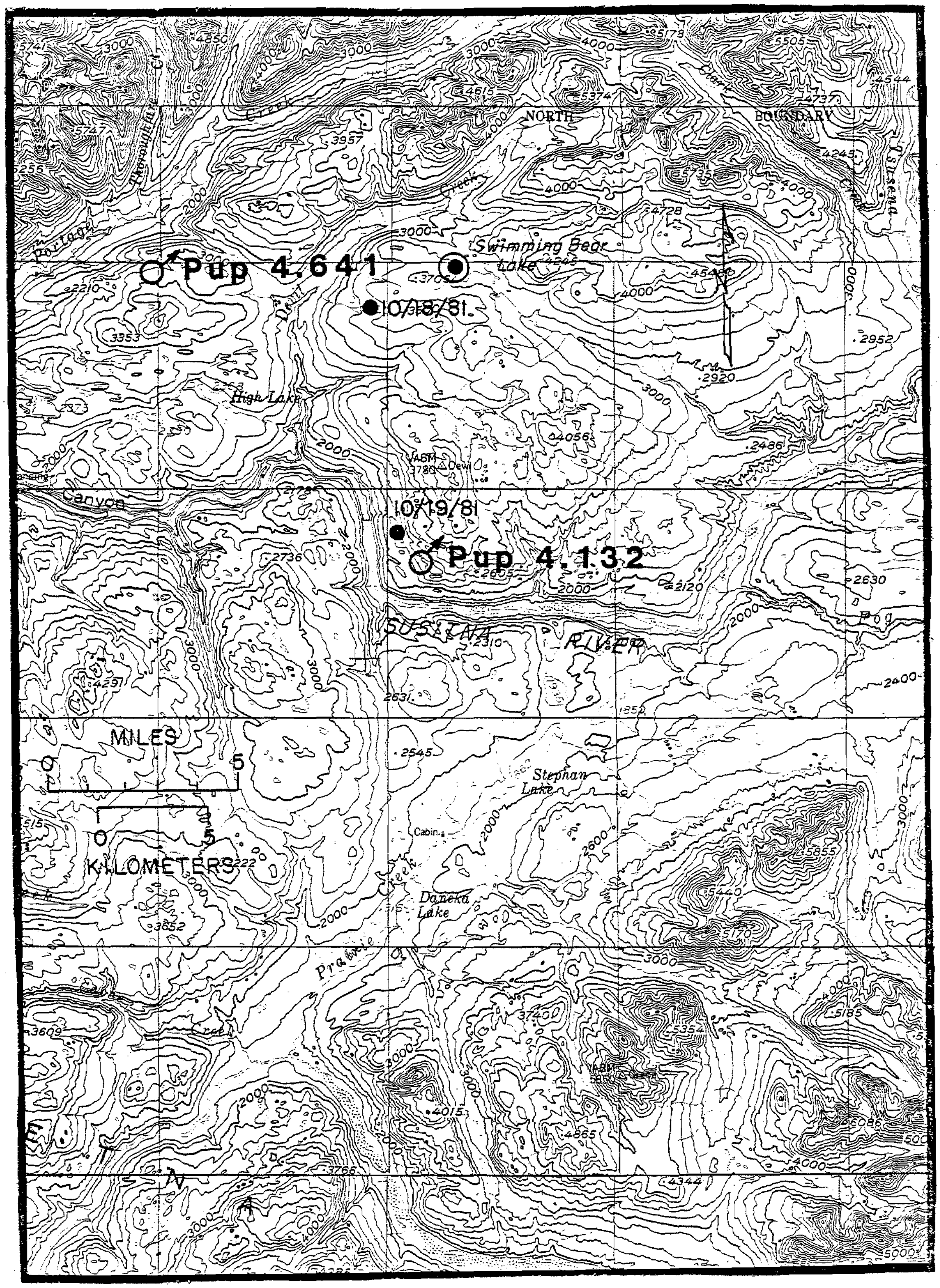

Figure 4. Continued.

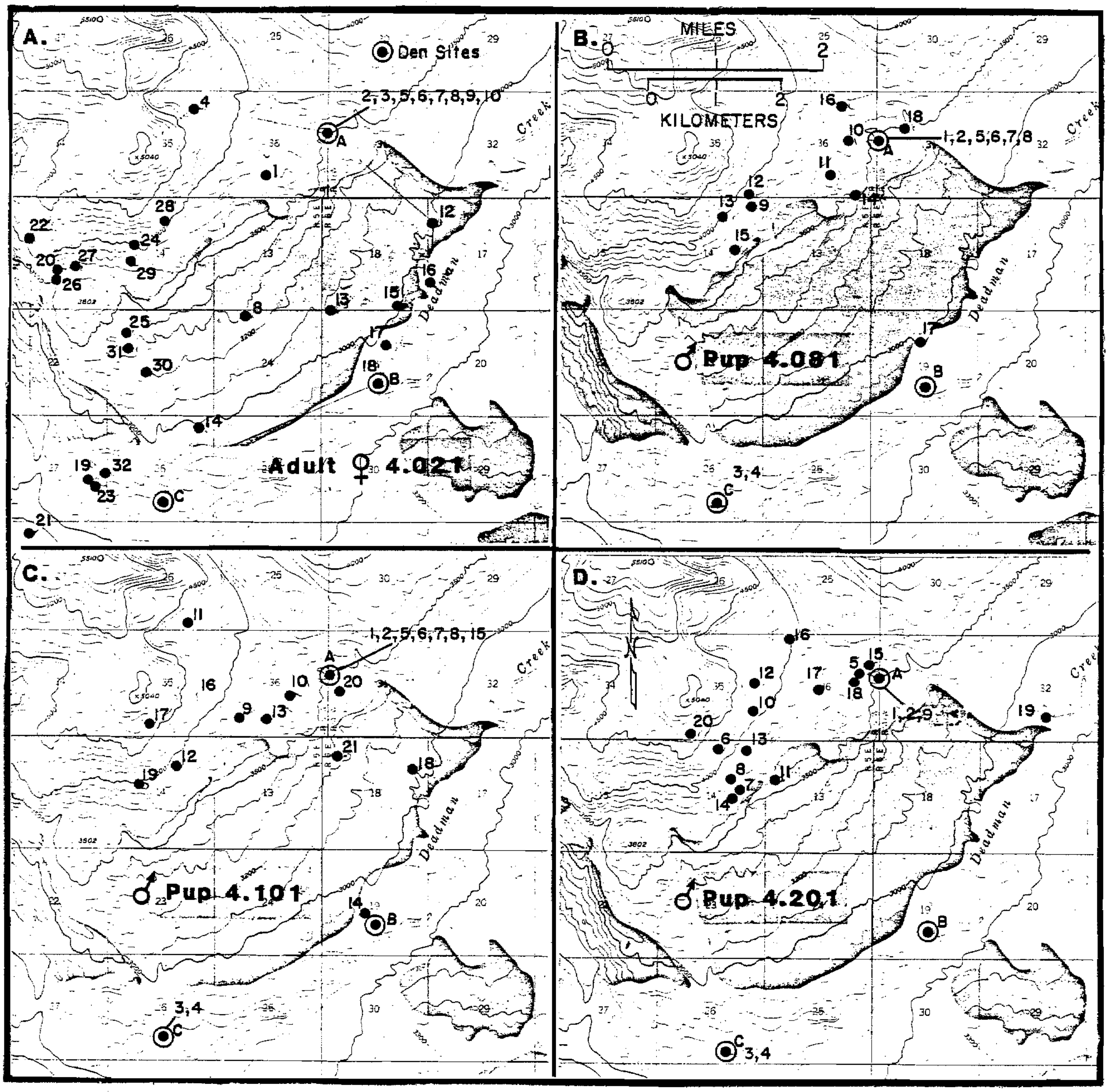

Figure 5. Radio locations of foxes captured at the Deadman Creek den, 1981. Location dates corresponding with numbered locations appear in Appendix I. Locations are numbered chronologically.

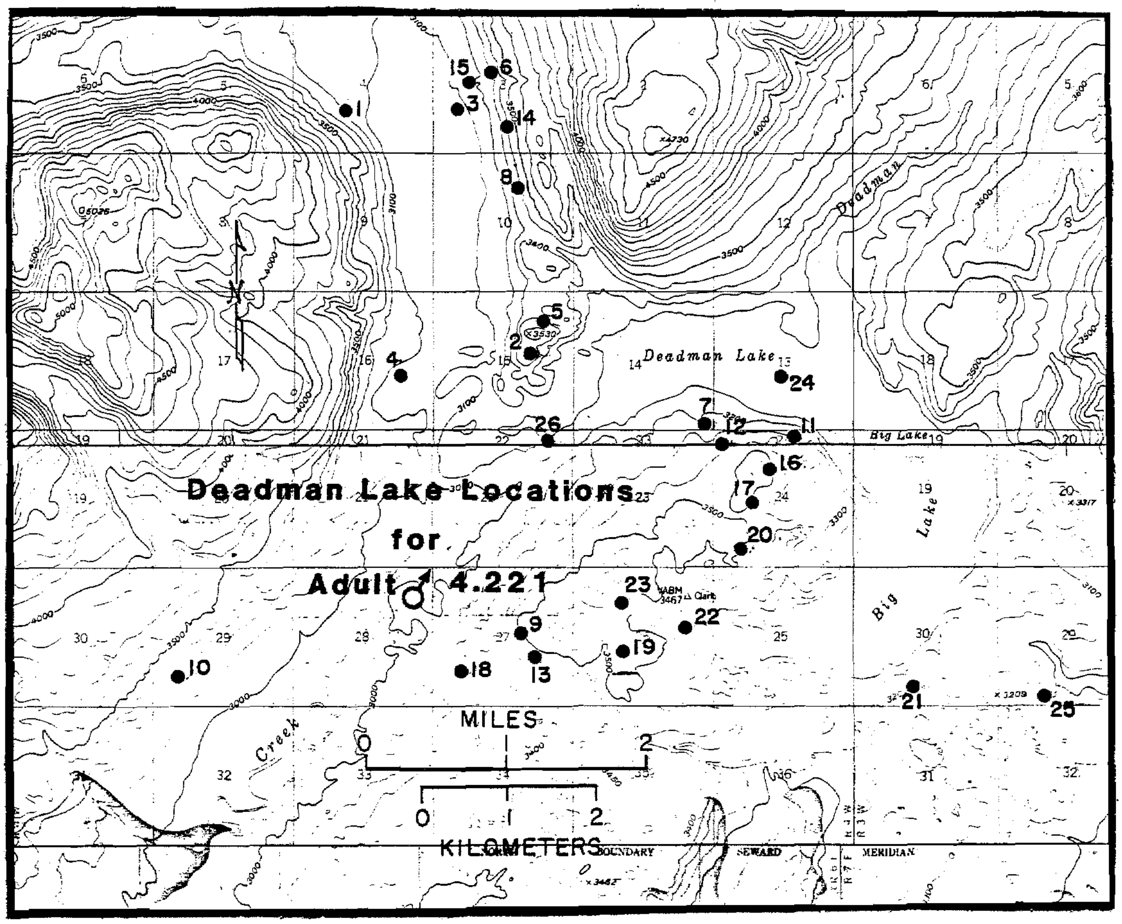

Figure 6. Radio locations of foxes captured at the Deadman Lake den, 1981. Location dates corresponding with numbered locations appear in Appendix I. Locations are numbered chronologically.

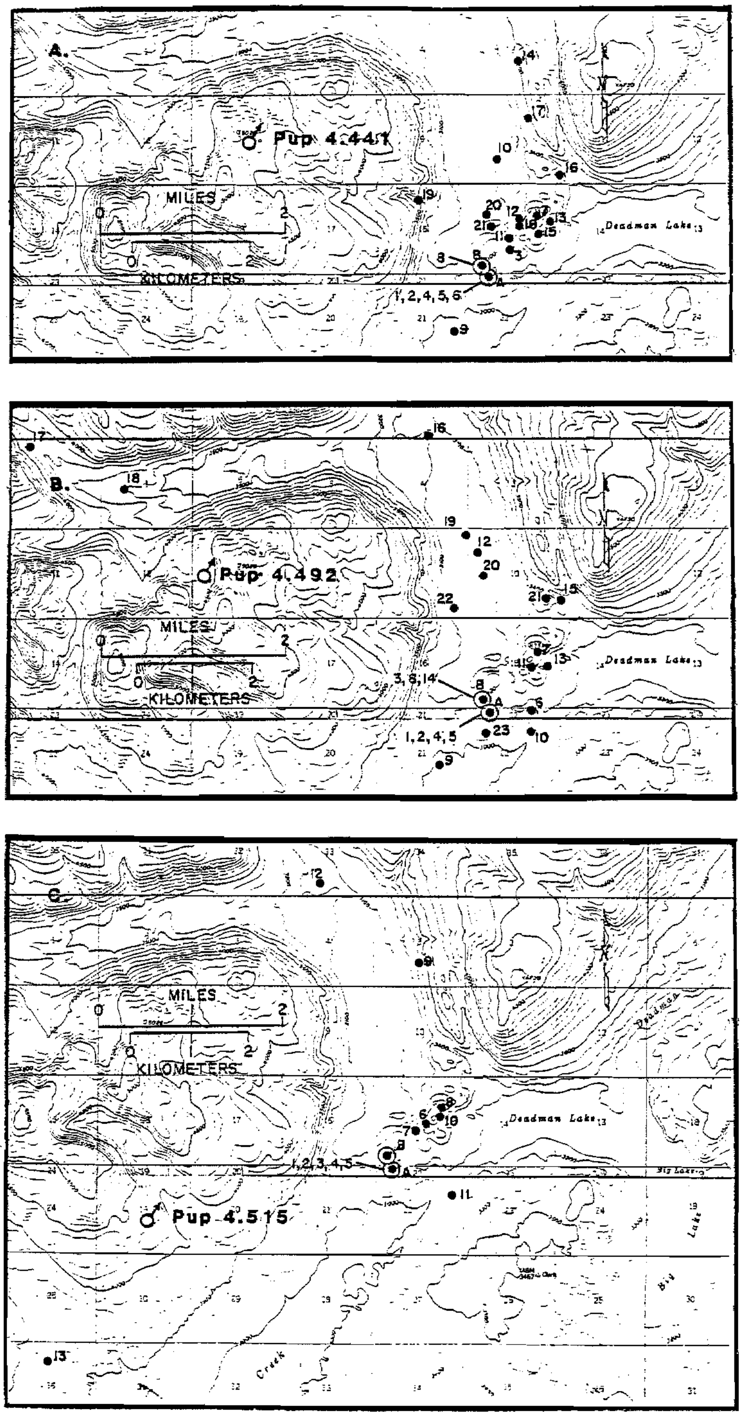

Figure 6. Continued.

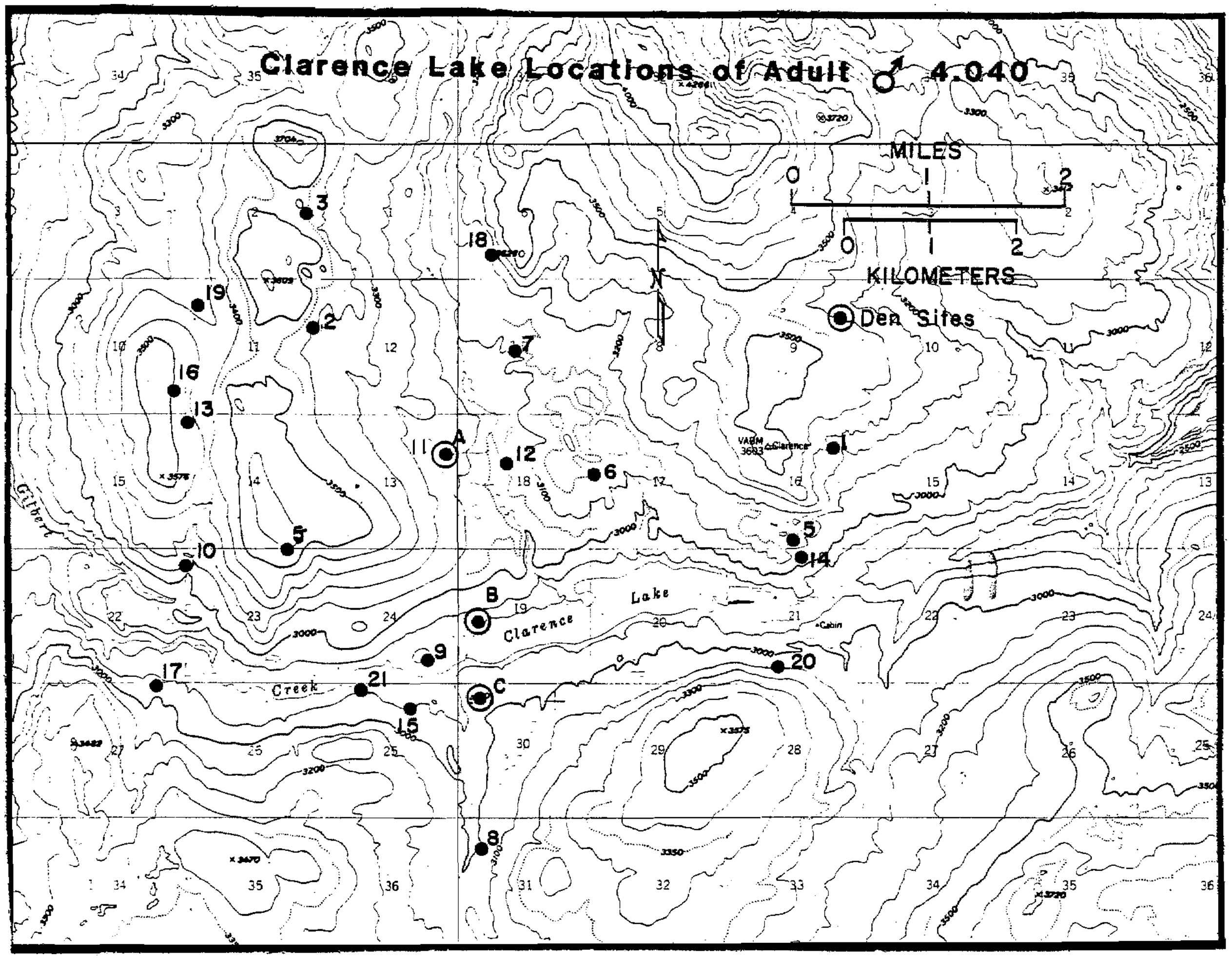

Figure 7. Radio locations of adult male fox captured at the Clarence Lake den, 1981. Location dates corresponding with numbered locations appear in Appendix I. Locations are numbered chronologically.

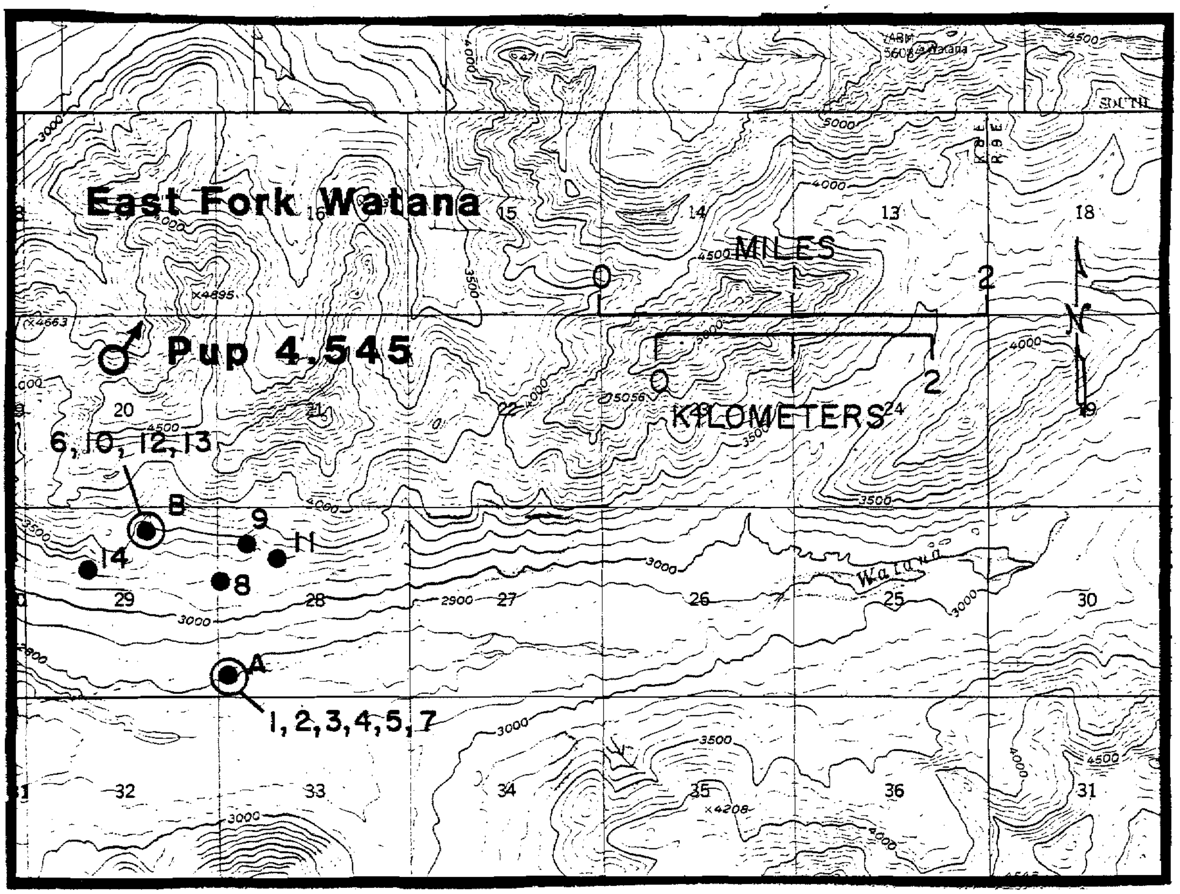

Figure 8. Radio locations of foxes captured at the East Fork Watana Creek den, 1981. Location dates corresponding with numbered locations appear in Appendix I. Locations are numbered chronologically.

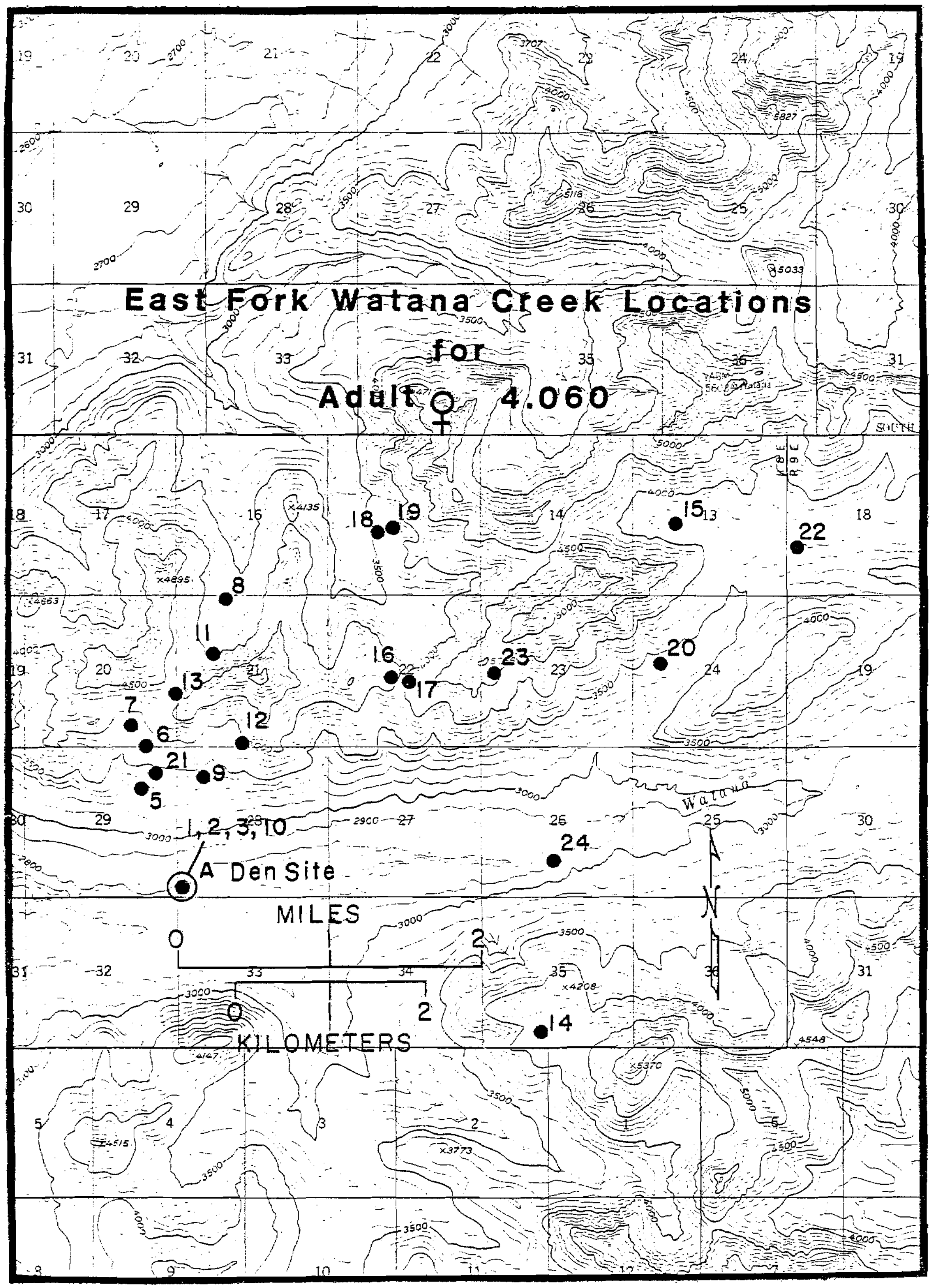

Figure 8. Continued.

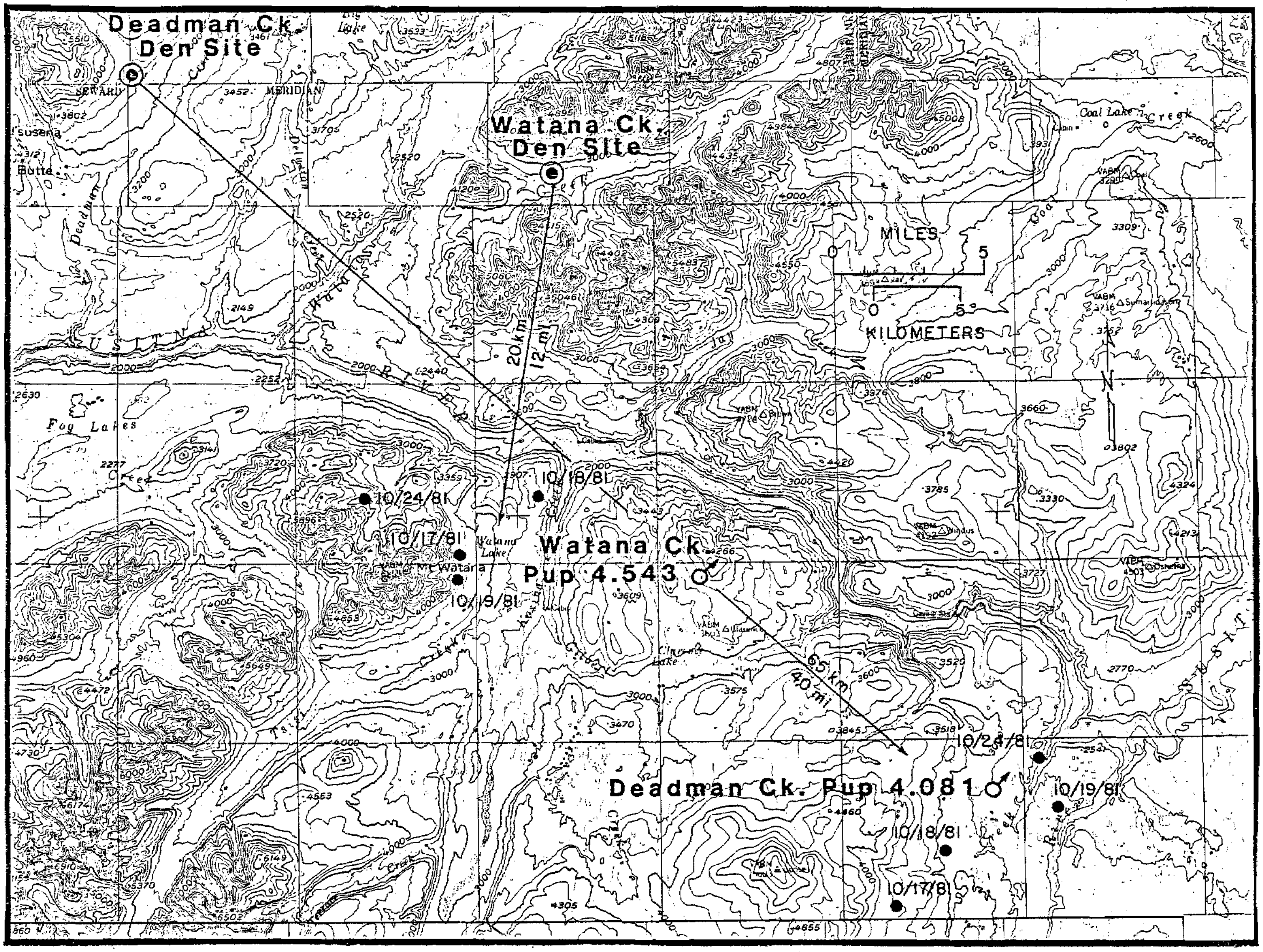

Figure 9. Dispersal of two young foxes and locations of their natal dens, 1981.

The trapper who captured fox #4641, stated that he had seen no foxes in that area in 20 years until this year (1981-82 season) when two had been caught. He attributed the presence of foxes to hard snow conditions and an unusual number of ptarmigan in the area.

Home ranges for six foxes captured in 1981 and home range found in other studies and other states are presented in Tables 4 and 5. Summer home ranges varied from 18.3 to 32.7 km^2 in the Susitna study area and there appeared to be little difference in the overall summer home ranges of males and females. Data in Tables 4 and 5 show ranges found for Susitna foxes are generally three or four times larger than ranges determined for foxes in other areas. The availability of high numbers of small mammals and nesting birds in the midwest may account for higher densities of red foxes in that region compared with the upper Susitna Basin.

3.4 Fox Habitat Relationships

Fox trails in snow were followed in early and late winter 1980 and 1981. Trail sampling was hampered by lack of snow, crusted snow, and blowing snow. Trails were sampled only after fresh snow had fallen in the study area. Approximately 40 km of fox trails were sampled. Vegetation type at each sample point was recorded. Results of the vegetation and fox trail associations are presented in Table 6. These data suggest foxes may prefer mat-cushion tundra, low shrub, alpine tundra, medium shrub, and woodland black spruce.

The vegetation types in which fox tracks were encountered during aerial transect surveys in autumn 1980 are presented on Table 7 . Table 7 shows fifty percent of all fox tracks were found in medium shrub vegetation. In addition, 28.6% of fox tracks were located in woodland black spruce and a scattering of tracks were observed in a variety of other vegetation types. It should be noted that the aerial transects only extended 4.8 km (3 mi.) either side of the river and therefore did not always extend into tundra areas that were generally preferred over the river valley by foxes.

Table 8 summarizes the radio locations of foxes according to the type of vegetation in which they occurred. Radio-collared foxes were most often found on rock, medium shrub, alpine tundra and mat-cushion tundra.

Red foxes were found from 516 m. (1600 ft.) to 1129 m. (3500 ft.) mean sea level. Eighty percent of ail fox tracks recorded were located between 710 m. (2200 ft.) and 1000 m. (3100 ft.) elevation (Table 9). Transect data demonstrate a marked increase in numbers of fox tracks encountered as one progressed upstream from Devil Canyon to the Tyone River. Table 9 shows that almost twice as many (151 tracks vs. 79 tracks) tracks were located on the south side of the Susitna River when compared to the north side. However, transects 1 through 11 had almost even numbers of tracks north and south of the river (67 on the north side vs. 51 on the south side). All of the north side - south side discrepancy is accounted for in transects 12 through 14.

TABLE 4. HOME RANGES OF ADULT RED FOXES IN THE SUSITNA STUDY AREA.

FOX (sex)	HOME RANGE (km^2)
#4021 (female)	26.6
#4040 (male)	32.7
#4280 (male)	28.1
#4181 (female)	31.2
#4221 (male)	19.8
#4060 (female)	18.3
Averages	26.1, males and females
	26.9, males
	25.4, females

TABLE 5. HOME RANGES OF RED FOXES STUDIED IN OTHER STATES.

STATE	HOME RANGE (km^2)	REFERENCE
Illinois	9.7	Storm (1972)[a]
Michigan	4.9	Murie (1936)[b]
Iowa	3.1	Scott (1943)[c]
Michigan	2.8	Schofield (1960)[d]
Wisconsin	5.6	Ables (1969)[e]
Wisconsin	7.1	Pils and Martin (1978)[f]
Wisconsin	7.9	Pils and Martin (1978)[f]

[a] Average (2.5 X 1.5 mi)

[b] 1200 acres (1 pair)

[c] average, estimated

[d] average nightly hunting range

[e] male fox

[f] adult female measured from home range map

TABLE 6. RED FOX AND VEGETATION ASSOCIATIONS DETERMINED BY SNOW TRACKING.

Vegetation type	Number sample points	Percent of total
Mat and cushion tundra	109	35.6
Low shrub	59	19.3
Alpine tundra	43	14.0
Medium shrub	36	11.7
Woodland black spruce	33	10.7
Rock	15	4.9
Sedge grass tundra	6	2.0
Lake	5	1.6
TOTALS	306	100.0

TABLE 7. VEGETATION TYPES SURVEYED FOR TRAILS OF RED FOXES DURING FALL 1980 AERIAL TRANSECT SURVEYS.

Vegetation type	Number fox sample points	Percent total
Medium shrub	108	51.2
Woodland black spruce	61	28.9
Low shrub	9	4.3
River bar	8	3.8
Mat and cushion tundra	5	2.4
Woodland white spruce	5	2.4
Lake ice	4	1.9
Marsh	4	1.9
Sedge grass tundra	3	1.4
Alder shrub	2	0.9
River ice	1	0.4
White spruce forest	1	0.4
TOTALS	211	99.9

TABLE 8. RED FOX AND VEGETATION ASSOCIATIONS DETERMINED BY RADIO LOCATIONS

Vegetation type	Number location points	Percent total
Rock	52	29.2
Medium shrub	49	27.5
Alpine tundra	43	24.1
Mat and cushion tundra	27	15.1
Low shrub	5	2.8
Woodland black spruce	2	1.1
TOTALS	178	99.8

TABLE 9. TRACKS OF RED FOXES ENCOUNTERED DURING FALL 1980 AERIAL TRANSECT SURVEYS

Elevation (m)	Number of fox tracks	
	North side Susitna	South side Susitna
516 - 547		1
548 - 581	2	4
582 - 613	5	-
614 - 645	1	-
646 - 677	-	-
678 - 709	-	-
710 - 741	20	2
742 - 774	9	6
775 - 806	10	18
807 - 838	-	2
839 - 870	12	47
871 - 902	5	1
903 - 935	-	38
936 - 967	5	1
968 - 1000	7	2
1001 - 1032	-	1
1033 - 1964	-	2
1065 - 1096	3	11
1097 - 1129	-	15
TOTAL	79	151
Transects 1 - 11	67	51

This appears to be at odds with the fact that more active dens were found on the north side of the river. Evidence gathered on dispersing foxes indicate that subadults from the lower river disperse toward and into the area of transects 12 through 14 and beyond. Further, collared foxes which dispersed in this direction crossed the Susitna from the north to the south side during dispersal. At the upper reaches of the proposed impoundment fox density was observed to increase markedly. The south side of the river above Vee Canyon changes from mountainous terrain to open, marshy flats which are characteristic of good fox habitat.

Transects were flown in mid-November, a time which has been documented to be a major period of fox dispersal, including some movement of adults to winter ranges. The effect of this on transect data is unknown but it is our belief that this accounts for, at least in part, some of the concentrations of foxes observed in some areas. Late winter or early spring aerial transect surveys are needed to clarify this matter as well as additional late fall transects such as the one we conducted.

In summary, foxes in the upper Susitna basin appear to prefer relatively high elevation areas, usually near or above timberline. Black spruce flats upstream from Vee Canyon were also commonly used. Searches of the area by project investigators in late winter and early spring 1980 produced no evidence of foxes along the Susitna River or the lower elevations along tributaries. Tracks and other signs of foxes were noted along the banks of the Susitna River in late fall and early winter 1980. Winter snow transect surveys in 1980 produced evidence of utilization of the shores of the Susitna River in late fall and early winter.

3.5 Fox Population Estimates

Reports from trappers operating in the Susitna area and fur buyers suggest fox numbers are not high between the Tyone-Susitna confluence and Devil Canyon. The annual harvest of foxes in the study area has been low in recent years. One trapper operated in the study area during winter 1979-80, two in 1980-81, and three in 1981-82. Two foxes were trapped in the winter of 1979-80, two in the winter of 1980-81, and none were trapped as of December 1981.

Alaska Department of Fish and Game fur records for five trapping seasons, 1976-81, indicate that trappers exported 2070 foxes from Game Management Units (GMU) 13, 14, 20 and 25. Trapper export figures reflect numbers of foxes exported out of Alaska by trappers, usually to out-of-state fur auctions. Dealer export figures were not used due to transfers of pelts among dealers from one unit to another for export. Units discussed were chosen because they represented various types of fox habitat in the state. Game Management Unit 14 includes the Anchorage area, GMU 20 includes the Fairbanks area, and GMU 25 includes the Ft. Yukon area. At least some trappers with Fairbanks and Anchorage addresses trap in units other than those in which they live, therefore these figures may be somewhat inflated.

TABLE 10. TRAPPER EXPORT OF RED FOX 1976-1981
STATE OF ALASKA (SELECTED LOCATIONS)[a]

Selected Game Management Units - Trapper Exports

Unit	1976-77	1977-78	1978-79	1979-80	1980-81	Total
13 - Susitna	136	146	302	192	207	983
14 - Anchorage	81	73	101	63	68	386
20 - Fairbanks	145	73	63	146	293	725
25 - Ft. Yukon	35	2	22	15	2	76
TOTAL	397	294	488	416	575	2070

Selected Locations within GMU 13

	1976-77	1977-78	1978-79	1979-80	1980-81	Total	GMU 13 Percent of Total
Cantwell	10	10	29	27	21	97	10
Gakona	44	41	51	85	82	303	31
Copper Center	21	28	67	10	47	173	18
Glennallen	47	63	118	43	56	327	33
TOTAL	122	142	265	165	206	900	92

[a]Alaska Department of Fish and Game, Fur harvest reports, 1976-1977 to 1980-1981.

Table 10 indicates that trapper exports from Cantwell, which lies closest to the study area, comprised approximately 11% of the total five-year GMU 13 export. Galena, Copper Center, and Glennallen lie relatively close to each other and comprise 80% of the take. Dean Wilson (pers. comm.), a fur buyer from Copper Center, purchases many of the foxes in that area. He indicated that most foxes are taken in the Upper Copper River - Solo Hills - Maclaren River area and west of Paxson in the Crossman Lake vicinity in open, marshy country. According to Mr. Wilson, prime fox habitat decreases from the Maclaren river country into the Tyone-Oshetna-Susitna areas as flat, open plains dissolve into mountainous, alpine terrain.

The density of red fox family units in the Susitna study area appears to be low compared to densities of red foxes in mid-western states (Table 11). In summer 1981, six active fox dens were found on a 1751 km^2 study area (Figure 3). Two pups were sighted briefly at one den site but neither the natal den nor a den utilized after the sighting was discovered. So, we can be relatively confident that at least seven dens were occupied by fox families during 1981. This is one fox family per 250 km^2. Probably, all dens in the study area were not sighted. If only half of all active dens were found, the figure is one family per 125 km^2. Correspondingly if only one-third of the active dens were found, the estimate is one family per 83 km^2 compared to one family per 10 km^2 estimates found by researchers in mid-western states (Table 11). Our estimate of one family per 83 km^2 seems reasonable for the upper Susitna basin in light of the fact that a variety of other study personnel continually combed the study area for a period of two years in addition to TES furbearer biologists and state game biologists.

Based on interviews and this study, the Susitna fox population level at this time appears to be low relative to good fox areas in Alaska. Dean Wilson (pers. comm.), who buys furs from most of the area east of the Susitna study area, believes that fox populations were a little above average for the last two years and show no signs of dropping off. Herbert Melchior (pers. comm.), state furbearer biologist in Fairbanks, Alaska, indicates that fox harvests were high and staying high in some areas of the state and that the hare population was increasing in other areas which would result in larger numbers of foxes there. This information is based on total Alaskan fox pelt exports, results of trapper questionnaires, and reports by state game biologists. Therefore, although the Susitna fox population is probably low relative to good fox areas in other parts of the state, it may be above the average level for the study area.

3.6 Fox Food Habits

The diet of red foxes in the upper Susitna basin was investigated by direct observation of foraging foxes, following fox trails in snow, identification of food remains at dens, examination of scats, and examination of stomachs from foxes taken by trappers. Principal foods during spring

TABLE 11. POPULATION DENSITIES OF RED FOXES REPORTED IN MIDWESTERN STATES DURING SPRING AND DENSITIES NOTED DURING SPRING IN THE UPPER SUSITNA BASIN.

Location	Year(s)	Area (km^2)	Families/km^2	Reference
Eastern Michigan	1942	36	0.1	Shick (1952)
Southeast Iowa	1946-48	10.6	0.1	Scott and Klimstra (1955)
Central N. Dakota	1969-73	559.4	0.1	Sargeant et al. (1975)
Southern Wisconsin	1972-75	83.7	0.1	Pils and Martin (1978)
Central Alaska	1980-81	1751	.008-.013	This study

[a] Adapted from Pils and Martin, 1978.

and summer included Arctic ground squirrels and voles, usually red-backed voles and singing voles. Ptarmigan were taken throughout the year. Remains of Arctic ground squirrel and ptarmigan were found during visits to all active den sites in 1980 and 1981, except Swimming Bear Lake den where no ptarmigan remains were seen. Shrews were commonly found at den sites but were either whole or in various states of decay. Murie (1944) mentioned that in Michigan he found that foxes often killed shrews but rarely ate them. Other remains found at den sites include muskrat, marmot, and caribou.

Trails in snow indicate that foxes commonly foraged in areas above timberline frequented by large flocks of ptarmigan. Muskrats are taken where available and they may be relatively important around large lakes such as Stephan Lake, Clarence Lake and Deadman Lake. Dispersing young muskrats and muskrats at push-ups are particularly vulnerable to predation by foxes. Mr. Edward Powell (pers. comm.), a trapper, reported observing foxes hunting muskrats at muskrat push-ups on Stephan Lake during winter. Aerial and ground observation by our study team at Clarence Lake indicate that foxes visit muskrat push-ups frequently.

Carrion may be important to red foxes in parts of the study area. Caribou carcasses appear to be the main source of carrion in the Clarence Lake area where sport hunting is relatively heavy during fall. Two foxes near Watana Camp fed on remains of a caribou and a moose carcass through most of winter 1980-81. Two foxes were also observed feeding on a sheep killed by wolves on the east fork of Watana Creek in October 1981.

Several investigators have found that snowshoe hares are a very important component in the diets of red foxes. Snowshoe hares are presently scarce in the Susitna study area and therefore relatively unimportant in the diets of foxes. No hare remains were observed at six active fox dens during summer of 1981 nor at two active dens found in 1980. No evidence of foxes preying on hares was found during trail sampling of foxes in 1980 and in 1981.

3.7 Reactions of Foxes to Human Disturbance

Results of disturbances of foxes at dens by helicopter and foot traffic (Table 12) were not analyzed statistically due to insufficient data in some blocks. Preliminary conclusions, however, are presented below and are discussed by the type of disturbance.

Helicopter Disturbance

The proximity of a helicopter to a den site less than 30 meters, as well as 30 to 80 meters often involved rash evasive and defensive behavior from adults as well as juvenile foxes. At 81 to 150 meters and 151 to 300 meters, reactions varied from alert to very excited. The severity of the "average" reaction decreased as the distance from the

TABLE 12. FOX REACTIONS TO HUMAN DISTURBANCES AT DEN SITES.

	Number of Encounters by Reaction Type[a]				
Distance (m)	1	2	3	4	5
HELICOPTER DISTURBANCE					
Juveniles					
0 - 30	0	1	7	1	0
31 - 80	0	32	23	0	0
81 - 150	8	9	8	0	0
151 - 300	8	4	5	0	0
301 - 400	2	2	0	0	0
Adults					
0 - 30	0	0	0	0	0
31 - 80	0	0	1	1	0
81 - 150	0	1	0	1	0
151 - 300	0	1	0	1	0
301 - 400	0	0	0	0	0
FOOT TRAFFIC DISTURBANCE					
Juveniles					
0 - 30	0	6	1	1	3
31 - 80	1	1	0	0	0
81 - 150	1	0	1	3	0
151 - 300	0	3	0	0	0
301 - 400	0	0	0	0	0
Adults					
0 - 30	0	0	0	0	0
31 - 80	4	2	0	0	1
81 - 150	0	1	0	1	0
151 - 300	0	0	0	0	0
301 - 400	0	0	0	0	0

a - reaction type
1 - ignore, observe casually
2 - alert, stand up
3 - crouch, run back and forth, enter den
4 - run, evasive maneuvers
5 - run, warning barks

animal increased. Between 301 and 400 meters, reactions of juveniles were less intense, more an attitude of alert curiosity than of imminent danger. It seems apparent from data collected and from den site observations that reactions of juvenile foxes to helicopters are negligible at distances (whether ground or air distances) over 500 meters.

The reaction of adult foxes to helicopters at den sites was somewhat different. Although observations were limited, they suggest that reactions of adults may be more extreme at longer distances than for pups. Two reactions were recorded where adults moved away from the den site when a helicopter was approximately 1600 m (1 mi.) distant and at an altitude of 300 to 400 m. Reactions such as these may account for the low success achieved in attempting to observe reactions of adult foxes to helicopters. Also, many of the adults were radio-collared and therefore were often located away from the den site by an antenna-equipped helicopter. Radio location by helicopter probably increased fear and anxiety of adults to helicopter sounds. In addition, adults in general were found to be far more alert and faster reacting to potential danger than pups. Reactions to over-flying helicopters during radiolocation also varied considerably among adults. It is possible that young foxes and possibly adult foxes become acclimated to helicopter over-flights and that the severity of reaction to helicopters decreases with continued exposure.

Foot Traffic

Based on a few observations it appears that foxes are far more tolerant of foot traffic than of helicopters. In comparing reactions to foot traffic vs. helicopter over-flights (Table 12), it is noticeable that both juveniles and adults react less drastically to people on foot, and at closer distances, than to helicopters. This is almost intuitive when one considers the number of fox dens located near dwellings, farms, and even construction facilities in some cases (Gipson, pers. comm.).

Juveniles became aware of humans approaching the den site at 100 to 200 meters. Adults were usually aware of human presence at 400 to 500 meters in open country. Adults reacted to human disturbances at 100 to 150 meters by moving away from the den and barking warnings. This response was probably an attempt to lure intruders away from the den.

Dens were repeatedly disturbed by humans during our study. Foxes were captured and released, scats were collected, and recording units were placed at den sites and serviced. No dens were abandoned during the study. In the Fairbanks area, den density is apparently higher than in the Susitna study area. Often, dens visited in the Fairbanks area will be abandoned quickly after a single visit by humans (Guthrie, pers. comm.). This is probably due to the availability of alternative den sites nearby whereas alternative den sites in the Susitna study area are widely spaced in most cases with one site being just as secure as the next. Also, due to the elevation and vegetation in the study area, excellent visibility of the surrounding area is to be had at every den site located, possibly contributing to the security of the denning foxes. Many den sites in the Fairbanks area are located in marshy, brushy areas and on tree-covered pingos where the view of the surrounding area is much less than the study area. A pingo is an ice heave which creates a mound of debris and dirt.

3.8 Radio-telemetry Studies of Marten

Seventeen marten were captured in live traps 23 times and equipped with 20 radio collars. Excluding those animals for which inadequate data were gathered, the number of radio locations obtained by animal and season, are presented in Table 13. For the purpose of this tabulation and other seasonal determinations, the seasons are defined as follows:

Spring	=	March-May
Summer	=	June-August
Autumn	=	September-November
Winter	=	December-February

Home ranges of marten (for which there are sufficient data) are presented in Figures 10-16. These range perimeters indicate that marten establish home ranges, but that fidelity to home ranges varies considerably. Home ranges of adult male marten were in almost all cases mutually exclusive. Overlap of home ranges of marten of different sex/age classes is common. Marten rarely cross bodies of water which require them to swim. The Susitna River and larger tributary creeks form partial home range boundaries for many marten.

Seasonal home range sizes of radio-collared animals are presented in Table 14. Two sets of totals are presented, one including data gathered from animals 514 and 515, the other excluding these data. Animals 514 and 515 had unusual home ranges. Each animal possessed a home range with two nodes separated by a distance greater than the diameter of either node. The minimum area polygon method of home range size determination does not accurately indicate true home range size for this type of home range and tends to bias home range size upwards.

Marten were found to rest below ground during late autumn, winter and early spring months. The characteristics of marten winter resting sites are presented in Table 15. Of 37 marten resting sites found during the study, 26 (70%) were active red squirrel middens, two (5%) were inactive red squirrel middens, three (8%) were red squirrel grass nests in white spruce trees and six (16%) were burrows or holes of unknown origin in soil. All of these resting sites were in forest or woodland vegetation types.

Martens rest above ground during summer months. Soil temperatures are lower than air temperatures then, and the relative humidity in subterrainean chambers is probably near saturation. Marten radio-tracked on

Table 13. Marten radio locations. Number of radio locations by individual animal and season.

Marten number (sex)	Autumn 80	Spring 81	Summer 81	Autumn 81	Totals
044 (male)	--	--	--	8	8
045 (female)	--	--	--	11	11
126 (male)	--	27	13	--	40
128 (male)	--	39	6	46	91
200 (male)	--	--	--	42	42
512 (male)	--	37	11	49	97
514 (male)	--	46	--	--	46
515 (female)	--	40	3	--	43
516 (male)	5	--	--	--	5
517 (male)	--	23	12	--	35
518 (male)	22	--	--	--	22
519 (male)	18	--	--	--	18
520 (male)	32	--	--	--	32
654 (female)	--	--	--	34	34
655 (female)	--	--	--	36	36
Total (females)	0	40	3	81	124
Total (males)	77	172	42	145	436
TOTALS	77	212	45	226	560

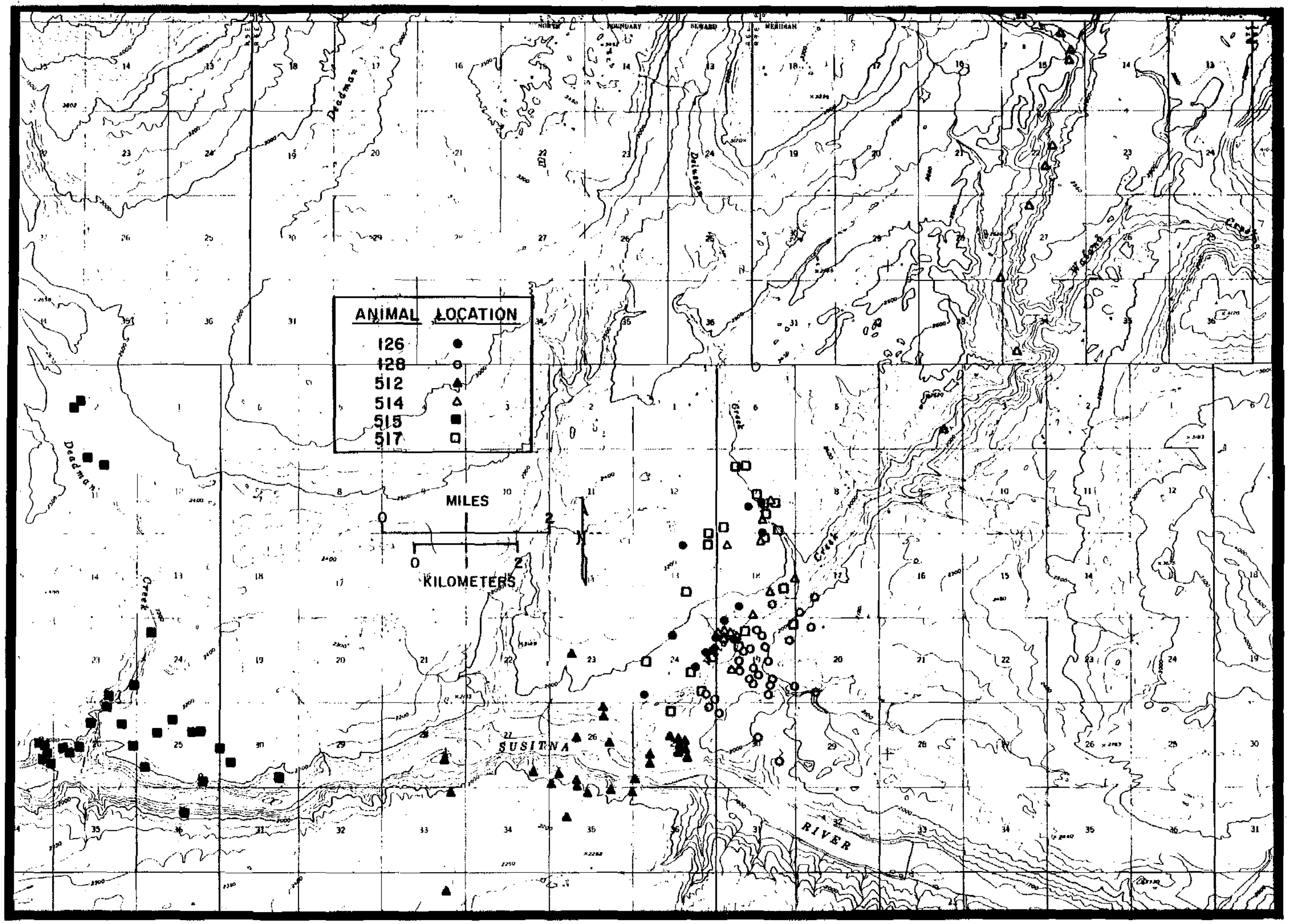

Figure 10. Radio locations of marten, spring 1981.

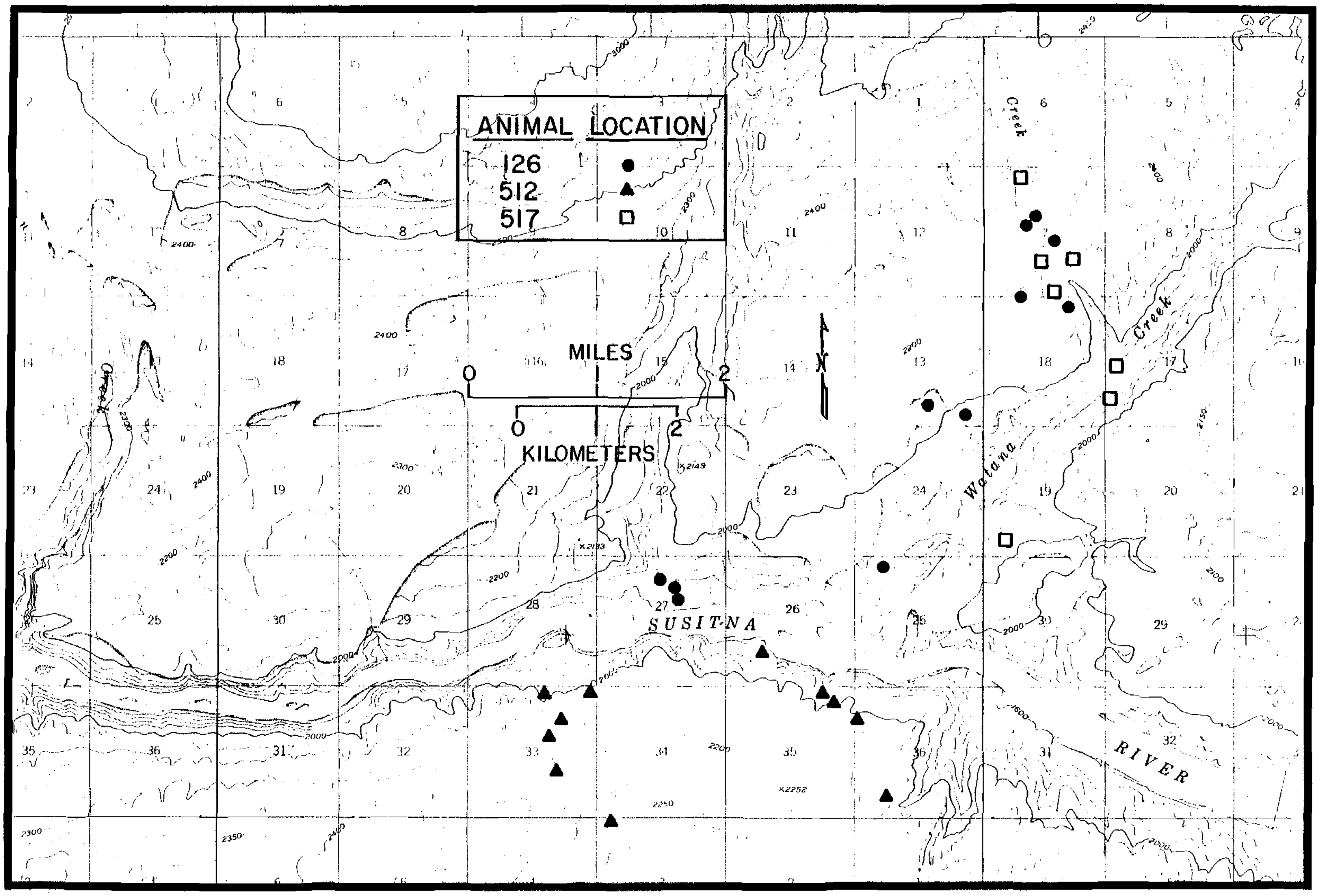

Figure 11. Radio locations of marten, summer 1981.

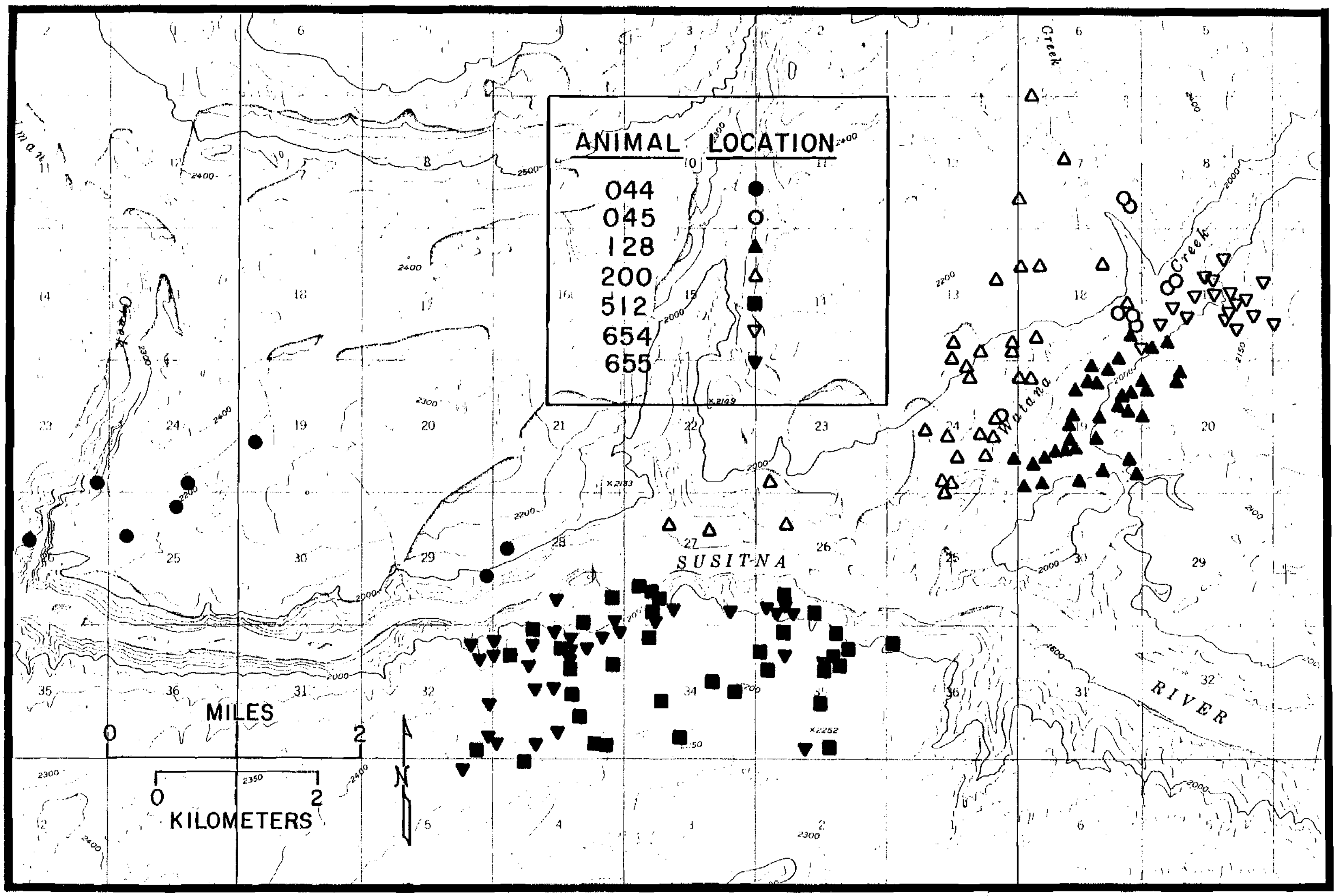

Figure 12. Radio locations of marten, autumn 1981.

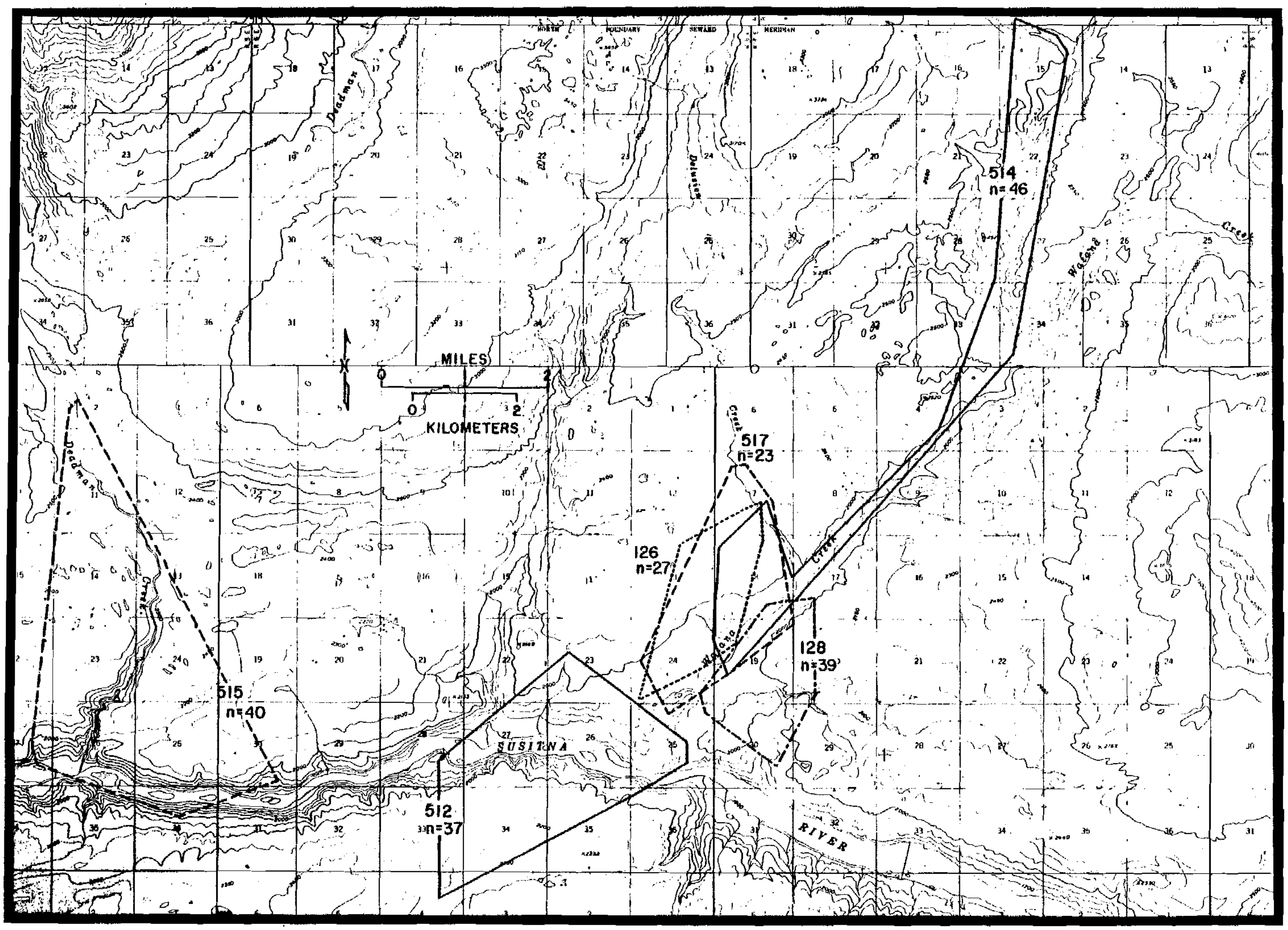

Figure 13. Polygon home range perimeters of radio-collared marten, spring 1981. (n=number of locations within perimeter).

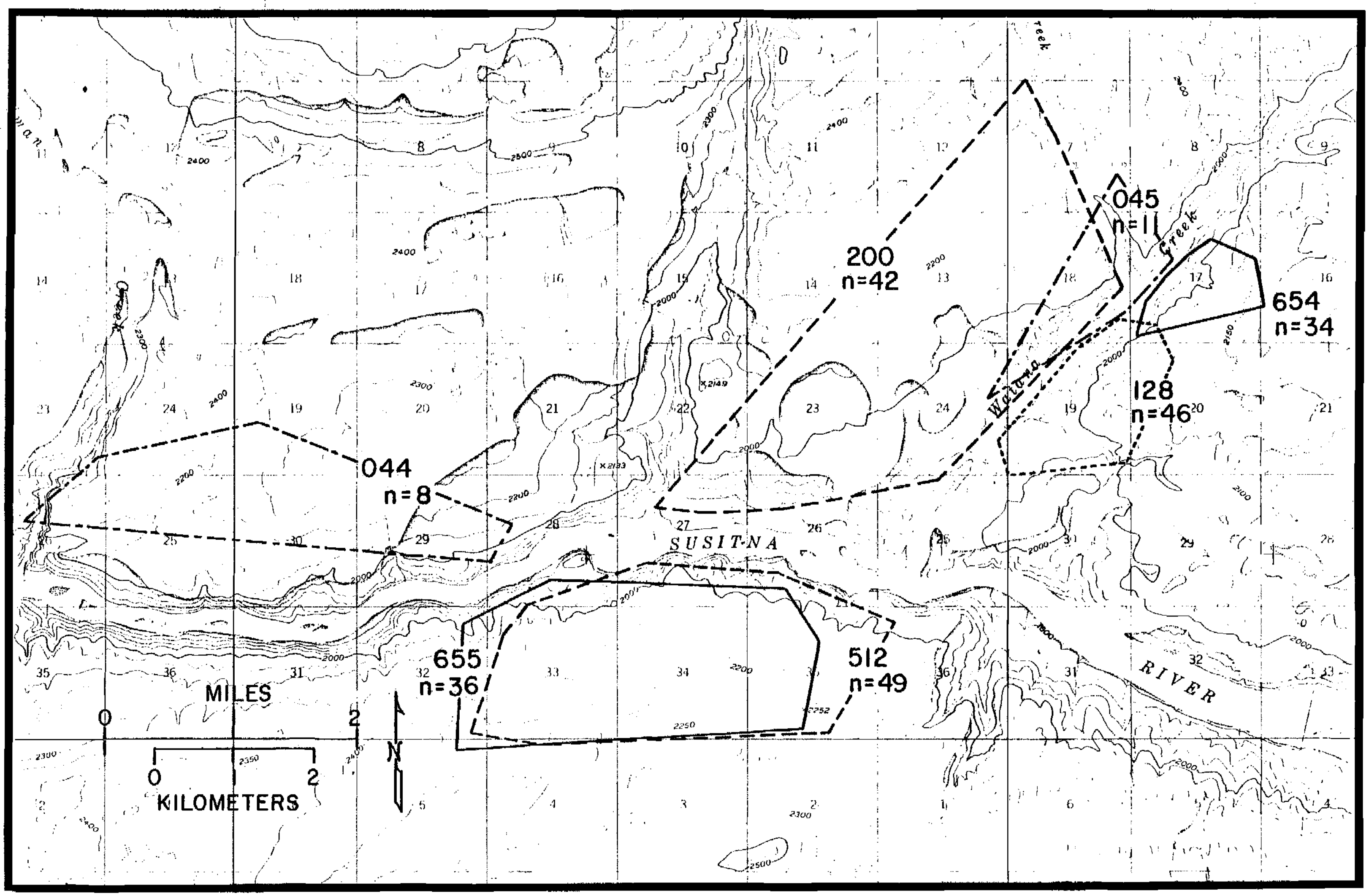

Figure 14. Polygon home range perimeters of radio-collared marten, autumn 1981. (n=number of locations within perimeter).

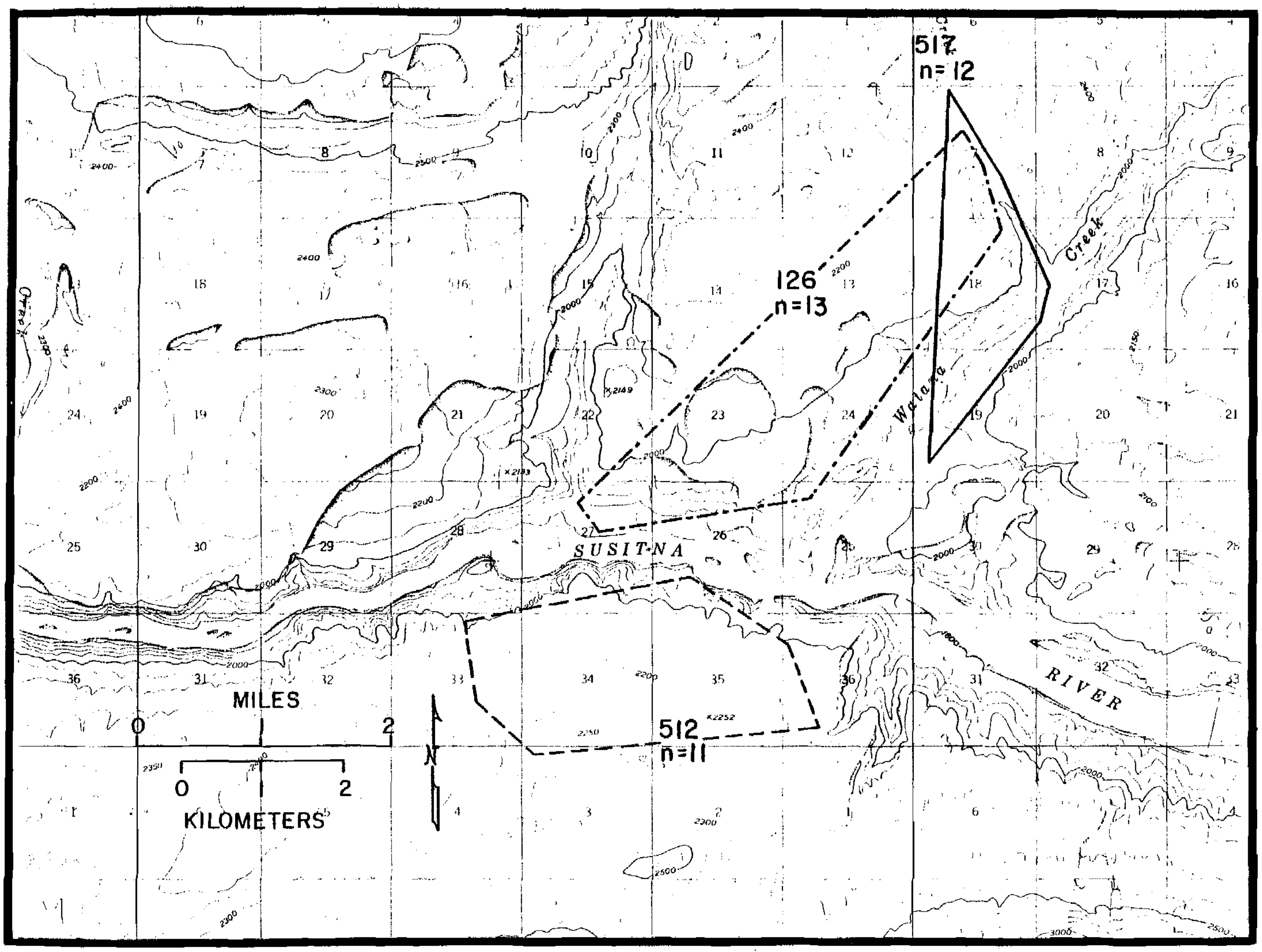

Figure 15. Polygon home range perimeters of radio-collared marten, summer 1981. (n = number of locations within perimeter).

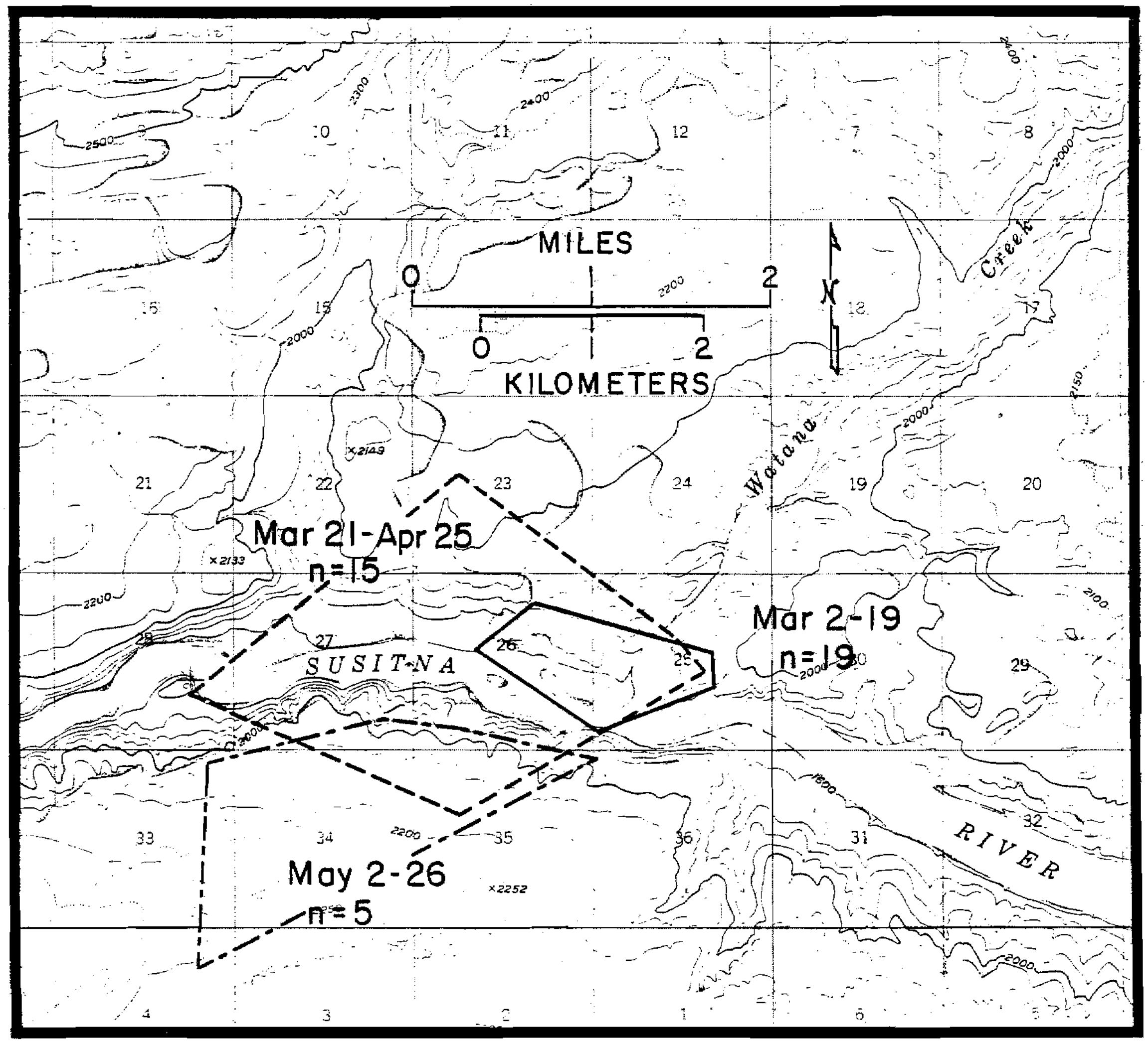

Figure 16. Home range shifts of an adult male marten, spring 1981. (n=number of locations within perimeter).

Table 14. Seasonal home range sizes (km^2) of radio-collared marten.

Marten Number (sex)	Autumn 80	Spring 81	Summer 81	Autumn 81	$\overline{X}$	
044 (male)	----	----	----	5.98	5.98	
045 (female)	----	----	----	2.15	2.15	
126 (male)	----	4.74	9.69	----	7.22	
128 (male)	----	4.48	----	2.46	3.47	
200 (male)	----	----	----	13.42	13.42	
512 (male)	----	12.04	7.49	8.57	9.37	
514 (male)	----	9.95	----	----	9.95	
515 (female)	----	20.56	----	----	20.56	
517 (male)	----	7.64	3.86	----	5.66	
518 (male)	4.74	----	----	----	4.74	
519 (male)	5.44	----	----	----	5.44	
520 (male)	4.87	----	----	----	4.87	
654 (female)	----	----	----	1.09	1.09	
655 (female)	----	----	----	7.90	7.90	
Females	----	20.56	----	3.71	7.92	(n=4)
Males	5.02	7.77	7.01	7.61	7.02	(n=15)
Both Sexes	5.02	9.90	7.01	5.94	7.21	(n=19)
Females[a]	----	----	----	3.71	3.71	(n=3)
Males[a]	5.02	7.23	----	7.61	6.82	(n=14)
Both sexes[a]	5.02	7.23	7.01	5.94	6.27	(n=17)

[a]Excluding numbers 514 and 515.

Table 15. Characteristics of 37 marten resting sites (autumn, winter and spring).

TYPE OF SITE	NUMBER OF RESTING SITES	% 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	99
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	100
ASPECT		
North	1	3
Northeast	1	3
East	2	5
Southeast	4	11
South	10	27
Southwest	6	16
West	6	16
Northwest	1	3
None	6	16
Total	37	100

ELEVATION

$\bar{x}$ = 562 m (1845 ft.)

Range: 451-722 m (1480-2370 ft.)

SLOPE

$\bar{x}$ = 15.3°

Range: 0-45°

the ground in summer flee the researcher at his approach, or seek refuge in white spruce trees, well above ground level. Due to the escape response of marten above ground it is seldom possible to characterize marten summer resting sites. Some of these are probably in the branches of white spruce trees, others are probably in red squirrel nests, in hollow tree trunks and at the base of spruce trees.

3.9 Activity Patterns

Activity pattern data for marten were compiled and tabulated for autumn 1980 (n=573) and spring 1981 (n=1207). These data are presented in Figures 17 and 18 respectively. Data from autumn 1980 strongly suggest that marten are nocturnal in their circadian activity patterns and have a peak of activity near 0500 h. Very little activity takes place between 0900 h and 1600 h and what activity does occur during this midday period probably consists of grooming or other non-foraging activities.

The data from spring 1981 differ markedly. During spring, extremes of activity and inactivity are less pronounced than in autumn. There is more activity during afternoon hours, and the total amount of time spent active is much less.

3.10 Pine Marten Populations

Pine marten are locally abundant in the vicinity of the proposed Devil Canyon and Watana impoundments. Information from former and present trappers indicates that marten have historically been important and are presently the most economically important furbearer species to trappers in the vicinity of the impoundment zones. Data from aerial transects flown in November 1980 indicate that marten are present along the Susitna River at least as far downstream as Portage Creek and as far upstream as the Tyone River., The highest marten densities occur between Devil Creek and Vee Canyon (see Table 19). Marten were most numerous in coniferous and mixed forest and woodland habitats below 1000 meters in elevation. Our preliminary estimates indicate approximately 150 marten are present in the area that would be inundated by the Watana impoundment and approximately 55 are in the area that would be inundated by the Devil Canyon impoundment.

3.11 Muskrat and Beaver Surveys Upstream from Gold Creek

Findings of the spring 1980 surveys for muskrats in the upper Susitna basin are summarized in Table 16. The beaver and muskrat surveys in May 1980, plus observations by team members on shuttle flights and sightings reported by helicopter pilots and other project personnel, indicated that populations of these species occur along much of the Susitna River and its main tributaries. Sign of these animals was most visible in early spring when snowmelt was in advanced stages but lake and river ice still remained. During aerial surveys made in July 1981 upstream from Gold Creek the bulk of sign of these aquatic species was found in lakes on plateaus above the river valley between 610 m (2000 feet) and 730 m (2400 feet) MSL.

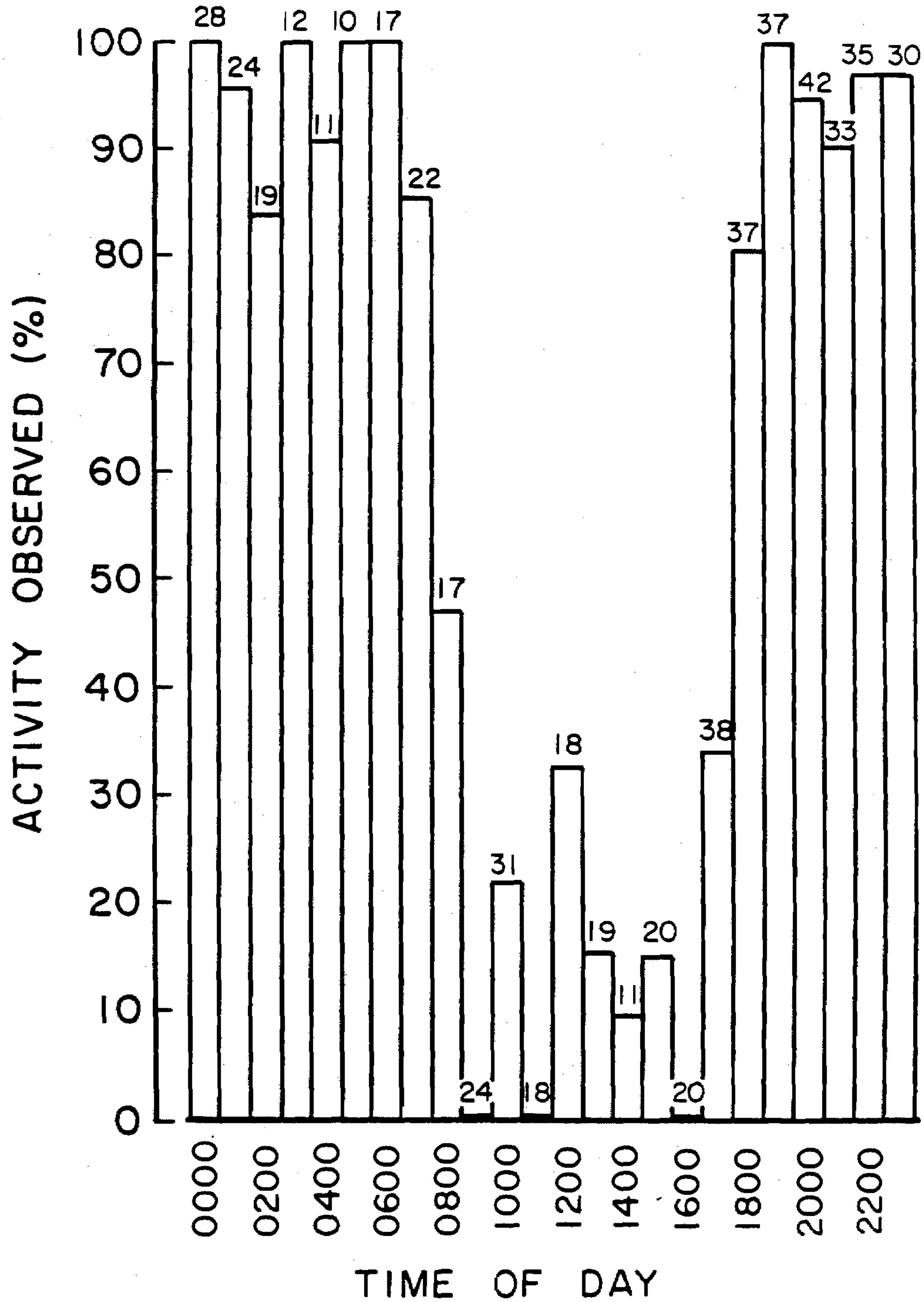

Figure 17. Activity patterns of radio-collared male marten, autumn 1980. Numbers represent total observations for each one-hour time period.

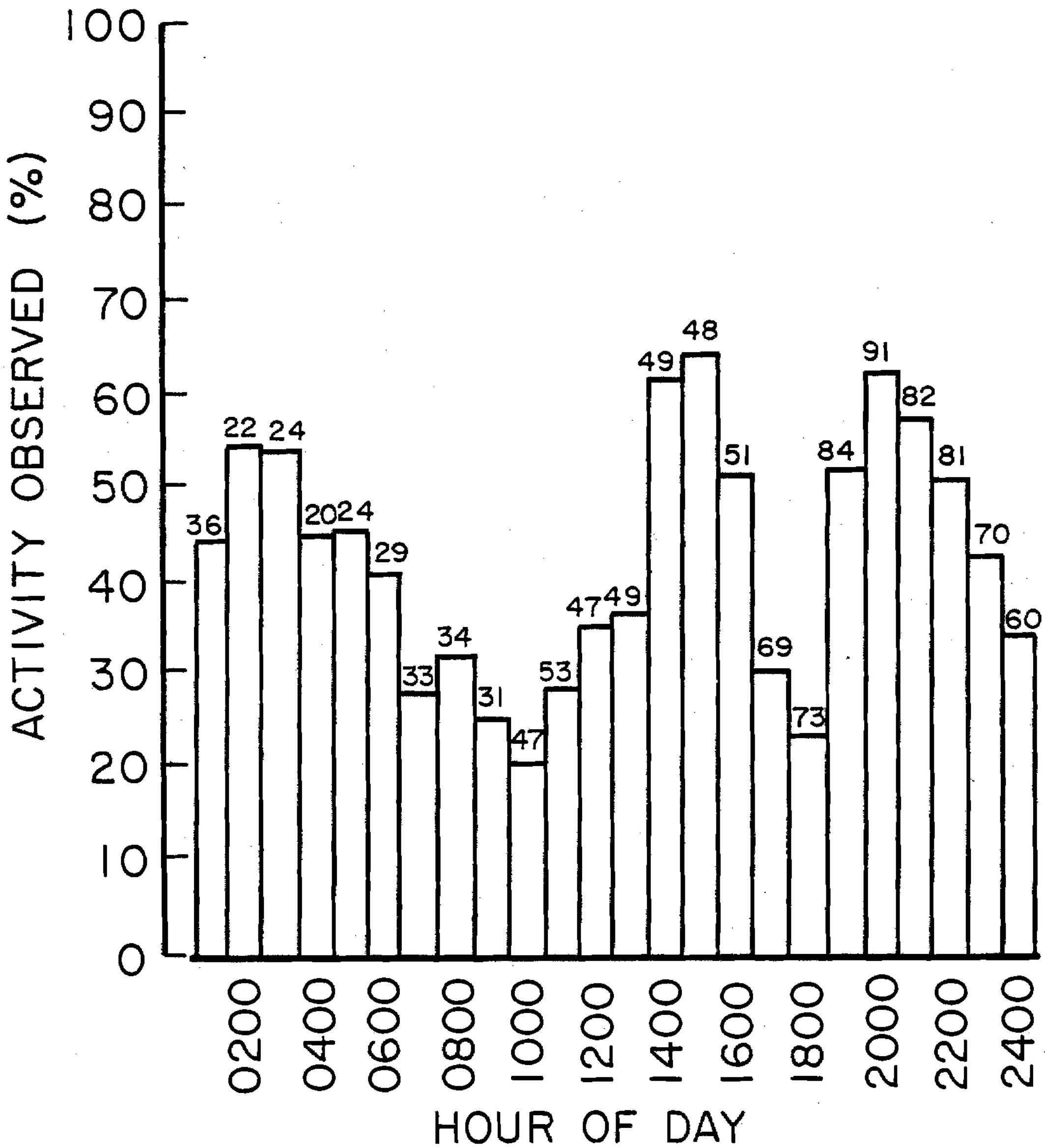

Figure 18. Activity patterns of radio-collared male marten, spring 1981. Numbers represent total observations for each one-hour time period.

TABLE 16. RESULTS OF SURVEYS FOR MUSKRAT PUSHUPS UPSTREAM FROM GOLD CREEK DURING SPRING, 1980.

Lake number	Elevation MSL (m)	No. pushups	Locations of Lakes: Quarter section	Section	Range	Township
001	267	2	SW	31	1W	32N
			SE	31	1W	32N
002	472	4	SE	30	1W	32N
			SW	29	1W	32N
003	526	14	NE	30	1W	32N
			NW	29	1W	32N
004	640	0	NE	20	1W	32N
			NW	21	1W	32N
			SE	20	1W	32N
005	500	26	SE	15	1W	32N
			SW	14	1W	32N
			SE	14	1W	32N
			NW	23	1W	32N
006	495	0	NW	23	1W	32N
			NE	23	1W	32N
007	480	0	NW	24	1W	32N
			SW	24	1W	32N
			SE	23	1W	32N
			NE	23	1W	32N
008	463	0	SW	6	1E	31N
009	463	0	SE	6	1E	31N
010	442	0	SW	32	1E	32N
011	472	0	SE	32	1E	32N
012	419	0	SE	32	1E	32N
013	542	0	SW	4	1E	32N
			SE	4	1E	32N
014	724	0	NW	28	1E	32N
015	724	0	NE	21	1E	32N
			NW	22	1E	32N
			SW	22	1E	32N
			NW	27	1E	32N
			SE	21	1E	32N
016	712	0	SW	16	1E	32N
			SE	16	1E	32N
			SW	15	1E	32N
			NW	22	1E	32N
			NE	21	1E	32N
017	754	0	NE	22	1E	32N
			NW	23	1E	32N
018	572	0	NW	35	1E	32N
019	503	0	SW	35	1E	32N
			NW	2	1E	31N
020	541	0	SE	35	1E	32N
			NE	2	1E	31N

Table 16. Continued

Lake number	Elevation MSL (m)	No. pushups	Locations of Lakes: Quarter section	Section	Range	Township
021	724	0	NW	36	1E	32N
022	724	0	NW	36	1E	32N
023	686	0	SW	24	1E	32N
			SE	24	1E	32N
			SW	19	2E	32N
			NW	30	2E	32N
			NE	25	1E	32N
			NW	25	1E	32N
024	724	0	NE	19	2E	32N
			NW	20	2E	32N
025	722	0	NW	20	2E	32N
			NE	20	2E	32N
			SE	20	2E	32N
			SW	20	2E	32N
026	709	0	SW	21	2E	32N
027	533	0	NW	27	2E	32N
			NE	27	2E	32N
			SE	27	2E	32N
			SW	27	2E	32N
028	754	0	NE	7	4E	31N
029	716	0	SW	8	4E	31N
030	602	0	NW	17	4E	31N
031	602	0	NE	17	4E	31N
032	693	1	NW	5	5E	31N
			SW	5	5E	31N
033	693	0	SW	5	5E	31N
034	716	0	SW	4	5E	31N
			SE	5	5E	31N
035	680	0	SW	9	SE	31N
			SE	9	5E	31N
			NE	16	5E	31N
			NW	16	5E	31N
			NE	17	5E	31N
			NW	17	5E	31N
			NE	18	5E	31N
			SE	7	5E	31N
			SW	8	5E	31N
			SE	8	5E	31N
036	678	8	SW	10	5E	31N
			SE	9	5E	31N
037	693	0	SE	3	5E	31N
			SW	3	5E	31N
			SE	10	5E	31N
			SW	10	5E	31N
			NE	9	5E	31N
038	643	0	SE	11	5E	31N
			SW	11	5E	31N

Table 16. Continued

Lake number	Elevation MSL (m)	No. pushups	Locations of Lakes: Quarter section	Section	Range	Township
			NW	14	5E	31N
			NE	15	5E	31N
			SW	15	5E	31N
			NW	15	5E	31N
			SW	10	5E	31N
039	709	0	NW	3	5E	31N
040	683	0	SW	21	5E	32N
041	678	1	NW	21	5E	32N
042	683	0	NE	21	5E	32N
043	689	1	NE	21	5E	32N
			NW	22	5E	32N
			SE	21	5E	32N
			NE	21	5E	32N
044	693	0	SW	15	5E	32N
			NW	22	5E	32N
045	683	0	SE	16	5E	32N
			NE	21	5E	32N
046	693	0	SE	15	5E	32N
			SW	45	5E	32N
047	683	7	NW	15	5E	32N
			NE	16	5E	32N
048	739	6	NW	10	5E	32N
049	716	0	NW	14	5E	32N
			SW	14	5E	32N
050	716	0	NW	14	5E	32N
051	716	0	NW	14	5E	32N
052	716	0	NW	14	5E	32N
			NE	14	5E	32N
053	716	0	NE	14	5E	32N
054	716	0	SE	14	5E	32N
055	716	0	NE	14	5E	32N
			SE	14	5E	32N
056	716	0	NE	14	5E	32N
			NW	13	5E	32N
057	693	0	SW	35	5E	32N
058	708	0	NE	53	5E	32N
059	693	32	NE	13	5E	31N
			NW	18	5E	31N
			SW	18	5E	31N
			SE	13	5E	31N
			SW	13	5E	31N
			SE	14	5E	31N
			NE	14	5E	31N
			NE	13	5E	31N
060	692	0	SW	5	6E	31N
			SE	5	6E	31N
			NE	8	6E	31N

Table 16. Continued

Lake number	Elevation MSL (m)	No. pushups	Locations of Lakes: Quarter section	Section	Range	Township
086	808	0	SE	2	8E	31N
087	808	0	SE	2	8E	31N
088	741	1	SE	7	9E	31N
089	866	25	SE	25	11E	30N
			SW	30	11E	30N
			NW	31	11E	30N
			NE	36	11E	30N
090	870	2	SE	30	11E	30N
			NW	31	11E	30N
091	869	0	NW	31	11E	30N
092	777	1	SW	5	11E	29N
			NW	8	11E	29N
093	777	0	NW	8	11E	29N
			NE	8	11E	29N
			SE	8	11E	29N
			SW	8	11E	29N
094	780	0	SE	5	11E	29N
			NE	8	11E	29N
095	777	0	SW	4	11E	29N
096	777	0	NW	9	11E	29N
097	777	0	NW	9	11E	29N
098	777	0	NW	9	11E	29N
			SW	9	11E	29N
099	777	0	SE	8	11E	29N
			SW	9	11E	29N
100	853	1	NE	26	10E	30N
101	853	0	NE	26	10E	30N
			NW	25	10E	30N
102	853	0	SW	24	10E	30N
103	853	0	SW	23	3E	30N
			NW	26	3E	30N

Trapper reports suggest that beavers and muskrats inhabiting alpine streams and lakes have seldom been pursued by trappers. Beavers and muskrats in alpine areas represent an important fur resource, but in higher elevations both species are particularly vulnerable to environmental alterations and/or overharvest because of their dependence upon small isolated riparian habitats. Populations of beavers and/or muskrats were noted along slow flowing sections of most larger creeks, particularly where lakes drain into streams such as the Stephan Lake/Prairie Creek drainage and the Deadman Creek/Deadman Lake drainage. Two sightings of beavers were reported by surveyors working along the Susitna River between Fog and Devil creeks. These beavers may have been dispersing two-year-olds since to our knowledge no active lodges or bank dens have been sighted on the river, or on the lower reaches of the feeder streams.

3.12 Muskrat and Beaver Furbearer Surveys Downstream from Devil Canyon

Use of the Susitna River by aquatic furbearers, especially beavers, increases progressively downstream from Devil Canyon. Increasing abundance of aquatic furbearers is best illustrated by sign of beavers noted during surveys from a riverboat during summer 1980 (Table 17). In Section I, above the confluence with the Talkeetna and Chulitna Rivers, beaver sign is limited to occasional foraging sites and lodges along protected banks of the river, sloughs and tributaries. In Section II foraging sign is common along sloughs, deltas of tributaries and along stable banks of the Susitna River. Additional lodges and possibly bank dens not observed by the survey team probably exist away from the main channel of the river. Sign of beavers is in sight almost continuously along Section III. The numerous islands and sloughs provide ideal habitats for foraging, caching food and building lodges, and only a portion of the sign was visible from the riverboat. An attempt to correct for increasing width and braiding of the river and limited visibility was made in Table 17.

Aerial surveys flown along the lower Susitna River during July 1981 verify that beaver sign increases progressively from Devil Canyon downstream to Cook Inlet.

Results of these surveys agree with findings of Boyce (1974) and Hakala (1952) who reported beavers in Alaska favor lakes or slow flowing streams bordered by subclimax stages of shrub and mixed coniferous and deciduous forests. This description fits Section III of the Susitna River. Large rivers with narrow valleys and high velocity flows (such as Section I of the Susitna River), are generally sparsely populated by beavers (Retzer 1955).

3.13 Aerial Transects Surveys for Furbearer Sign

Results of aerial transects have been discussed in part, in sections 3.4, 3.6 and 3.7 under marten and red fox.

Table 17. Occurrence of beaver signs along three sections[a] of the lower Susitna River.

River Section	Kilometers Surveyed	Beaver Sign: Number Cuttings	Cuttings per Km	Number Houses	Houses per Km
Section I	62	12	.19	2	.03
Section II	30	7	.23 (.46)[b]	2	.06 (.12)
Section III	26	16	.62 (1.86)	4	.15 (.45)
Entire Survey	118	35	.30	8	.07

a. Section I=Devil Canyon to Confluence with Talkeetna and Chulitna Rivers, Section II=Confluence with Talkeetna and Chulitna Rivers to Confluence with Montana Creek, Section III=Confluence with Montana Creek to Delta Islands.

b. Numbers in parentheses are adjustments to realistically reflect signs present in Sections II and III. Signs were multiplied by a correction factor of 2 in Section II and a factor of 3 in Section III. The increasing width and braiding of the river permitted the team to see approximately half the signs in Section II and only a fourth to a third in Section III.

Table 18. Preliminary tabulation of autumn 1980 aerial transect data, species by vegetation type.

Vegetation Type	Marten	Fox	Short-tailed weasel	Mink	Otter	Totals
Forest, white spruce	35	1	4	0	0	40
Forest, birch	3	0	2	0	0	5
Forest, poplar	0	0	1	0	0	1
Forest, black spruce	0	2	0	0	0	2
Forest, mixed	54	0	1	0	0	55
Alpine mat-cushion	3	5	29	0	0	37
Woodland, white spruce	525	5	88	1	0	619
Woodland, black spruce	605	61	401	3	1	1071
Woodland, mixed	29	0	5	0	0	34
Shrub, low	12	9	8	0	0	29
Shrub, medium	35	108	190	0	0	333
Shrub, alder	25	2	11	0	0	38
River ice	2	1	2	20	20	45
Lake ice	0	4	0	0	0	4
Creek ice	6	0	2	4	2	14
Marsh	3	4	0	3	0	10
River bar	9	8	1	3	7	28
Rock	0	0	1	0	0	1
Totals	1353	213	746	34	30	2376

A total of 741 short-tailed weasel tracks were encountered during the transects, of these, 57% were located in woodland black spruce and 23% were in medium shrub (Table 18). Eighty-seven percent of tracks recorded were located along transects 10 through 14 indicating that a substantial portion of the weasels inhabit the upper reaches of the Susitna study area in the region of the Oshetna River (Table 19).

Aerial transect data indicate that nearly 50% of mink tracks encountered were found in transects 12, 13 and 14 (Table 19), suggesting that mink also prefer the upper reaches of the proposed impoundment. Otter (Table 19) were fairly evenly distributed throughout the Susitna drainage with both mink and otter primarily inhabiting the area immediately adjacent to the Susitna River.

note also

3.14 Otter and Mink Surveys

In November 1980, an unusually high incidence of otter tracks was noted on shelf-ice along the Susitna River in the proposed impoundment zones. A survey was carried out in which 37 points on the river between Portage Creek and the Oshetna River were examined for the presence of otter tracks (Figure 2). Forty-three otter tracks were present at 17 of these points (Table 20). The significance of these tracks is not clear. They may represent upriver or downriver movements of otters prior to freeze-up. Another possibility is that otters were concentrated along the river to feed on grayling as they left tributaries at freeze-up to overwinter in the Susitna River. A total of 54 mink trails were observed at 31 points. The mink tracks were fairly uniformly distributed along the river, although a slight increase in mink track density was observed upstream from Kosina Creek.

River otters are common in the upper basin of the Susitna River. Tracks were often sighted along the river, on tributary creeks to 1200 m and around Stephan Lake and other large lakes. Some otter trails were observed in cross-country travel, away from bodies of water. Such tracks may represent dispersal of subadult animals and have been noted in other areas of southcentral Alaska. Local trappers seldom take river otters. The animals are relatively difficult to trap and pelt values have usually not been high enough to justify the effort.

Mink are locally abundant near some streams and lakes. A total of 34 mink tracks were counted along aerial transects in November 1980 (Table 19). Of these, 27 were in riparian or lake shore habitats (Table 18). Mink tracks were observed along all major tributary creeks below 1200 meters in elevation.

Table 19. Preliminary tabulation of autumn 1980 aerial transect data, species by transect number.

Transect Number[a]	Marten	Fox	Short-tailed weasel	Mink	Otter	Totals
01	41	1	3	5	2	52
02	80	0	7	1	6	94
03	91	9	5	3	0	108
04	198	0	20	0	3	221
05	84	0	11	1	0	96
06	163	0	6	0	1	170
07	202	23	39	0	2	266
08	86	11	0	2	5	104
09	85	11	1	2	0	99
10	125	20	95	2	3	245
11	39	30	58	2	1	130
12	40	38	96	5	1	180
13	7	60	77	5	3	152
14	112	10	328	6	3	459
Totals	1353	213	746	34	30	2376

[a] See Figure 2 for transect locations.

TABLE 20. RESULTS OF OTTER AND MINK SURVEYS, SUSITNA RIVER, 10 NOVEMBER - 12 NOVEMBER 1980. NUMBER OF TRACKS OF EACH SPECIES OBSERVED AT NORTH AND SOUTH SIDES OF 37 RIVER CHECK POINTS.[a]

Checkpoint Numbers	North		South	
	Otters	Mink	Otters	Mink
01	3	0	0	0
02	0	2	0	0
03	0	0	0	0
04	0	0	3	1
05	0	0	2	0
06	0	0	0	0
07	0	1	0	1
08	0	0	0	2
09	0	0	1	0
10	0	0	0	2
11	4	1	0	1
12	3	1	0	0
13	0	0	0	1
14	2	0	3	1
15	0	0	4	0
16	3	1	0	2
17	0	3	0	4
18	0	0	0	2
19	0	0	1	2
20	2	0	1	0
21	1	1	0	0
22	0	0	0	0
23	2	1	0	2
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	4	0
28	0	0	4	0
29	0	0	0	2
30	0	0	0	0
31	0	0	0	0
32	0	0	0	3
33	0	2	0	3
34	0	1	0	2
35	0	1	2	3
36	0	0	2	2
37	0	1	0	2
Totals	20	16	27	38

[a] See Figure 2 for locations of river check points.

3.15 Other Furbearers

Coyotes

Coyotes occur in the study area, but their distribution is generally restricted to areas downstream from Devil Canyon. Mr. Ed Powell reported that on 12 September 1980, he heard a coyote howling a short distance southwest of the Stephan Lake Lodge. Mr. Harold Larsen, an employee of the Alaska Railroad at Gold Creek, reported trapping one coyote and seeing tracks of others during the winter of 1979-80. Mr. Phil Roullier, also of the Gold Creek area, informed us that during the past several years, he has found coyotes to be common in the Indian River - Canyon area. He reported hearing them howling often. Upstream from Devil Canyon, coyotes are less common. No coyotes or their tracks were observed by the furbearer team, nor were coyotes seen or taken by trappers upstream from Devil Creek.

Lynx

Lynx occur in the study area, but their distribution is very limited. On 19 November 1980, probable lynx tracks were observed on the Susitna River bar across from the mouth of Goose Creek. On 22 October 1981, this area was visited by members of the furbearer study team and a dense concentration of lynx tracks and scats was discovered. On 30 October 1981, two team members found lynx tracks at the mouth of Jay Creek and, on 3 November 1981, lynx tracks were seen along Goose Creek, 1.6 km from the mouth. Two trappers from Glenallen reported taking lynx in the vicinity of the mouth of the Oshetna River during winter 1976-77. Their impression was that lynx had not been numerous before or since that time. Trappers in the vicinity of the impoundments reported no sightings of lynx or their tracks. Reports from trappers in the Gold Creek area suggest that lynx have been uncommon there in recent years.

Although lynx appear to be uncommon in the study area at present (with the exception of the upper reaches of the proposed Watana Impoundment), populations may have been significantly higher in the past. The historical frequency of natural fire appears to increase between Portage Creek and the Tyone River. It may be that snowshoe hares have periodically been numerous in these burned areas in the past, and that lynx numbers were correspondingly higher.

Short-tailed Weasel

Short-tailed weasels are locally abundant in the study area. Their tracks have been observed in a variety of habitat types from the banks of the Susitna River to elevations over 1500 m. Seven hundred and forty-six tracks of short-tailed weasels were observed during transect surveys in November 1980; 328 were counted on a single transect near the Tyone River. Four hundred and eighty-nine of the total tracks were observed in woodland white or black spruce vegetation types and an additional 190 were counted in medium (Betula) shrub types. Trappers on upper Tsusena Creek, in the Fog Lakes area, and elsewhere take short-tailed weasels intentionally and incidental to the trapping of other species.

Least Weasel

Least weasels occur sparsely throughout the study area. Several sets of tracks were observed on lower Watana Creek in March 1980 which we felt were definitely made by least weasels. A carcass of a least weasel taken by a trapper at Fog Lakes was obtained in February 1981 and a live least weasel was observed near the southeast edge of borrow site A on 25 October 1981. Least weasels may be locally common in the study area, however, their small size and secretive behavior make confirmation of their presence difficult.

4 - ANTICIPATED IMPACTS UPON FURBEARERS

(a) Watana Dam and Impoundment

The flooding of the Watana reservoir will eliminate terrestrial furbearer habitat and create some habitat for aquatic furbearers. Quantity and quality of habitats created will depend upon the maximum pool elevation, stability of pool level, ice characteristics, draw-down zone vegetation and reservoir fish and invertebrate populations. Assuming that annual fluctuations in water level will be 30-50 m (90-150 ft.) vertically, and that water level will rise during summer, peak in autumn, and decline during winter, there will be a large, unvegetated draw-down zone. This draw-down zone and the aquatic habitat created will be of limited value to otters, mink, muskrats, and beavers.

The flooding of the Watana reservoir will cause loss of terrestrial furbearer habitat. The species most severely impacted from this habitat loss will be marten due to their high dependence upon forested habitats along the Susitna River and its tributaries. Foxes utilize riparian zones along the Susitna River and its tributaries during summer and autumn. Flooding of these areas may reduce the carrying capacity of the region for foxes and block traditional dispersal corridors. Limited numbers of lynx occur along the lower reaches of some tributaries and adjacent to the Susitna River between Vee Canyon and the Tyone River. Flooding of these sites may eliminate lynx from the immediate vicinity of the Watana Impoundment.

Development and maintenance of construction camps associated with the Watana Impoundment may displace a limited number of furbearers, particularly if camps are near fox dens or favored foraging areas for pine marten. Camps and construction areas should be designed to be as compact as possible. Care should be taken to properly store and dispose of garbage to avoid attracting foxes, marten and weasels to camps. Also, an educational program should be developed to prevent workers from feeding wild animals.

(b) Devil Canyon Dam and Impoundment

The Devil Canyon Reservoir will eliminate terrestrial furbearer habitat and create some aquatic furbearer habitat. The effects of these habitat changes will depend upon the pool elevation, ice conditions, and stability of the pool.

Aquatic habitat created by this reservoir may be of considerable value to otters, mink, and possibly to beavers and muskrats. Assuming that water level fluctuations are less than 2 m (6 ft.) vertically, that these fluctuations have a circadian cyclic nature, that vegetation is permitted to grow within 19 m (57 ft.) of the reservoir's shore and that suitable populations of prey fish are found in the reservoir we predict that otters and mink will be favorably affected by the habitat created. Beavers and muskrats utilize the area within the Devil Canyon impoundment zone very little at this time and may be favorably affected by the aquatic habitat created. However, Murray (1961) indicated that the rise and fall from the normal water level should be no more than .6 meters (2 feet) for beavers to utilize an area.

Construction camps associated with the Devil Canyon Impoundment may displace a limited number of furbearers. Problems are not expected to be as serious around Devil Canyon as they are in the Watana impoundment zone because furbearer numbers are generally lower near Devil Canyon. Property could be damaged and workers could be exposed to bites and wildlife-transmitted diseases if foxes, marten or weasels are attracted to camps by garbage stored or disposed of in a manner that leaves foods available to scavengers. Workers may attract furbearers to camps and construction sites by feeding them directly or establishing feeding stations.

(c) Borrow Areas

Excavation of borrow sites would have negative effects upon furbearers using the area. Left unvegetated, borrow areas would have little value to furbearers. Vegetation restoration measures would determine the suitability of restored habitats for various furbearer species. The creation of graminoid and shrub vegetation may be attractive to small mammals and birds and could provide valuable foraging habitat for foxes, weasels and coyotes, especially if vegetative heterogeneity is established. Because of the dependence of marten on a well-developed understory and specifically red squirrel middens, it is highly unlikely that marten would use revegetated borrow areas for resting sites in less than 100 years. Developing borrow sites under consideration along Tsusena Creek (c, e, f) could have negative effects on foxes, marten, mink, otters and short-tailed weasels throughout the drainage of that creek because of the relatively large area of land involved.

(d) Downstream Impacts

Projected changes in the flow rates of the Susitna River downstream from the Devil Canyon impoundment could result in marked changes in aquatic furbearer habitat. This was the case in the downstream portion of the Peace River following construction of the W.A.C. Bennett Dam where an extensive marsh on the Peace-Athabaska Delta became dry and furbearer numbers were reduced. Reduced circannual water level fluctuations could conceivably create a water flow regime more favorable to muskrats and beavers. On the other hand, elimination of peak flows at breakup or at other times may have the effect of drying up wetlands and reducing the amount of subclimax, riparian vegetation along the river's edge.

Aquatic and semiaquatic furbearers (beaver, muskrat, otter and mink) are not known to select habitats on the basis of water turbidity. It seems unlikely that these species would be affected favorably by a reduction in water turbidity. Altered fish populations may have major (positive or negative) downstream effects upon otters and mink. Predictions of such effects must await projections of changes in downstream fish populations.

Clearly beavers and probably muskrats are of significant ecological and economic importance downstream from Devil Canyon. Both species exist in quantities that can sustain a high and continuous harvest. Foremost among the questions to be addressed in Phase II studies are, (1) What will be the effects of relatively stable water levels upon beavers, muskrats and their habitats? (2) How will altered ice conditions impact beavers and muskrats? (3) What plant species are beavers dependent upon and how will these plants be effected by the hydroelectric development?

(e) Access Route

If care is taken to avoid wetland areas, the physical disturbance and habitat loss from road construction would be relatively minor due to the small amount of land involved. Access Plan 5 (road access from Parks Highway to Gold Creek, south side of the Susitna River to Devil Canyon, north side of the river to Watana) will minimize negative impacts to furbearers. The negative impacts from borrow site development for fill for roads will depend upon location and restoration measures. Borrow sites or extended sections of roadways in or adjacent to wetland areas, stands of white spruce, or near fox dens could be harmful. The most serious impacts from road construction will arise from improved human access and collisions of wildlife with vehicles. The public use impacts of roads would consist primarily of increased harvest and human harassment of furbearers in the study area. Roads would provide convenient access to areas which are now and have historically been remote. The severity of this impact would depend upon regulatory measures imposed. Vehicle-wildlife collisions would be another source of impacts to furbearers. The severity of this impact is difficult to predict because of the paucity of relevant published information. We believe that losses of furbearers resulting from vehicle collisions will be relatively low.

(f) Transmission Line

We assume that transmission system construction will involve placement of transmission towers between the dam sites and the Parks Highway. We also assume that helicopter construction techniques will be employed and that roads will not be built. If roads are built during construction of transmission systems, our comments under (e) Access Route apply. Impacts to furbearers from helicopter-assisted construction would consist chiefly of behavioral disturbance and would be relatively minor.

We assume that the operation of transmission facilities consists chiefly of occasional maintenance activities at transmission towers between the dam sites and the Parks Highway. We also assume that access for such maintenance work would be by means of helicopter. Impacts upon furbearers from these occasional maintenance activities would probably be negligible.

Vegetation clearing in transmission line corridors could provide habitat for small mammals, hares and nesting birds, provided the climax vegetation and soils are conducive to seral graminoid or woody browse communities. Small mammals, hares and nesting birds might then be utilized by foxes, marten, weasels, coyotes and possibly lynx.

5 - MITIGATION

A variety of techniques can be used to mitigate the negative impacts of the Susitna project on furbearers. In cases where the impacts are caused by loss of habitat, there are no practical management options available to compensate for the loss. In these situations the designation of replacement lands could serve to offset the loss.

Where project components represent a temporary loss or alteration of habitat, such as the borrow areas, construction camps, and most of the construction zone, it would be beneficial to restore the areas. Replacing topsoil, seeding, and fertilizing would permit these areas to return to some level of use by furbearers. The early successional vegetation that would develop would provide good foraging areas for furbearer species such as fox, short-tailed weasel and possibly lynx.

The impacts associated with the improper disposal of garbage and feeding of animals by workers could also be avoided through well-planned preventative programs. Prompt collection and proper disposal of refuse would greatly reduce the magnitude of this impact. Educating workers and strictly enforcing state laws concerning the feeding of animals would also help to avoid, or at least minimize, this problem. Fencing landfills and camp facilities could be done to further reduce the likelihood of a negative impact on furbearers.

The most difficult impact to mitigate is the influence of increased human access. Any efforts to restrict or control human activity within the upper basin will help reduce the negative consequences of this aspect of the project. Restricting the use of ATVs would be a major step in confining the extent of human disturbance.

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AUTHORITIES CONTACTED

Ralph Archibald, Biologist, Yukon Wildlife Branch, Whitehorse, Yukon Territory - Presently conducting marten studies in the Yukon. Provided information about marten habitat preferences.

Theodore Atwater, Alaska Railroad Employee, Talkeetna, Alaska. - Discussed historical furbearer population status in proposed impoundment region.

Joan Foote, Biologist, Institute of Northern Forestry, Fairbanks. - Contacted regarding habitat sampling procedures.

Dale Guthrie, Professor of Biology, University of Alaska, Fairbanks. - Valuable source of information on fox ecology in Alaska.

David Johnson, Biologist, Alaska Department of Fish & Game, Delta Junction, Alaska. - Provided information about furbearer harvests in interior Alaska.

Gregory Konkel, Habitat Evaluation Coordinator, U.S. Fish and Wildlife Service. - Discussed possibility of using HEP in assessment studies.

Ron Long, Trapper and Fur Buyer, Fairbanks, Alaska. A local fox trapper with extensive knowledge of furbearers. Discussed historical furbearer population changes.

Harold Larson, Trapper and agent for the Alaska Railroad at Gold Creek. - Provided information about coyotes and other furbearers near Gold Creek.

Robert Larson, Biologist, Alaska Department of Fish and Game, Delta Junction, Alaska. - Provided information about furbearer harvest in interior Alaska.

Audrey Magdun, Ph.D. candidate, Fairbanks, Alaska. - Volunteered information on red foxes in her North Slope study area.

Herbert Melchior, Furbearer Biologist, Alaska Department of Fish & Game. - Discussed furbearer harvests and management plans.

John Morrison, Supervisor of Biological Services Program, U.S. Fish and Wildlife Service. - Discussed possibility of using USFWS data bases to aid in assessing impacts of development upon wildlife in Alaska.

Don Newman and Mary Kay McDonald, Trappers, Denali Highway, Alaska. - Provided furbearer carcasses and local trapping information.

Edward Powell, Trapper and Lodge Manager, Stephan Lake Lodge, Alaska. - Discussed furbearer population history and habits in the Susitna study area.

Leroy Shank, Trapper, Fairbanks, Alaska. - Local marten trapper, provided historical information about furbearers.

Roger Smith, Trapper, Tsusena Creek, Alaska. - Local trapper, discussed trapping in the area and arranged for collection of carcasses.

Dr. Vic VanBallenberghe, Wildlife Biologist, Institute of Northern Forestry, Fairbanks, Alaska. - Former furbearer biologist with the Alaska Department of Fish and Game. Provided information on furbearers in the Susitna Basin and sampling and field techniques.

Glen Wingkte, Trapper, Kenai, Alaska. - Traps between Gold Creek and the Devil's Canyon dam site, provided information about furbearers trapped.

Bill Zielinski and Wayne Spencer, Biologists, Sagehen Creek Field Station, Truckee, California. - Conferred with these biologists about marten research they are conducting in California.

Lester E. Eberhardt, Terrestrial Ecology Section, Battelle Pacific Northwest Laboratories, Battelle Boulevard, Richland, WA 99352 - Provided techniques for radio collaring mink and weasels.

Al Sargeant, Northern Prairie Wildlife Research Center, P.O. Box 1747, Jamestown, ND 58401 - Conferred radio collaring mink and weasels.

Carol Resnick, Tsusena Creek, Alaska. - Provided information on furbearer occurrence in the study area, furbearer carcasses.

Dean Wilson, Copper Center, Alaska. - Discussed red fox harvests and trends in the study area vicinity.

APPENDIX I

Radio-location Data, Fox

Appendix I. Dates on which foxes were located by radio telemetry. Locations of foxes are numbered chronologically on Figures 5-9.

Deadman Creek Area, 1981

Adult ♀ 4021

Location Numbers	Dates of Location
1	2/27
2	5/13
3	5/19
4	5/20
5	5/26
6	6/4
7	6/15
8	6/18
9	6/20
10	6/22
11	6/25
12	7/16
13	7/17
14	7/30
15	8/2
16	8/7
17	8/15
18	8/25
19	8/28
20	9/9
21	9/13
22	9/16
23	9/20
24	9/27
25	9/30
26	10/2
27	10/3
28	10/16
29	10/20
30	10/25
31	10/30
32	11/17

Juvenile ♂ 4201

Location Numbers	Dates of Location
1	8/7
2	8/15
3	8/25
4	8/28
5	9/5
6	9/7
7	9/9
8	9/13
9	9/16
10	9/18
11	9/20
12	9/22
13	9/27
14	9/29
15	9/30
16	10/2
17	10/3
18	10/7
19	10/15
20	10/25

Juvenile ♂ 4081

Location Numbers	Dates of Location
1	8/7
2	8/15
3	8/25
4	8/28
5	9/5
6	9/7
7	9/9
8	9/13
9	9/16
10	9/18
11	9/20
12	9/22
13	9/25
14	9/27
15	9/29
16	10/2
17	10/3
18	10/7

Juvenile ♂ 4101

Location Numbers	Dates of Location
1	8/7
2	8/15
3	8/25
4	8/28
5	9/5
6	9/7
7	9/9
8	9/13
9	9/16
10	9/18
11	9/20
12	9/22
13	9/27
14	9/29
15	9/30
16	10/15
17	10/18
18	10/20
19	10/24
20	10/27
21	10/30

Appendix I. Continued

Clarence Lake Area, 1981

Adult ♂ 4040

Location Numbers	Dates of Location
1	5/14
2	5/20
3	5/27
4	6/11
5	6/13
6	6/15
7	6/20
8	6/22
9	6/25
10	7/17
11	7/27
12	8/2
13	8/7
14	8/25
15	8/28
16	9/5
17	9/20
18	10/1
19	10/7
20	10/19
21	10/24
22	11/10
23	11/17

Appendix I. Continued

East Fork Watana Area, 1981

Adult ♀ 4060

Location Numbers	Dates of Location
1	6/15
2	6/18
3	6/20
4	6/22
5	6/25
6	7/15
7	7/16
8	7/18
9	7/27
10	7/30
11	8/2
12	8/7
13	8/14
14	8/25
15	8/28
16	9/3
17	9/14
18	9/16
19	9/20
20	9/27
21	10/1
22	10/7
23	10/19
24	11/17

Juvenile ♂ 4545

Location Numbers	Dates of Location
1	7/16
2	7/17
3	7/27
4	7/30
5	8/2
6	8/7
7	8/14
8	8/25
9	8/28
10	9/14
11	9/16
12	9/20
13	9/27
14	10/1

Appendix I. Continued

Swimming Bear Lake Area, 1981

Adult ♂ 4280		Adult ♀ 4181		Juvenile ♂ 4132		Juvenile ♂ 4641		Juvenile ♂ 4471	
Location Numbers	Dates of Location	Location Numbers	Dates of Location	Location Numbers	Dates of Location	Location Numbers	Dates of Location	Location Numbers	Dates of Location
1	6/15	1	6/16	1	8/25	1	8/25	1	8/25
2	6/16	2	6/20	2	8/28	2	8/28	2	8/28
3	6/20	3	6/22	3	9/5	3	9/5	3	9/5
4	6/22	4	6/25	4	9/7	4	9/7	4	9/7
5	6/24	5	7/16	5	9/9	5	9/9	5	9/9
6	6/25	6	7/24	6	9/11	6	9/13	6	9/11
7	7/24	7	8/2	7	9/13	7	9/16	7	9/13
8	7/30	8	8/25	8	9/18	8	9/18	8	9/18
9	8/2	9	8/28	9	9/20	9	9/20	9	9/20
10	8/28	10	9/5	10	9/22	10	9/22	10	9/22
11	9/5	11	9/7	11	9/25	11	9/25	11	9/25
12	9/7	12	9/9	12	9/27	12	9/27	12	9/27
13	9/9	13	9/16	13	9/29	13	9/29	13	9/29
14	9/13	14	9/18	14	10/1	14	10/1	14	10/1
15	9/16	15	9/20	15	10/2	15	10/2	15	10/2
16	9/17	16	9/22	16	10/3	16	10/3	16	10/3
17	9/18	17	9/25	17	10/7	17	10/15	17	10/7
18	9/20	18	9/27	18	10/15	18	10/17		
19	9/22	19	9/29	19	10/17	19	10/25		
20	9/25	20	9/29	20	10/18				
21	10/1	21	10/1	21	10/20				
22	10/7	22	10/3	22	10/25				
23	10/3	23	10/7	23	10/29				
24	10/7	24	10/15	24	11/11				
25	10/15	25	10/17	25	11/17				
26	10/20	26	10/25						
27	10/25	27	10/29						
28	10/29	28	11/11						
29	11/11	29	11/17						
30	11/17								

Appendix I. Continued

Deadman Lake Area, 1981

Adult ♂ 4221

Location Numbers	Dates of Location
1	7/27
2	7/30
3	8/2
4	8/7
5	8/14
6	8/25
7	8/28
8	9/9
9	9/5
10	9/7
11	9/14
12	9/16
13	9/18
14	9/20
15	9/22
16	9/25
17	9/27
18	9/29
19	9/30
20	10/1
21	10/3
22	10/7
23	10/17
24	10/24
25	11/10
26	11/17

Juvenile ♂ 4441

Location Numbers	Dates of Location
1	7/27
2	8/2
3	8/7
4	8/14
5	8/19
6	8/25
7	9/5
8	9/9
9	9/9
10	9/14
11	9/16
12	9/18
13	9/20
14	9/22
15	9/25
16	9/27
17	9/29
18	9/30
19	10/2
20	10/7

Juvenile ♀ 4492

Location Numbers	Dates of Location
1	7/27
2	8/2
3	8/7
4	8/14
5	8/19
6	8/25
7	9/5
8	9/9
9	9/9
10	9/16
11	9/18
12	9/18
13	9/20
14	9/22
15	9/25
16	9/27
17	9/30
18	10/1
19	10/2
20	10/3
21	10/20
22	10/24
23	10/27

Juvenile ♂ 4515

Location Numbers	Dates of Location
1	7/27
2	8/2
3	8/2
4	8/14
5	8/19
6	8/19
7	8/25
8	9/5
9	9/7
10	9/9
11	9/13
12	9/16
13	10/7