SUSITNA HYDROELECTRIC PROJECT
1983 ANNUAL REPORT

BIG GAME STUDIES

VOLUME VII WOLVERINE

Jackson S. Whitman and Warren B. Ballard

ALASKA DEPARTMENT OF FISH AND GAME
Submitted to the Alaska Power Authority
April 1984

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NOTICE

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

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PREFACE

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

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

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

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

The reports are organized into the following 9 volumes:

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

SUMMARY

From 1980 to 1983, 22 wolverine were instrumented and monitored for various lengths of time to assess the impacts of the proposed Susitna Hydroelectric Project. To gain additional information on mortality, natality and sex and age ratios, 136 additional wolverine were examined that were harvested from or adjacent to the study area.

Annual home ranges of males averaged 535 km^2 and females 105 km^2. It is suspected that there is very little overlap between home ranges of adult males, but much overlap between the sexes. Wolverine showed differential elevational and subsequent vegetation use in different seasons. In July, elevational use averaged 1,043 m with a corresponding decreased use of spruce habitat types. January elevational use averaged 818 m, with a concurrent increase in spruce forest use. Seasonal diet changes probably induce the elevational differences. The sex ratio of 158 captured and harvested wolverine was 50:50. Data indicate that approximately 30% of the harvest was comprised of juveniles.

Probably the most serious impact of Susitna Hydroelectric development on wolverine will be permanent loss of winter habitat. Forty-five percent of all instrumented wolverine had home ranges that overlapped the impoundment zone and will be displaced to some degree when reservoir clearing or filling begins. Also, a reduction in the moose population will result in a reduction in the amount of carrion available to wolverines during winter.

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INTRODUCTION

As a licensing requirement for Susitna Hydroelectric Project, the Alaska Power Authority contracted the Alaska Department of Fish and Game (ADF&G) to provide data on certain big game species including wolverine (*Gulo gulo*). Baseline data on wolverine ecology were collected during Phase I feasibility studies (Gardner and Ballard 1982). Wolverine studies continued during Phase II, providing additional information to be used by the Federal Energy Regulatory Commission in assessing the Susitna Project license application. Phase II studies continued through June 1983 (Whitman and Ballard 1983) at which time the Alaska Power Authority decided sufficient data were available upon which to base impact assessments. This report summarizes Phase I and Phase II efforts, and cites impacts on the wolverine population resulting from this project.

METHODS

From April 1980 to April 1983, 22 wolverine were captured and fitted with transmitter-equipped collars. Capture methods followed Ballard *et al*. (1981). Immobilization of wolverine (Ballard *et al*. 1982) was done utilizing one of three chemical combinations: (1) 0.25 cc phencyclidine HCl (100 mg/ml Sernylan, Bioceutic Lab., Inc.) and 0.20 cc Xylazine HCl (100 mg/ml Rompun, Barrett Division of Cutter Laboratories, Inc.); (2) 0.4 cc etorphine (1 mg/cc M-99, D-M Pharmaceuticals, Inc.) and 0.5 cc Rompun; and (3) 0.5 cc Sernylan and 0.5 cc promazine HCl (50 mg/ml Sparine, Wyeth Laboratories, Inc.). In cases where M-99 was used, an equal dose of diprenorphine (0.5 mg/cc M-50-50, D-M Pharmaceuticals, Inc.) was administered intra-muscularly as an antagonist once handling of the animal was finished. When Sernylan was used, no antagonist was given. Once immobilized, each wolverine was fitted with a radio-collar (Gardner and Ballard 1982), measured, ear tagged, and an estimate of age was recorded.

Instrumented wolverine were located utilizing methods described by Mech (1974). Point locations were recorded on 1:63,360 U.S.G.S. topographical maps along with the following parameters: date, time, activity, number of associates (wolverine or other large vertebrates within approximately 400 m), elevation, aspect, slope, and vegetation type. For evaluation of home range and habitat use, date, elevation, aspect, slope and vegetation type were analyzed.

From the mapped point locations, seasonal and annual home ranges were calculated (Mohr 1947). Only one wolverine was repeatedly located for an entire year before contact was terminated. Calculations of annual home range size were done using logarithmic curves with time and cumulative home range size as X and Y axes, respectively.

Use of various elevational strata by instrumented wolverine was recorded and statistical analysis of areas avoided or preferred was completed using chi-square analysis. To arrive at a value for available elevations, all section corners within the boundaries of wolverine territories were used as random samples, and they were compared to elevations of known point locations. Elevations were delineated into 300 m strata for analysis.

For analysis of the vegetation component of habitat selection, dominant vegetation was recorded for each wolverine radio-location. For tree and tall shrub categories, this consisted of the overstory vegetation, and for types where no trees or tall shrubs were present, the dominant low vegetation type was recorded. Because vegetation cover typing in the Susitna Basin has been done only on 1/63,360 scale (McKendrick *et al*. 1982), scattered small habitat types such as rockpiles were not detectable. However, based upon wolverine use of various cover types at different times of year, it was possible to compare seasonal use of vegetation.

Aspect at each location was also recorded. Based on a sample of 1,000 randomly selected aspects within territories of instrumented wolverine, there was no significant ($P > 0.05$) deviation from an expected 12.5% availability within each of the 8 compass directions. Therefore, a chi-square analysis with equal expected values was employed for determing preference.

Although slopes were recorded at each wolverine point location into one of 6 classes (from flat to steep), these data were not analyzed as part of habitat use. We felt that the classifications done aerially were far too subjective and related more closely to micro-habitat which could not be accurately delineated on 1:63,360 scale maps, making availability comparisons inaccurate. Therefore, no preference or avoidance analysis was done.

In addition to captured wolverine, carcasses of harvested wolverine were purchased from trappers to gain additional data on morphology, reproduction and distribution. Harvest records and track sightings by project personnel and the public were used to supplement tracking data.

STUDY AREA

The core study area is a 7,700 km^2 portion of the Susitna and Talkeetna River drainages (Fig. 1). The Talkeetna Mountains are the major geologic feature, with elevations rising over 2,200 m. Elevations on the Susitna River at the western boundary of the study area are less than 260 m. Vegetation throughout the lower elevations (generally less than 1,000 m) is dominated by spruce forests (*Picea glauca* and *P. mariana*) with a mosaic of interwoven shrub and deciduous tree types (McKendrick *et al*. 1982). Above treeline, sedge-grass tundra, mat and cushion tundra and birch shrub (*Betula glandulosa*) are interspersed in most areas.

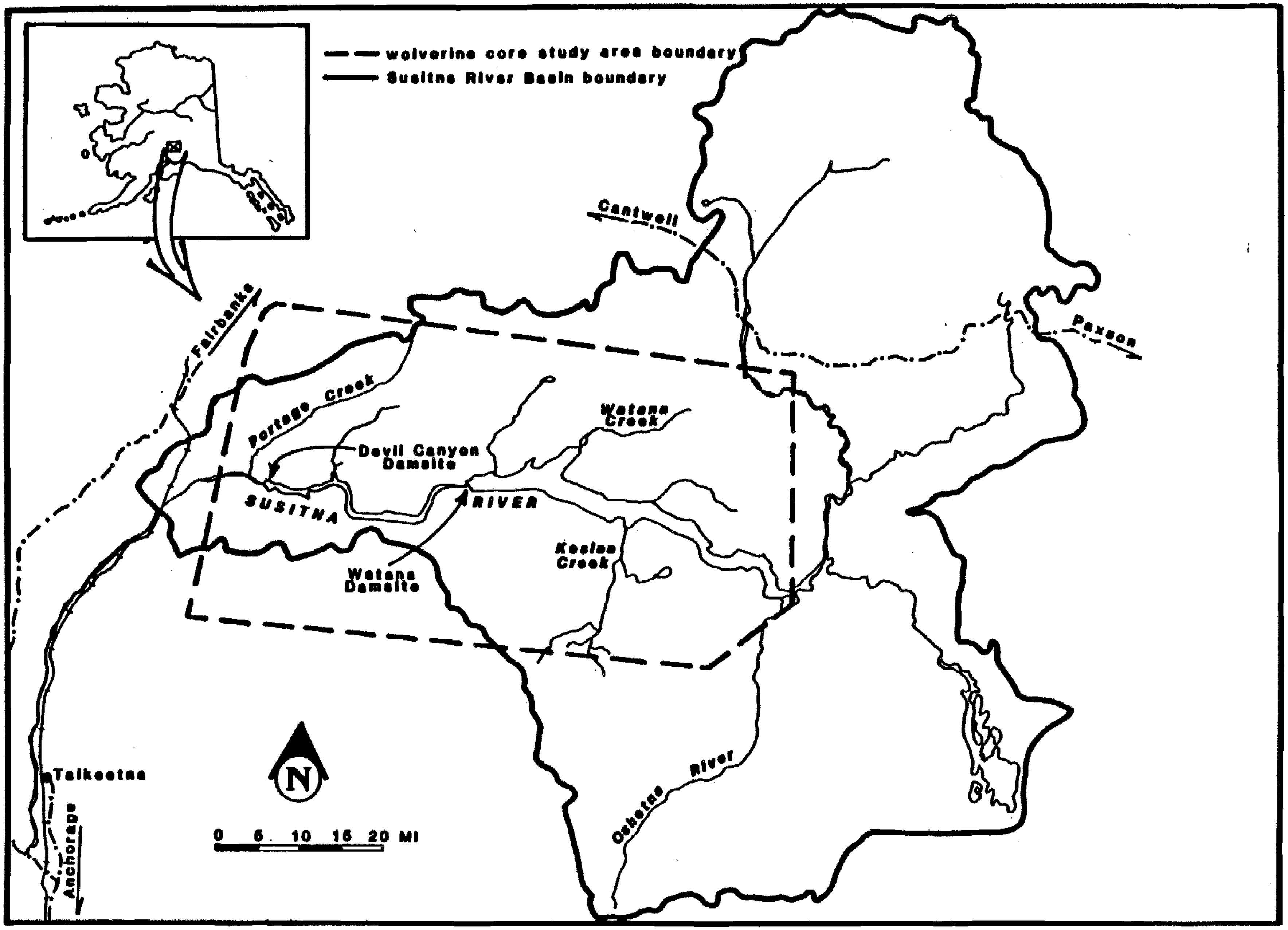

Figure 1. Wolverine study area within the middle Susitna River Basin in southcentral Alaska.

The climate of the study area is characterized by cool, rainy summers and cold, relatively dry winters. Snow is usually present from October through April in the lower elevations. At higher elevations, snow cover normally lasts from September through May. A weather station at Summit, located near the northwest boundary of the study area, shows a mean annual precipitation of 480 mm. Daily average temperature extremes are -18.0C and 11.0C in January and July, respectively, for an annual mean of -3.5C.

Additional habitat, climate, and topography descriptions are given by Gardner and Ballard (1982), Skoog (1968), Bishop and Rausch (1974) and Ballard and Taylor (1980).

RESULTS AND DISCUSSION

From April 1980 to April 1983, 22 wolverine were captured a total of 25 times (Table 1) and fitted with transmitter-equipped collars. Data from instrumented wolverine was gathered until June 1983, at which time limited funds precluded further monitoring. Between date of instrumentation and date of final contact, monitoring of all wolverine averaged once every 12.2 days. Length of contact varied significantly and ranged from 0 days to 426 days. Mortality and transmitter failure were the primary reasons for loss of contact with individual wolverine (Table 1). Another plausible explanation for shorter than expected contact may have been due to wolverine dispersing from the study area. In most cases, however, adjacent areas were searched extensively before the wolverine's status was listed as "unknown" and in four cases (18%) wolverine whose status was listed as "unknown" were either harvested or recaptured by us within the study area at later dates, verifying the suspected transmitter malfunction. In only one case (5%) dispersal out of the study area was verified (Gardner, pers. comm.).

Table 1. Wolverine capture and telemetry data from the middle Susitna River from April 1980 through December 1983.

Wolverine Identification No.	Sex	Age	Weight (Kgs)	Date Instrumented	Contact Days	Number of Locations	Present Status
040	M	Adult	14.5	4/10/80	369	40	Dead; natural mortality
041	M	Adult	15.5	4/19/80	-	1	Dead; capture-related mortality
042	F	Adult	9.5	4/19/80	115	18	Unknown
043	M	Unknown	17.7	5/06/80	212	26	Dead; trapper harvest
044	M	Unknown	-	5/07/80	155	13	Unknown
050	M	Young	17.7	3/06/81	19	5	Dead; dispersed then trapper harvest
066	M	Adult	12.7	11/13/81	52	7	Dead; trapper harvest
067	M	Young	14.5	12/04/81	167	15	Dead; trapper harvest
068	M	Adult	16.3	12/04/81	217	18	Dead; trapper harvest
069	F	Adult	10.4	12/05/81	38	4	Unknown
070	M	Adult	17.2	12/06/81	234	20	Unknown
071	M	Young	15.9	12/08/81	8	3	Dead; trapper harvest
088	F	Adult	11.3	4/09/82	66	8	Transmitter malfunction
089	F	Adult	11.8	4/09/82	311	18	Monitoring continuing
090	M	Adult	19.1	4/10/82	83	6	Unknown
091	M	Adult	16.8	4/10/82	426	12	Monitoring continuing
092	F	Adult	13.2	10/14/82	146	8	Dead; trapper harvest
096	F	Adult	10.9	12/03/82	6	4	Dead; capture-related mortality
145	F	Adult	15.9	4/06/83	220	12	Monitoring continuing
146	F	Young	15.0	4/06/83	182	11	Monitoring continuing
147	F	Adult	14.1	4/07/83	98	9	Monitoring continuing
148	M	Adult	15.4	4/07/83	15	5	Unknown
					3,139	258	

Home Range Estimation

Only 1 wolverine (040) was continuously monitored over an entire year. Using Mohr's (1947) methodology for calculating home range size, 040 utilized an area encompassing 627 km^2, with an average of 9.97 days between contacts. Because length of time between locations probably influences the apparent home range size, the variance of days between locations was also calculated, along with the standard error. Because no strict sampling regimen was adhered to due to inclement weather and other factors, a wide variation was noted between location dates (e.g., in some cases wolverine were located on successive days and other times it was over 30 days between locations). When mean number of days between locations was ≥20 days or when the standard error was ≥15 days, the data were deemed inappropriate for analysis based upon this method, and no home range calculations were done. Additionally, wolverine monitored for periods of time ≤100 days and/or those that provided ≤10 locations were not subjected to the logarithmic curve analysis simply because the data were judged to be insufficient.

After disqualifications due to the above constraints, only 7 wolverine (4 males, 3 females) were subjected to the logarithmic curve analysis for annual home range estimation (Table 2). Based upon logarithmic transformations of the number of days versus the cumulative size of home range, an analysis of variance showed plotted line slopes to be similar (F test for difference between slopes is 1.6709). However, using a 1-tailed F-test, a highly significant difference ($P < 0.001$) was evident between the line amplitudes of the two sexes, indicating males have a significantly larger annual home range than females (F value = 266.9, $P < 0.001$). Although no standard error can be statistically calculated because of the log transformation, it appeared males utilized an average annual home range of 535 km^2 and post-partus females 105 km^2. Two of the 4 males used in the analysis were

Table 2. Wolverine relocation data upon which extrapolations of annual home ranges were made, and estimated annual home ranges of 7 wolverine in the middle Susitna River Basin, Alaska

Wolverine number	Sex	Age class	Number of relocations	Total days monitored 1/	Mean no. days between monitoring	Standard deviation of days between monitoring	Used for analysis	r	Estimated annual home range
040	M	adult	37	369	9.97	7.85	Yes	0.985	612
041	M	adult	0	-	-	-	No 2/	-	-
042	F	adult	17	115	6.76	5.65	Yes	0.889	137
043	M	unknown	26	212	8.15	5.68	Yes	0.964	359
044	M	unknown	12	155	12.92	9.30	Yes	0.954	601
050	M	young	4	19	4.75	2.22	No 2/	-	-
066	M	adult	6	52	8.67	5.16	No 2/	-	-
067	M	young	14	167	11.93	13.21	No 3/	0.755	-
068	M	adult	17	217	12.76	8.77	Yes	0.922	566
069	F	adult	3	38	-	-	No 2/	-	-
070	M	adult	19	234	12.32	8.34	No 3/	0.812	-
071	M	young	3	8	-	-	No 2/	-	-
088	F	adult	7	66	9.43	6.24	No 2/	0.806	-
089	F	adult	16	256	16.00	13.36	Yes	0.877	107
090	M	adult	5	83	16.60	11.76	No 2/	0.970	-
091	M	adult	11	426	38.73	48.31	No 4/	-	-
092	F	young	7	146	20.86	21.64	No 2/	0.825	-
096	F	young	3	-	-	-	No 2/	-	-
145	F	adult	12	220	18.58	13.14	Yes	0.917	72
146	F	young	9	182	20.22	15.37	No 2/	0.964	-
147	F	adult	8	98	12.25	10.62	No 2/	0.949	-
148	M	adult	3	15	5.00	2.65	No 2/	-	-

1/ Number of days between date of capture and date of final location.

2/ Too few relocations.

3/ r value not significant.

4/ Standard deviation of periodicity of tracking flights too high.

not accurately assigned to an age class in the field, so it is not known whether they were adults or young. Wolverine 043 may have been a young individual with a smaller home range, thus the pronounced difference from the other males. The females, however, were known adults, and it is suspected that in all 3 cases they were accompanied by or associated with their young during most or all of the monitoring period. Magoun (pers. commun.) suggested that post-partus female wolverine on the North Slope of Alaska utilized extremely limited home ranges, simply because of site attentiveness to the den location where the young were being reared.

Although one other adult female wolverine (147) had too few locations upon which to base an accurate logarithmic curve analysis, she utilized an area of more than 290 km^2 (almost 3 times greater than the average of 3 post-partus females) in a period of 98 days (based on 8 locations). She was lactating slightly when captured, but was never accompanied by young on subsequent radio-tracking flights; therefore, we assumed she had lost her litter. Based upon that observation alone, we can assume that females without young do utilize areas larger than those with young, but the degree of difference would be largely speculative. Therefore, our findings support the theory that an increase in the size of the home range does occur in winter when wolverine move to lower elevations.

In most, if not all mustelid populations, the males generally range over a much greater area than females (Magoun, pers. commun.; Melquist *et al*. 1981; Whitman 1981; Messick and Hornocker 1981; Messick *et al*. 1981). Harestad and Bunnell (1979) suggested that body weight in pine marten (*Martes americana*) was a factor in home range size, as the males, being heavier, utilize larger areas than the lightweight females.

However, Pullainen (1981) said that in *M. martes* in northern Europe, the home range of males is much larger than females and that the equation presented by Harestad and Bunnell (1979) is insufficient to predict that great difference in home range size.

Other factors undoubtedly contribute to an animal's home range size. Harestad and Bunnell (*op. cit.*) point out that "an animal living in a habitat of low productivity will have a larger home range than that predicted by the generalized relationship between home range and body weight," and that "regardless of trophic status or weight of the species there is a clear tendency for larger home ranges at higher latitudes." These points seemingly hold true for wolverine when one compares our results with studies conducted elsewhere. Hornocker and Hash (1981) reported annual home ranges in Montana of 422 km^2 for males and 100 km^2 for lactating females. In males, our estimate of 535 km^2 is slightly larger than the Montana study, probably due to a combination of habitat productivity and latitude differences. A comparison of post-partus female home range size shows Montana and Alaska wolverine to be similar.

Harestad and Bunnell (1979) also said that "*Martes* and *Mustela* may increase their home range during winter." As we show later, there is a significant change ($P < 0.05$) in altitude use from summer to winter. Therefore, our findings support the theory that an increase in the size of the home range does occur in winter when wolverine move to lower elevations.

Harestad and Bunnell (1979) presented a female:male ratio of size of home range for carnivores of 0.52 ± 0.08. Our findings suggest that the post-partus female:male ratio in southcentral Alaska is 0.20, substantially lower than suggested by Harestad and Bunnell (1979). Perhaps this gross difference is due, at least in part, to our sample being comprised wholly of post-partus females. Indeed, although not statistically sound, our data suggest that in one case where we suspected the female was not raising a litter, her home range size was significantly greater than those data gathered from the post-partus females, and would probably more closely approximate the 0.52 ± 0.08 ratio presented by Harestad and Bunnell (*op. cit.*). In studies conducted in Montana (Hornocker and Hash 1981) the female:male ratio of home range sizes was 0.92, indicating a disparity of even greater magnitude than our study, and in an opposite direction. Magoun (pers. comm.) said that post-partus females in her northwestern Alaska study area showed extreme site fidelity to denning locations where the young were being raised, and summer home ranges were extremely small, probably increasing in winter.

Despite the geographical differences in home range sizes between northwestern Alaska, Montana, and this study, there does appear to be a common attribute. Males utilize areas somewhat larger than females. The areas utilized by post-partus females is extremely limited, at least throughout the summer, and probably increases through the winter.

To provide meaningful population estimates, another primary factor which must be considered is the extent of overlap among and between sex and age groups. Very few data were collected in this study upon which we could provide an adequate assessment of this overlap. Koehler *et al*. (1980) found territorial defense to be nonexistent in Montana. Magoun (1980) reported that adult females excluded other adult females during the period April through September. Both authors concurred that overlap did exist between sexes. Further study should be encouraged in which all or most of the wolverine within a relatively small area be captured and monitored over an entire year.

Elevational Use of Habitat

Within the annual home ranges of any one wolverine, a diversity of habitats are available. Use of these habitats is variable according to season, and one easily measured parameter is elevation, since vegetation and associated potential prey species are distributed unevenly among elevational strata (Kessel *et al.* 1982).

Average elevations for all wolverine were calculated by month (Fig. 2). Wolverine generally moved to higher elevations in summer and lower elevations in winter (954 and 874 m elevation respectively) with no overlap between the means ($P < 0.05$) (Figure 3). There appeared to be no differences ($P > 0.05$) between sexes in mean elevation use.

Changes in elevational use between seasons is probably induced by differences in prey distribution and abundance (van Zyll de Jong 1975, Gardner and Ballard 1982, Kessel *et al.* 1982). Arctic ground squirrels (*Spermophilus parryii*) and other small mammals and ground-nesting birds probably constitute much of the spring and summer diet.

To further test elevational use of annual home ranges by wolverine, a chi-square test between availability and use was conducted (Figure 4). When elevations were analyzed in 61 m intervals, only 5 strata showed significant differences between availability and use ($P < 0.05$). However, at 305 m intervals (Figure 5) the 2 strata between 305 m and 914 m elevation were significantly preferred and elevations lying between 1,219 and 1,524 m elevation were avoided.

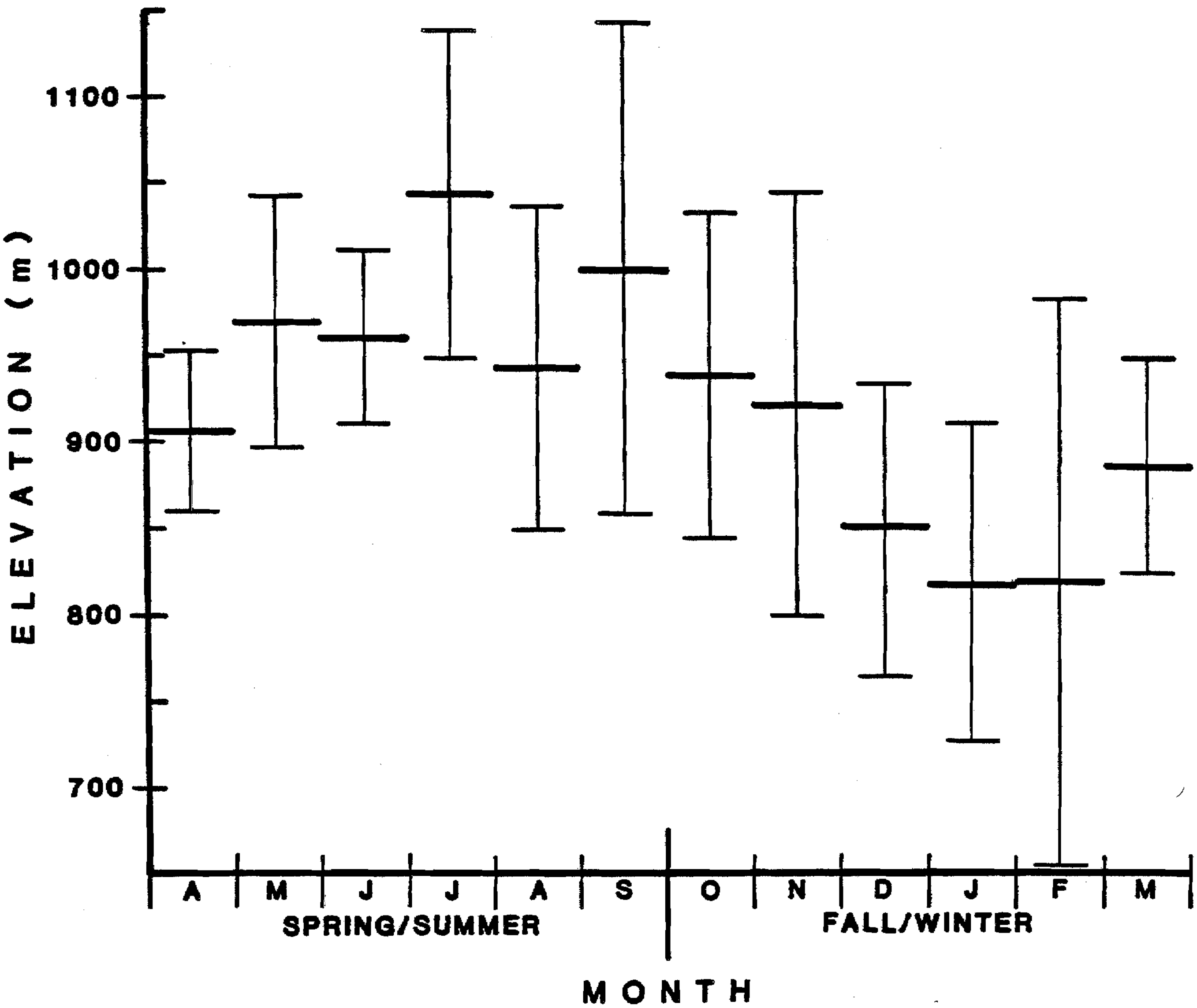

Figure 2. Mean monthly elevations and 95% confidence intervals for 22 instrumented wolverine in the Susitna River Basin, 1980-83.

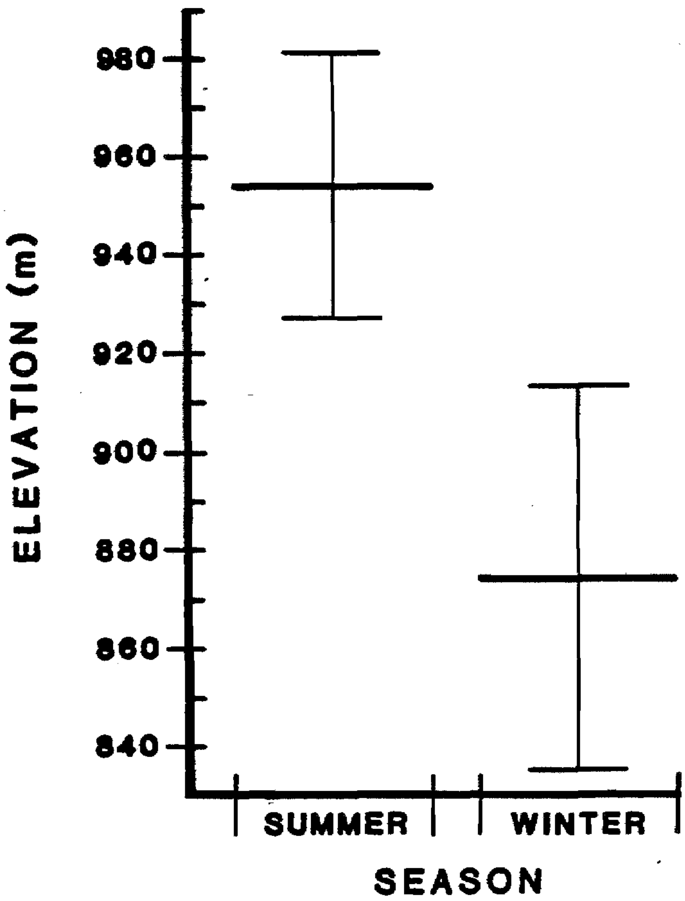

Figure 3. Summer and winter mean elevational distribution and 95% confidence intervals of 22 wolverine in the Susitna River Basin, 1980-83.

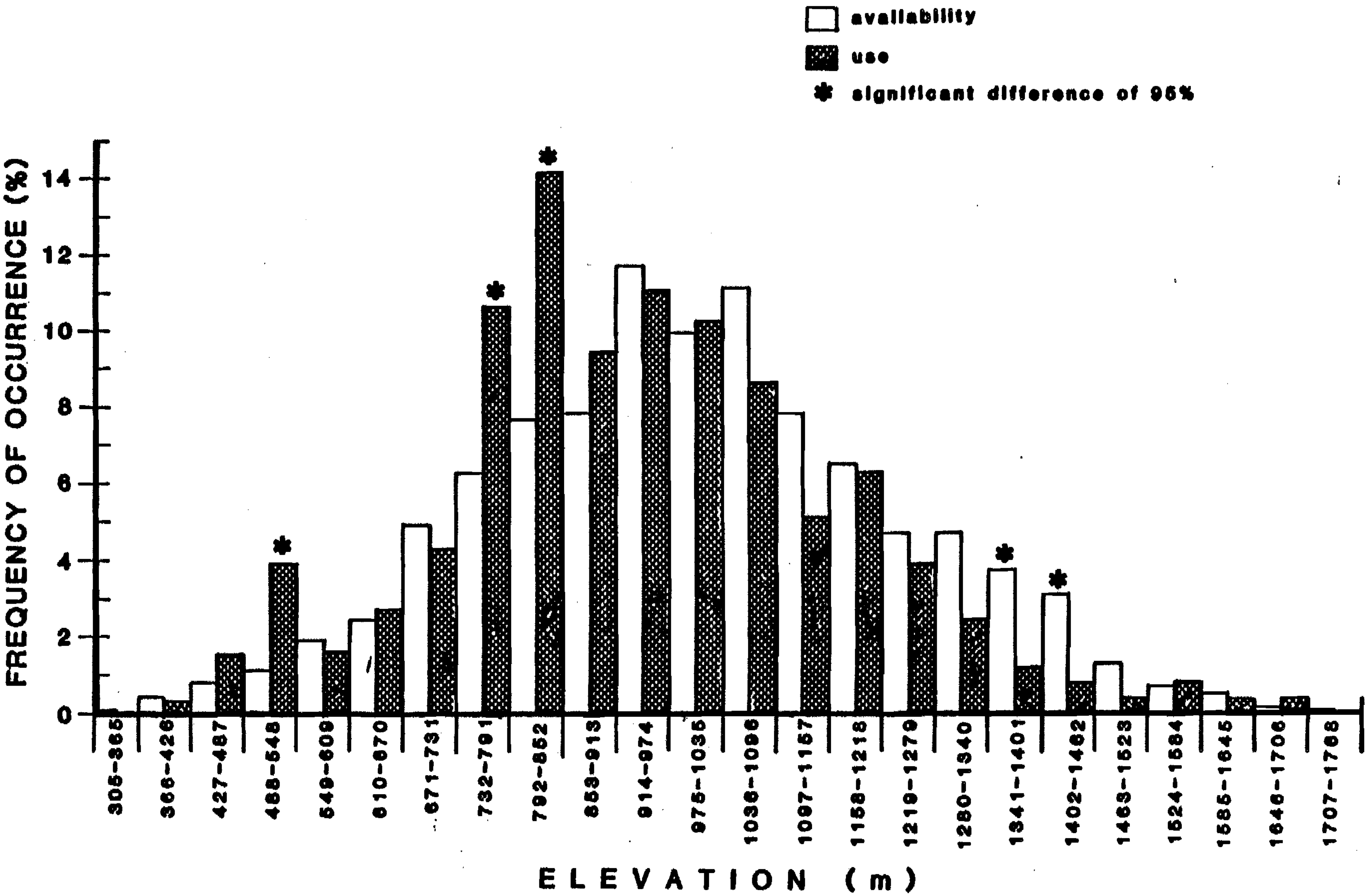

Figure 4. Availability versus use of various 61m elevational strata utilized by 22 instrumented wolverine in the middle Susitna River Basin, Alaska, 1980-83.

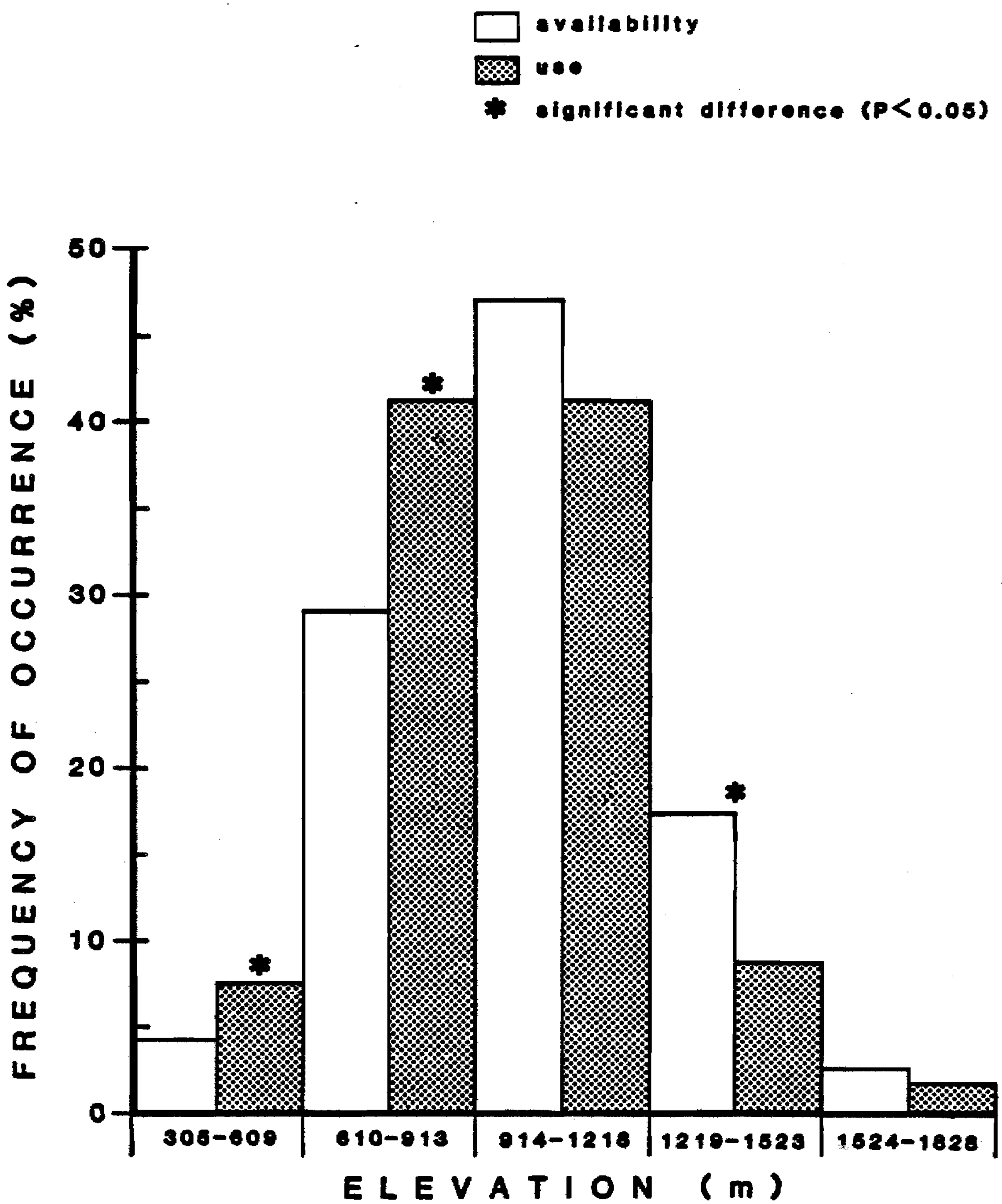

Figure 5. Availability versus use of various 305m elevational strata utilized by 22 instrumented wolverine in the middle Susitna River Basin, Alaska, 1980-83.

Vegetation Use

Gardner and Ballard (1982) present data for 4 wolverine where locations were related to vegetation type. They noted a preference for ecotonal areas, but admitted there were biases due to a limited number of data points. Our analysis is based upon differences in observed use between sexes and seasons.

At each wolverine point location, the surrounding vegetation was recorded. The 5 categories were broad vegetation types, based upon the dominant overstory vegetation. After plotting the percent of monthly use (Figure 6) for each vegetation type, only 1 type showed a significant difference between summer and winter. Use of areas dominated by spruce was significantly less ($P < 0.05$) in the period May through November than at other times of year. In the study area, an inverse relationship exists between percent of area covered by spruce forest and elevation, so it was not surprising that in summer, when use of higher elevational strata by wolverine was evident, concomittant use of spruce forests diminished.

No relationship existed between use of brush types, tundra, or rocks that was statistically significant, either between the sexes or seasonally. Based upon a subjective estimate of availability, talus slopes and rubble outcrops appeared to be preferred cover types. However, it is not known in most cases whether wolverine fled to these areas as escape cover when the radio-tracking aircraft approached or whether the wolverine was foraging actively in these areas.

Sex and Age Ratios

A total of 158 wolverine have been examined either alive during capture operations or as carcasses purchased from hunters and trappers (Table 3). Sex ratios were not significantly different from 1:1 ($chi^2 = 0.64$, $P > 0.05$).

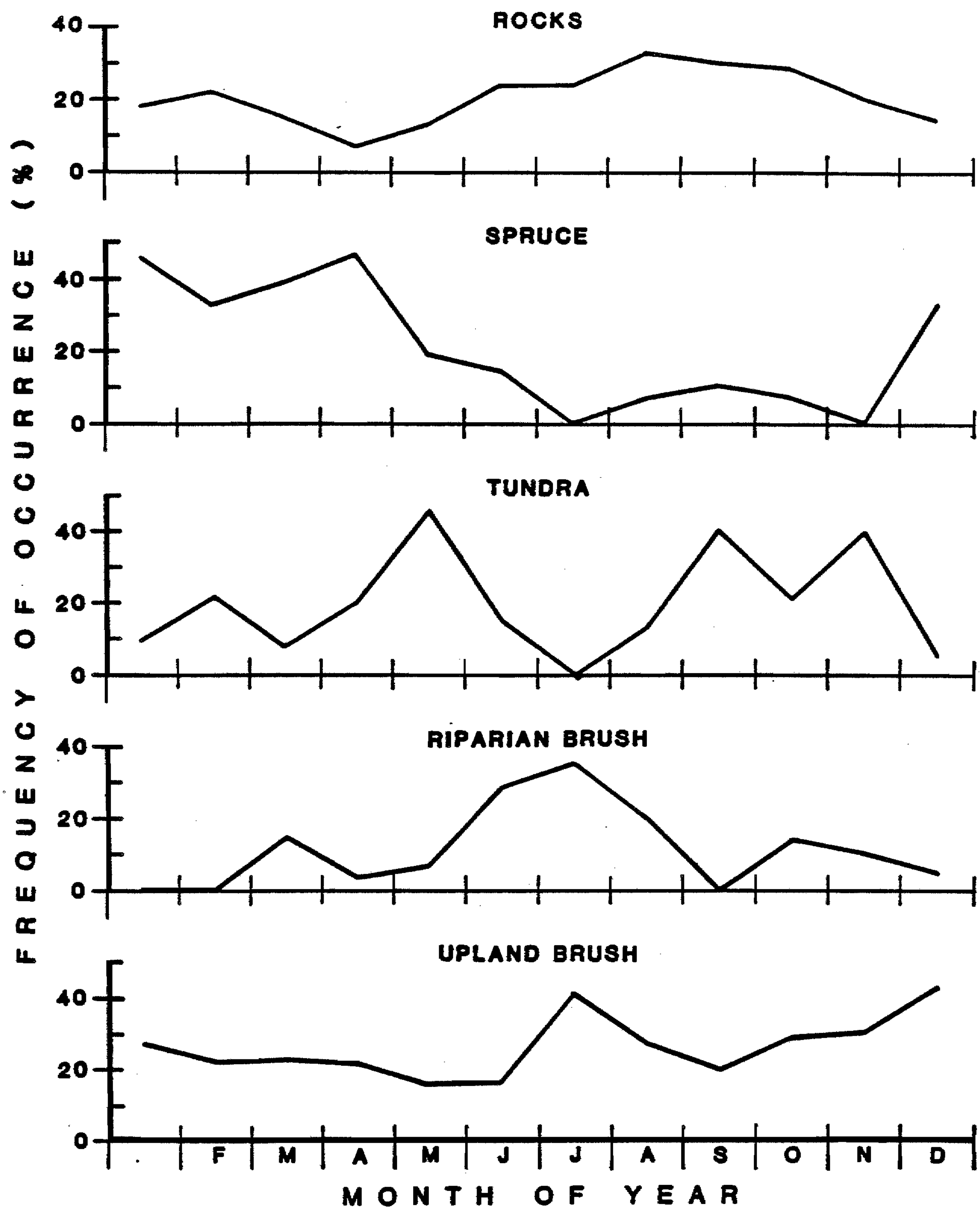

Figure 6. Average use of 5 habitat types by month of the year based on 250 radio-locations from April 1980 to November 1983 in the middle Susitna River Basin, Alaska.

The age structure of the population is not well known. Although we have undertaken some tooth cementum analysis, the technique has not been verified through analysis of known-age specimens. However, a subjective classification of young versus adults based upon tooth wear patterns and examination of reproductive organs suggest that about 30 percent of the harvest is made of juveniles (‘2 years old). No significant difference in the age ratios between the sexes was found.

POTENTIAL IMPACTS

Whitman and Ballard (1983) presented 3 scenarios which may occur following inundation of the area upstream of the Watana dam site. In all scenarios, decreased moose populations will eventually (1-3 years) result in decreased carrion available to wolverine in winter. These and other changes in prey density will affect wolverine movements, densities, and population size. Improved access and a larger human population in the area will undoubtedly present the potential for higher harvests. Should this prove excessive, however, the state game regulatory process can restrict these losses.

Localized avoidance of work camps and facilities will probably not significantly influence wolverine movements or productivity. However, habitat loss due to inundation and access corridors will certainly influence these parameters. The Alaska Power Authority (1983) has estimated that due to inundation and associated activities and facilities, the carrying capacity will be decreased by 2 wolverines. The reasoning behind this assumption is that since average wolverine home range size is 163 km^2 (Whitman and Ballard 1983) and a total of 206 km^2 will be affected, only 2 wolverine will be displaced. However, inundation of low-level areas will result in a permanent loss of winter habitat. We have calculated that 45% (9 of 20) of all instrumented wolverine have home ranges that overlap the impoundment zone. Assuming Whitman and Ballard's (1983) estimate is correct, at least 35 wolverine (45% of basin population) would be impacted to some degree by the impoundment alone. The additional wolverine habitat altered by transmission corridors, access roads, and work camps, will further increase the percent of wolverine affected.

ACKNOWLEDGEMENTS

Without the efforts of many people this report would not have been possible. The Alaska Power Authority provided operational funds. Karl Schneider, ADF&G, provided guidance, support and editorial review. Craig Gardner, ADF&G, provided many of the original ideas and much enthusiasm for the project. SuzAnne Miller, ADF&G, provided statistical review of the manuscript. Bush pilots Al and Jerry Lee, Lee's Air Taxi, Harley and Chuck McMahan, McMahan's Flying Service, and Ken Bunch and Ken Sumey, Gulkana Air Service all flew fixed-wing aircraft for collaring and radio-tracking operations. Helicopter piloting and on-site assistance for wolverine collaring was done by Vern and Craig Lofstedt, Kenai Air Service.

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