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H A B I T A T U S E

B Y M O U N T A I N G O A T S

BY
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Volume IV
Project Progress Report
Federal Aid in Wildlife Restoration
Project W-21-2, Job 12.4R

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Christian A. Smith, Kenneth Raedeke, Joseph Fox, Tom Hanley, and Paul Harrington

Project No.: W-21-2 Project Title: Big Game Investigations

Job No.: 12.4R Job Title: Habitat Use by Mountain Goats in Southeastern Alaska

Period Covered: July 1, 1980 through June 30, 1981

SUMMARY

Seven female mountain goats from 1.3 to 10 + years old and 3 male mountain goats 2.3, 9.3, and 10.3 years old were captured using projectile darts loaded with M99 and fired from a helicopter in July and August 1980. Each goat was ear-tagged and fitted with a Telonics radio collar. Two of these goats died during the winter and 1 died in the spring.

Radio-collared goats were monitored from fixed-wing aircraft from November through June, resulting in 100 radio relocations. Descriptive habitat data were collected each time a goat was located including: slope, elevation aspect, terrain type, habitat type, canopy cover, snow conditions and habitat patchiness.

Males were found to move between ridge complexes while females remained on the ridges where they were captured. Inter-ridge movements by males appeared to be associated with the rut and contributed to relatively large winter home ranges. Females generally occupied limited home ranges of 20 to 600 ha.

All goats, except one young male, primarily used higher elevation portions of the ridges, apparently because snow accumulations were not sufficient to restrict goat activity. Most radio relocations were made when animals were associated with steep, broken terrain in old-growth forest communities with moderate canopy coverage. The extensive use of forest habitat by these goats is atypical when compared with available literature and warrants further study. Additional data are required to critically evaluate seasonal trends and controlling forces in habitat selection.

CONTENTS

BACKGROUND

In southeastern Alaska mountain goats *(Oreamnos americanus)* occur on most major ridge complexes of the mainland and have been introduced successfully to Baranof Island. Throughout this region, goats utilize habitat types on a seasonal basis ranging from high volume, old-growth timber stands near sea level to barren rock and glaciers at several thousand meters elevation. Despite their wide distribution and importance as a game animal, virtually no studies of coastal goat populations were conducted in Alaska prior to the late 1970's. To some extent, this lack of research was due to the relatively low priority given to concern about human impact on goats. The combined effects of adverse weather and extremely limited access effectively restricted hunter kill, and it was assumed that logging activities would not affect goat habitat.

Recently, however, Fox (1979*a*, *b*) and Schoen (1978, 1979) have begun to quantify habitat relationships in the northern panhandle area and have found that goats may rely, to a greater than expected degree, on potential commercial forest habitat.

This knowledge comes at a time when demand for timber resources is expanding rapidly. Some National Forest lands are being transferred to State and private ownership and the Forest Service is attempting to meet the harvest goal set by Congress of 450 million board feet per year. If the Department is to adequately fulfill its responsibilities to protect and maintain goat populations and habitat in southeast Alaska, it needs to gain a better understanding of goat-habitat relationships. This knowledge will find practical applications through the IDT process in final planning of timber sales and road layouts in the Tongass National Forest, and provide data with which to test and refine current models of goat habitat suitability (Shea 1980).

Harrington (1980) identified the lower Cleveland Peninsula near Ketchikan as 1 place in the Tongass National Forest where proposed logging activities could have a major impact on goats. This area (Fig. 1) supports a population of goats which makes extensive use of forested habitats; the U.S. Forest Service plans to initiate logging here during the 1980-1985 operating period.

Accordingly, the Forest Service, the Alaska Department of Fish and Game and the University of Washington (on contract through the Forestry Sciences Laboratory) initiated a cooperative study in 1980 to determine goat numbers and distribution, habitat use and movements, and possible impacts of logging and road building on goats on the lower Cleveland Peninsula. The contribution of the Department to the study was to assist in capturing goats for radio-collaring and monitoring these collared goats to assess movements and habitat use. The project reported herein is designed to fulfill responsibilities under the cooperative agreement.

OBJECTIVES

To monitor mountain goat movements and determine seasonal habitat use in southeastern Alaska.

PROCEDURES

Goats were captured using the helicopter-aided darting technique described by Schoen (1978). A Hughes 500 "D" helicopter was used for locating and shooting goats. Projectile darts carrying 3.5 - 4 cc etorphine, (M99, D-M Pharmaceuticals, Inc., Rockfield, MD) were fired from a Palmer Cap-chur gun and goats were then herded onto relatively gentle slopes until the drug took effect.

Captured goats were aged by counting horn annuli; standard horn and body measurements were taken; general condition of body and dentition, lactative status of females, and presence of ectoparasites or anomalies were noted; and weight was estimated. Goats were marked with large, numbered, yellow plastic ear tags and fitted with Telonics radio collars (Telonics, Mesa, AZ) in the 150-151 MHZ range. The antagonist diprenorphine (M50-50) was injected following processing.

With the exception of the initial location of goat No..181 on 4 November and all goats on 3 December, radio relocations were determined from a PA-18-150 Super Cub with twin 2-element Yagi antennae. The initial relocations were made from a Cessna 185 (Nov) and a DeHavilland Beaver (Dec). The Super Cub proved to be the most efficient and inexpensive platform for tracking.

Radio signals were tracked until the observer was confident of the goat's location to within a 2300 m radius or visual contact was made. Once the location was established, the following data were recorded to describe the habitat characteristics: slope; elevation; aspect; terrain type; percent snow cover and snow

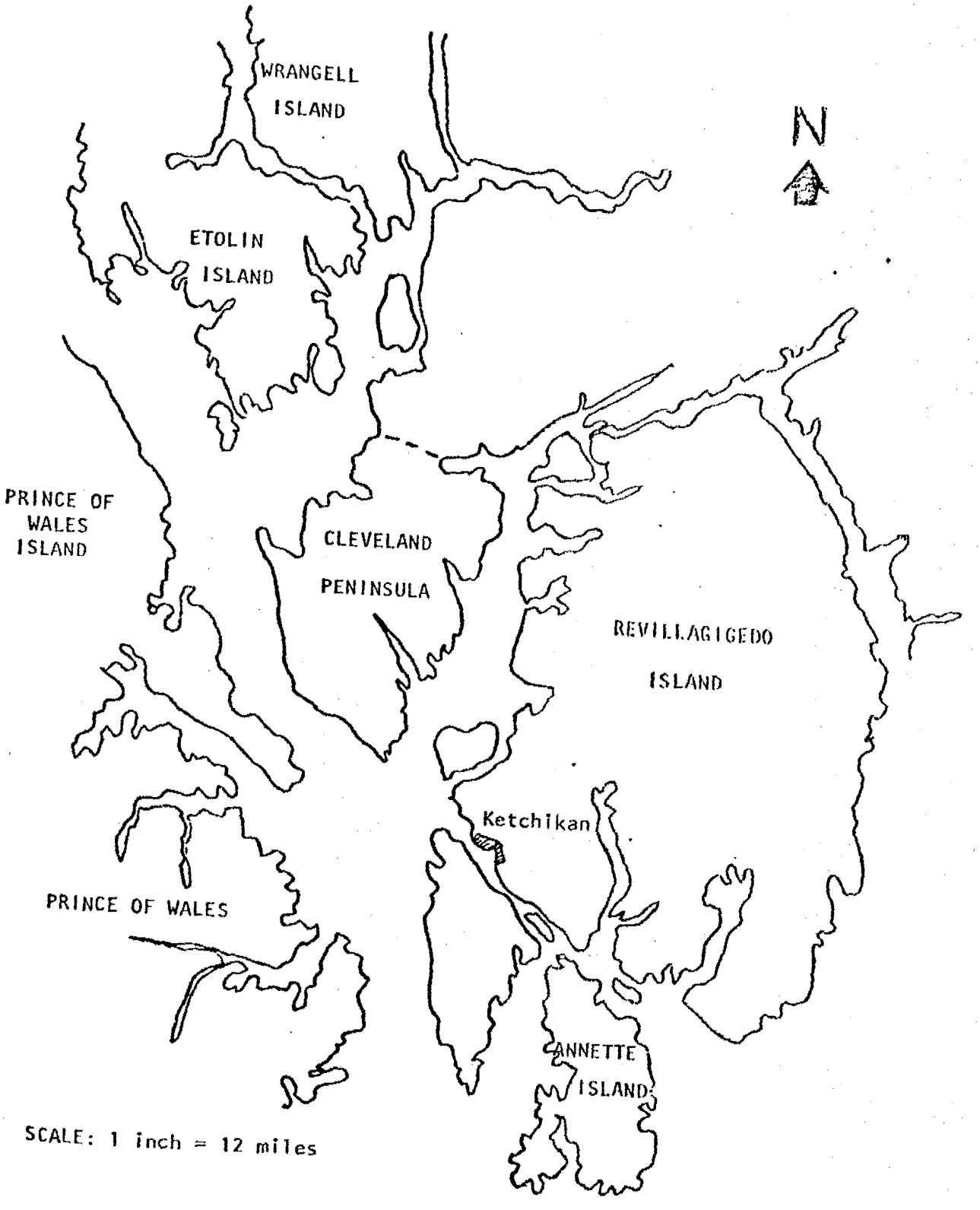

Fig. 1. The Cleveland Peninsula study area. The northern boundary of the study area is marked by a dashed line.

depth in inches and consistency as dry, wet or crusted; vegetation type; and percent canopy closure. The vegetation types were: old-growth forest, deciduous brush, subalpine, and rock or cliff face. Each radio relocation of a collared goat was also assigned an accuracy rating, such as: visual sighting; no visual contact, but habitat characteristics accurate and location known within 2.6 ha; location known, but habitat uncertain; habitat characteristics known, but location uncertain; and neither habitat nor location certain. A subjective rating of patchiness or habitat heterogeneity was also given as high, medium, or low. Finally, a grid system with 2.6 ha squares was overlaid on maps to assign X-Y coordinates to locations to facilitate computer storage, retrieval, analysis and mapping of movement data. Home range size estimates and maps were developed using a computer program which generated a 95% confidence ellipse surrounding relocations. This program is based on the model by Koeppl et al. (1975).

One 5-day field trip was made in early June. During this trip movements and activity of 1 collared goat were observed and the carcass of another was located and autopsied.

RESULTS

Ten goats were captured on 5 different ridge complexes between 8 and 24 August 1980. Seven females were captured ranging from 1.3 to over 10.3 years of age; the males were 2.3, 9.3, and 10.3 years old. Table 1 summarizes capture data for the goats. No mortalities occurred and the only significant problem encountered was the difficulty in locating goats to capture due to the extensive forested nature of the study area. The evening hours, especially on overcast days, were the most productive times for collaring goats.

Only 1 goat was positively relocated on the initial tracking flight on 4 November 1980. The survey was terminated due to severe weather. Regular tracking began on 3 December and continued through 22 June 1981. Over this period, a total of 100 radio relocations were established for the 10 goats.

Relocations were subdivided into 2 arbitrary time periods to represent winter (Nov-Apr) and spring-summer (May-Jun) seasons. If more data were available, it might be valuable to separate locations obtained during the rut. Given this year's limited results, however, we merely annotated movements apparently associated with the breeding season.

Individual Movements and Home Ranges

Goat No. .150: This 1.5-year-old female was captured on the subalpine ridge north of Port Stewart (Fig. 2) on 24 August 1980. All subsequent winter locations were on a north-to northwest-facing forested cliff 0.8 km to the northeast of the capture site. Her winter home range was estimated to be 19.6 ha of

Table 1. Summary of Goat Capture Results, August 1980.

Goat #	Location	Date	Age	Sex	Dose	Induction Time	Status on 6/30/81
.150	Pt. Stewart	8/24/80	1.3	F	3.5mg	6 min.	live, transmitting
.162	Pt. Stewart	8/16/80	4.3	F	3.5mg	-	live, transmitting
.170	Pt. Stewart	8/24/80	1.3	F	3.5mg	5 min.	live, transmitting
.181	Bear Lake	8/9/80	9.3	M	4.0mg	9 min.	live, transmitting
.190	Niblack Peak	8/21/80	1.3	F	3.5mg	9 min.	dead, transmitting
.200	Smugglers Rdg.	8/17/80	10.3	M	3.5mg	-	dead, recovered
.211	Smugglers Rdg.	8/21/80	4.3	F	3.5mg	-	live, transmitting
.221	Niblack Peak	8/9/80	1.3	M	3.3mg	12 min.	live, transmitting
.231	Bear Lake	8/10/80	10+	F	3.3mg	9 min.	dead, recovered
.291	Bear Lake	8/8/80	6.3	F	3.3mg	-	live, transmitting

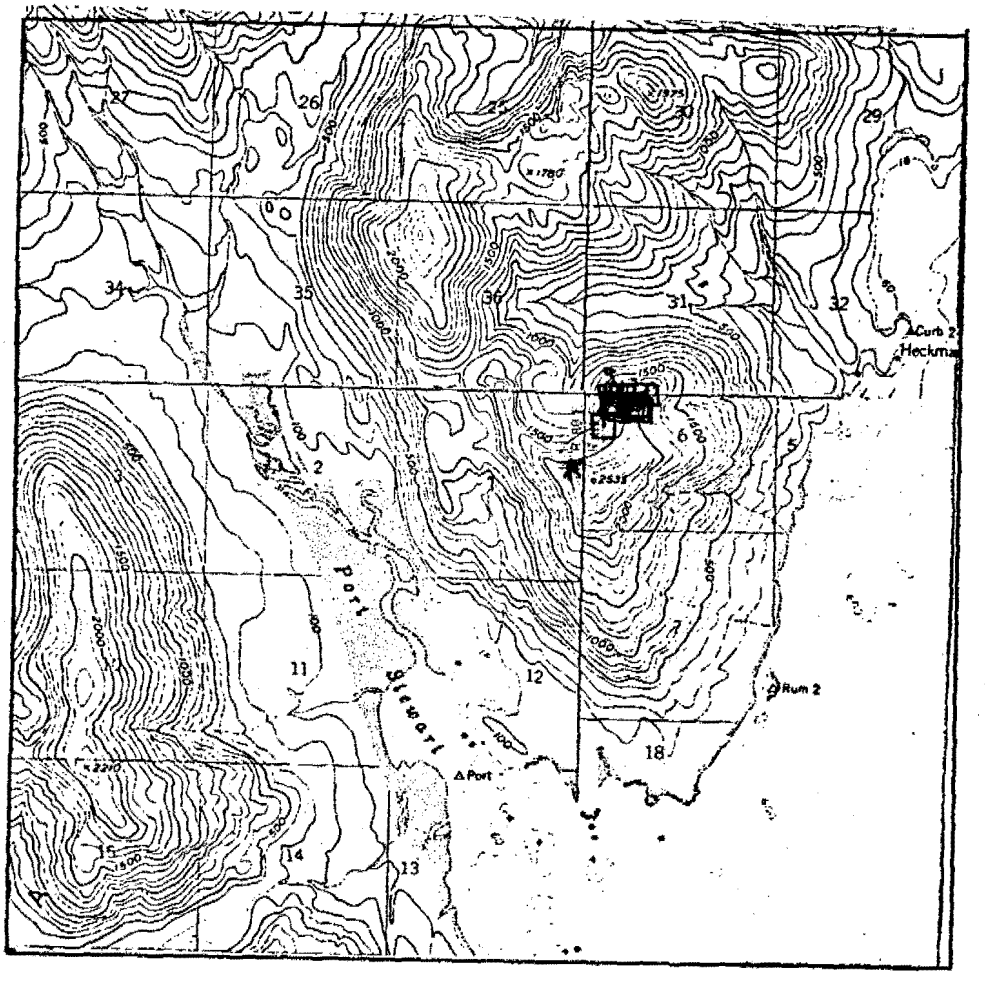

Fig. 2. Capture location (*) and winter radio-locations of goat .150; winter home range size 19.6 ha.

steep, forested rock outcrop. She was seen with goat .162 on 2 occasions.

Spring-summer locations of this goat in May and June were within her winter home range, but she was not found there in July. She was subsequently located by "accident" on a ridge 35 miles to the northeast. This apparent dispersal and later movements will be discussed in future reports.

Goat No. .162: This 4.5-year-old female was captured north of Port Stewart (Fig. 3) on August 16 and wintered on the north-facing, forested cliff with goats .150 and .170. Her winter home range was estimated to be 18.6 ha. Spring-summer locations were within her winter home range.

Goat No. .170: This 1.5-year-old female was captured north of Port Stewart (Fig. 4) at the same time as goat .150 and also wintered on the forested cliff. She did show wider movements, however, utilizing a home range of 210.2 ha, including the heavily timbered east to northeast slopes facing Heckman Point. Like the previous 2 goats, her winter home range was dominated by extremely steep forested rock outcrop and alder slide slopes, and spring-summer locations were within her winter home range.

Goat No. .181: This 9.5-year-old male was captured on the ridge east of Bear Lake (Fig. 5) on 9 August. He was initially re-located on the ridge northwest of Bear Lake on 4 November and remained on that ridge until 3 December. All subsequent relocations from 17 January through 24 April were on the ridge complex southeast of Bear Lake near Lake 1305 (Upper Bugge Lake). This goat used a winter home range of 3,329.8 ha. It is apparent from Fig. 5, however, that the majority of the season was spent in an area near Bugge Lake on a south- and southeast-facing slope dominated by the ecotone between old-growth western hemlock forest and the subalpine zone.

Sometime between 24 April and 22 May, this goat returned to the ridge east of Bear Lake where he was captured. He was observed from a camp on Bear Lake for several days in early June. During this time he moved over an area of 2-3 ha dominated by steep rock outcrops, deciduous brush and a few clusters of large hemlock trees, between 360 and 550 m elevation. A group of gold miners who have worked the area for several years reported that a lone goat, presumably number .181, was regularly seen on that rock face in the spring.

Goat No. .190: This 1.5-year-old female was captured on Niblack Peak on 21 August. A normal pulse rate signal was heard, but not located on 4 November. On 3 December, she was located in the north-facing basin of Niblack Peak with the transmitter indicating she had died. All subsequent locations were in the same area and were mortality mode signals. The gully she was in was searched by helicopter on 26 February, but deep snow prevented locating the animal. To date, the collar has not been recovered and the cause of death is unknown.

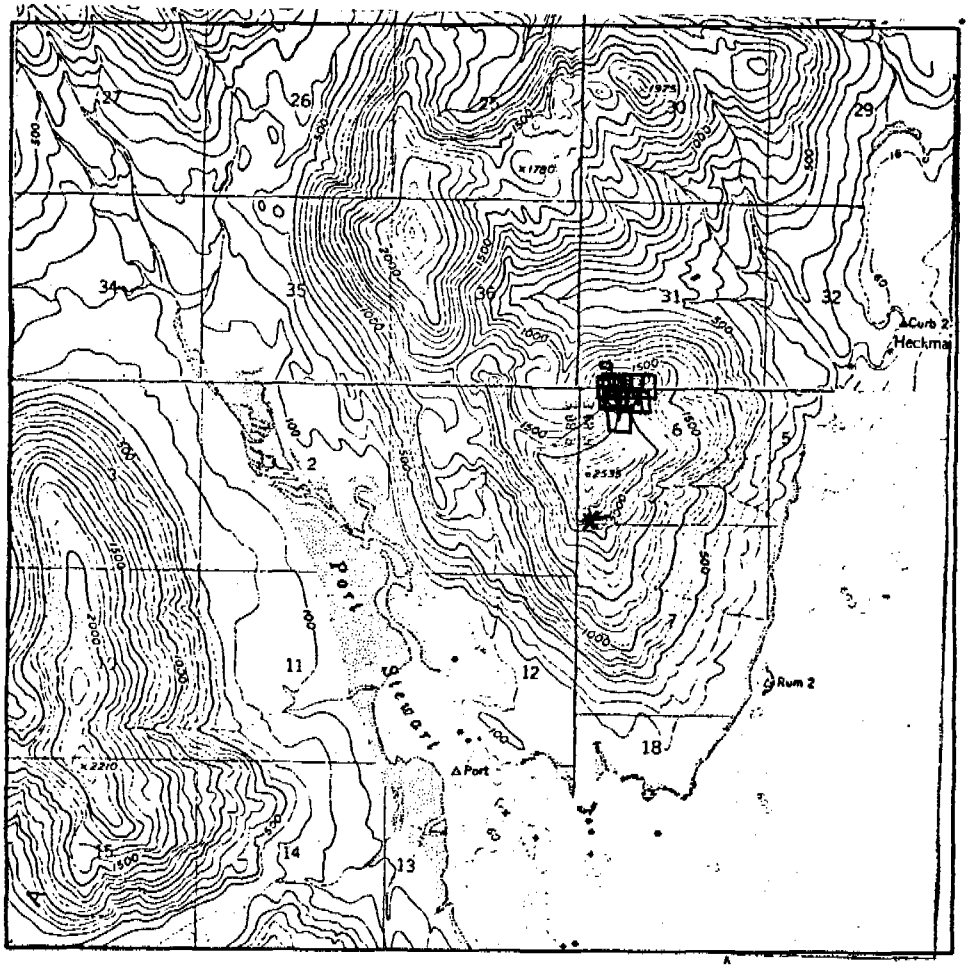

Fig. 3. Capture location (*) and winter radio-locations of goat .162; winter home range 18.6 ha.

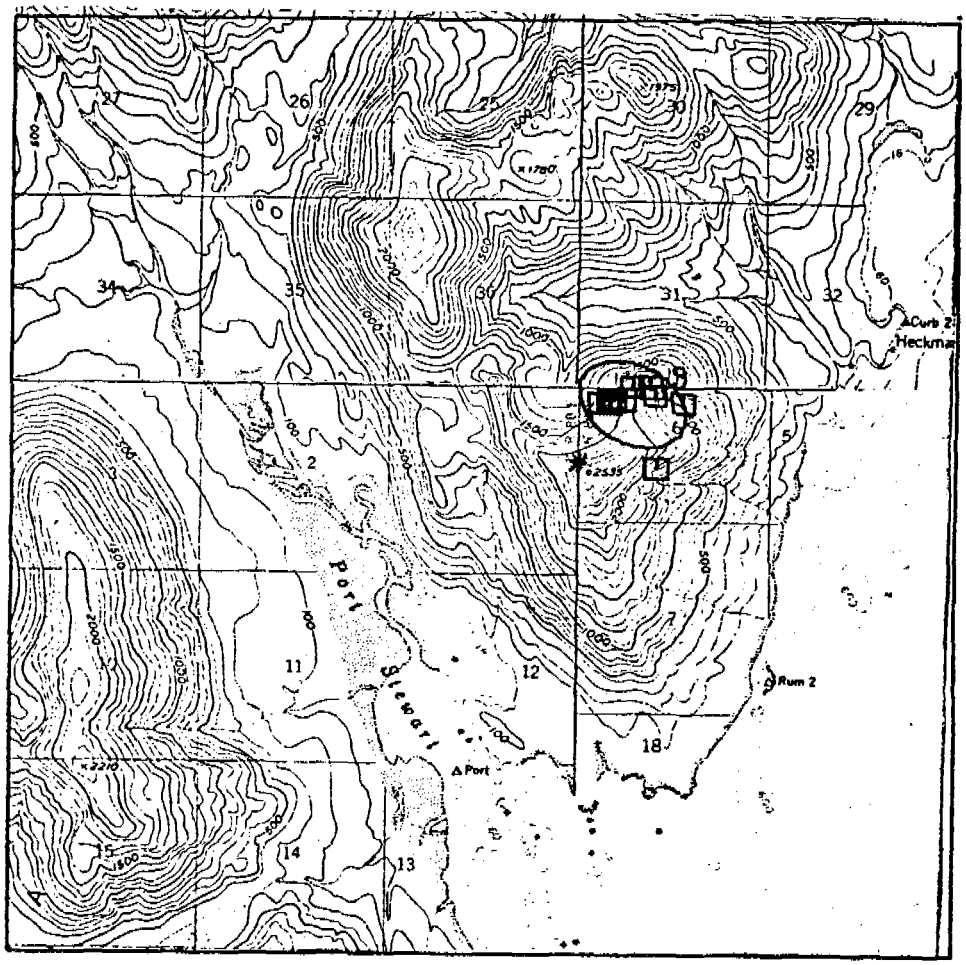

Fig. 4. Capture location (*) and winter radio-locations of goat .170; winter home range 210.2 ha.

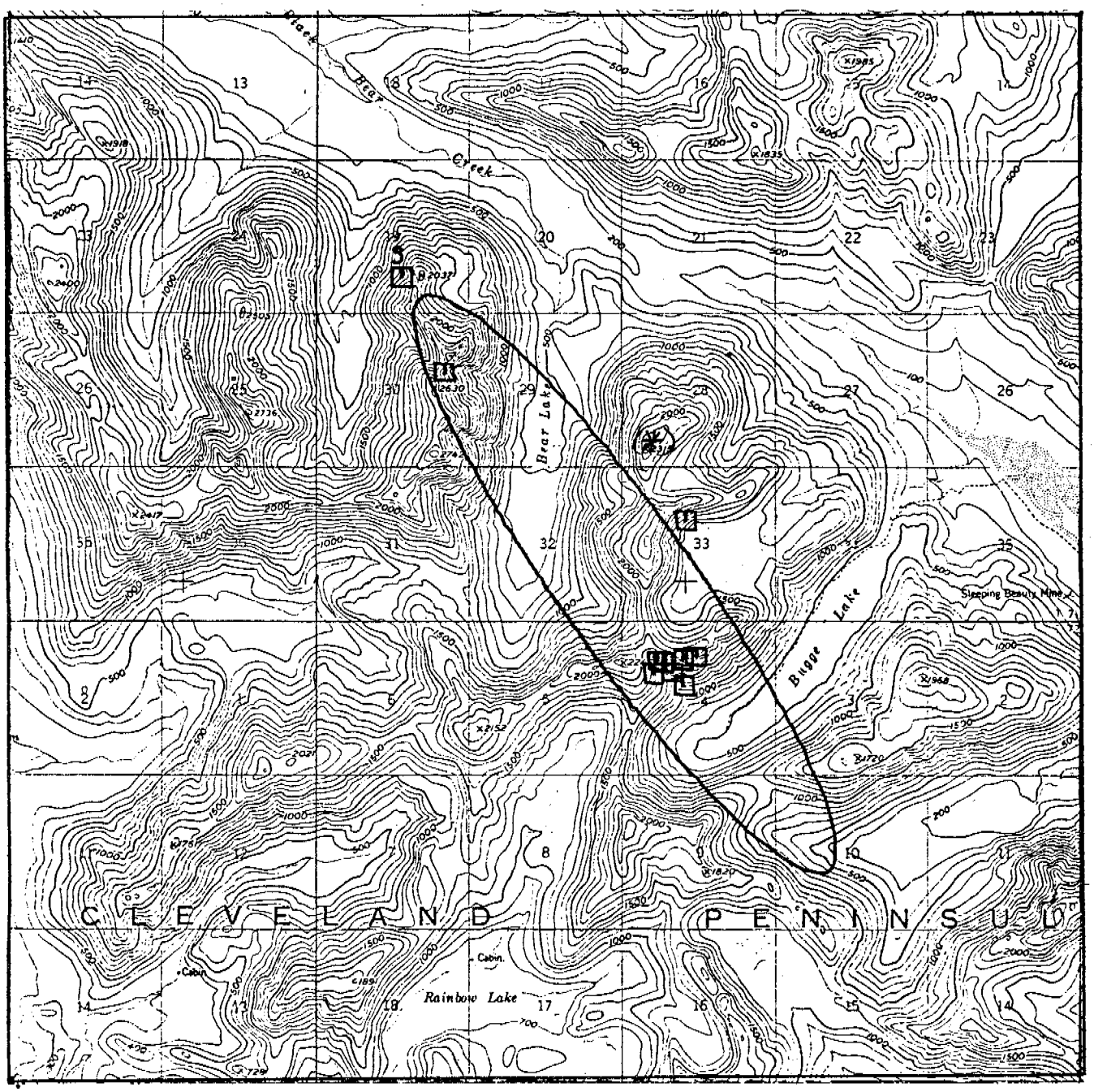

Fig. 5. Capture location (*) and winter radio-locations of goat .181; winter home range 3,329.8 ha.

Goat No. .200: This 10.5-year-old male was captured on the ridge southwest of Lake 496 (Upper Smugglers Lake) on 17 August (Fig. 6). From there he moved 1.5 km north to a limited (45.7 ha) winter range on a steep, forested southwest slope. His movements were restricted and after 27 January were consistently downslope. By 25 February, his signals switched to mortality mode. His remains were located on 26 February and his collar recovered. Cause of death was not determined, but neither predation nor serious injury caused by falling were evident. The skull and hide were salvaged; the body was emaciated. The goat was found in a normal bedded posture adjacent to a boulder in an area of steep, broken terrain with a complete hemlock-cedar canopy. Extensive growth of the hoof cuticle and spongy white nature of the foot pads indicated that the goat had moved very little during the winter. The feet were sent to Dr. R. Deitric, DVM, at the Arctic Health Laboratory, College, Alaska for examination. At this time, we speculate that death resulted from starvation. It is not known whether this was related to possible capture myopathy or simply a function of this goat's age.

Goat No. .211: This 4.5-year-old female was captured near goat .200 (Fig. 7) on 21 August. All subsequent relocations were on the same ridge complex. Her winter home range consisted of 259.2 ha of south- to east-facing slopes in the subalpine and upper hemlock forest zone. During late winter her activity was concentrated in one gully dominated by alder/grass and rock outcrops. Spring-summer locations were within her winter range.

Goat No. .221: This 2.5-year-old male was initially captured on Niblack Peak on 9 August (Fig. 8). A signal received on 4 November indicated that by that time he had moved 4.5 km southeast to the ridge complex north of Pen Point. This goat exhibited the widest movements of any collared animal over the winter, using elevations from 10 m to over 700 m above sea level, all aspects and a variety of forest cover types. His total winter home range exceeded 5,000 ha, but the majority of the late winter period was spent on a north-facing, forested cliff at 300-375 m elevation. In late May this goat was located above Stump Lake on the ridge complex where he was initially captured. A visual sighting by Joe Fox on 10 June confirmed that he had returned to the alpine on Niblack Peak. Subsequent spring-summer locations were in the subalpine or krumholtz zone on this ridge.

Goat No. .231: This 10.5-year-old plus female was captured on the ridge west of Bear Lake (Fig. 9) on 10 August. She remained in the same area utilizing a winter home range of approximately 625 ha. The habitat was predominately west-facing krumholtz and subalpine forest, broken by several gullies which provided good escape terrain.

This goat was located from the air on 27 May within her winter home range. She appeared normal and was not accompanied by a kid. On 5 June she was found dead, still within her winter home range. An autopsy revealed that the most likely cause of death

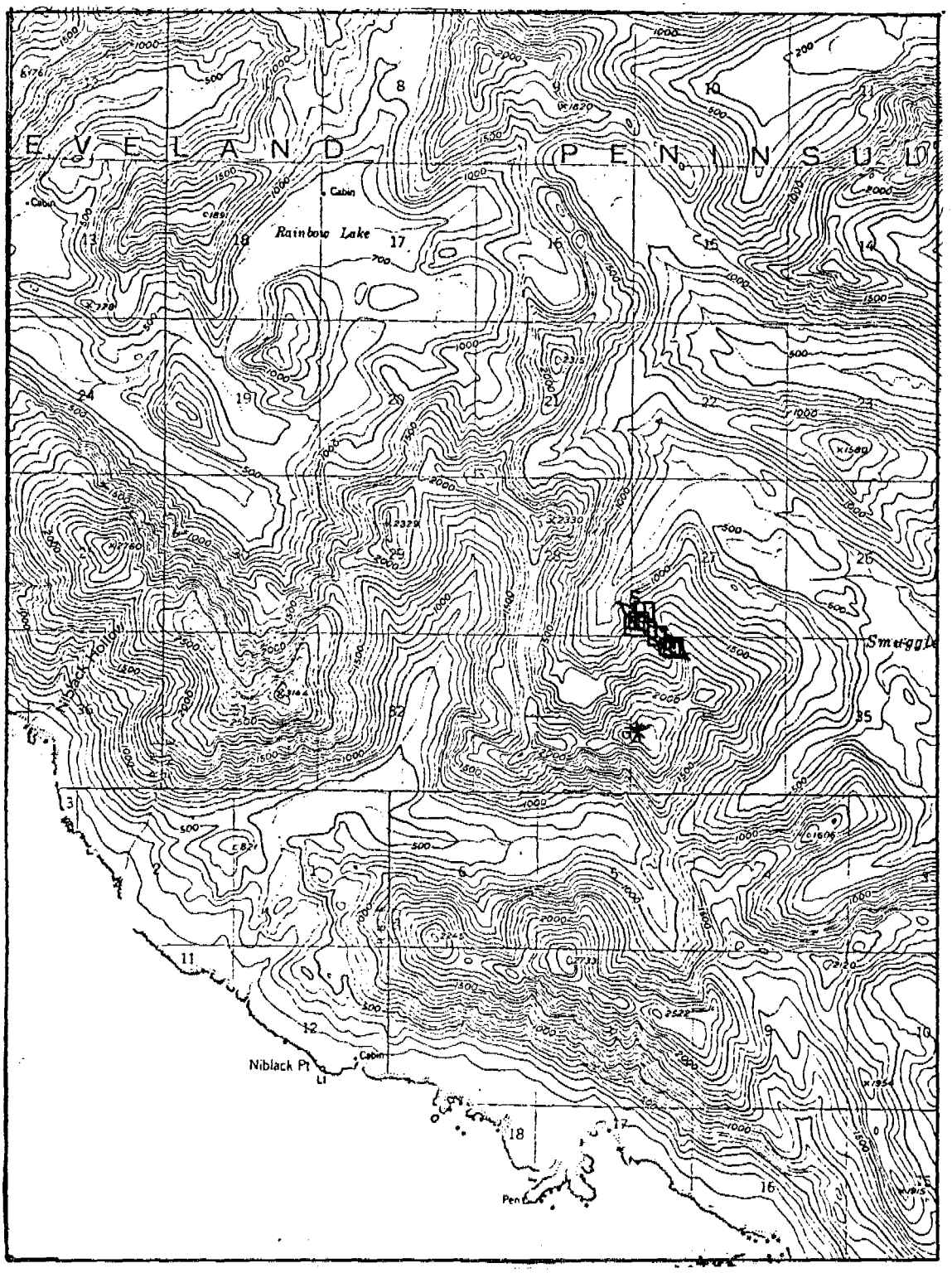

Fig. 6. Capture location (*) and winter radio-locations of goat .200; winter home range 45.7 ha.

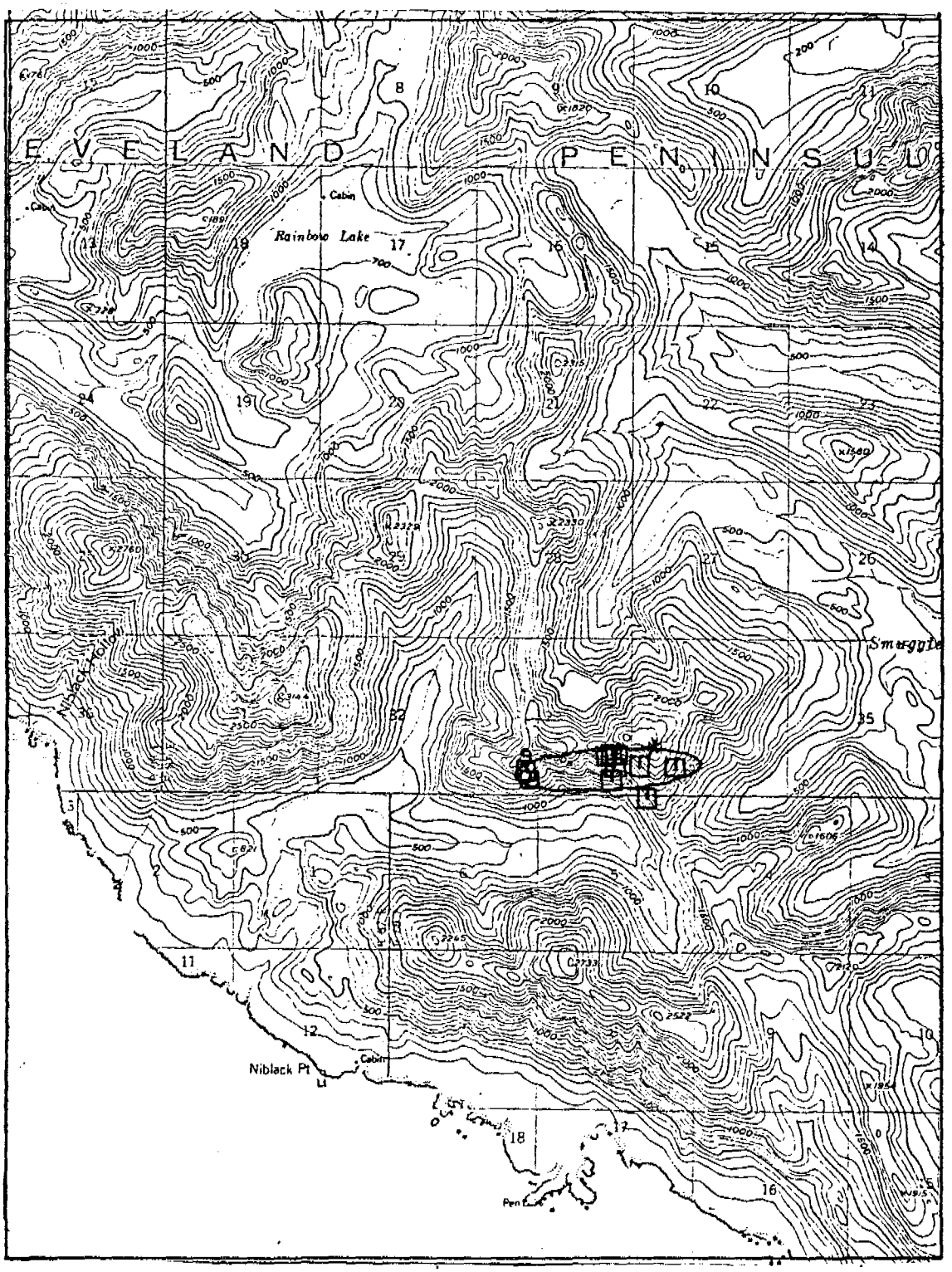

Fig. 7. Capture location (*) and winter radio-locations of goat .211; winter home range 259.2 ha.

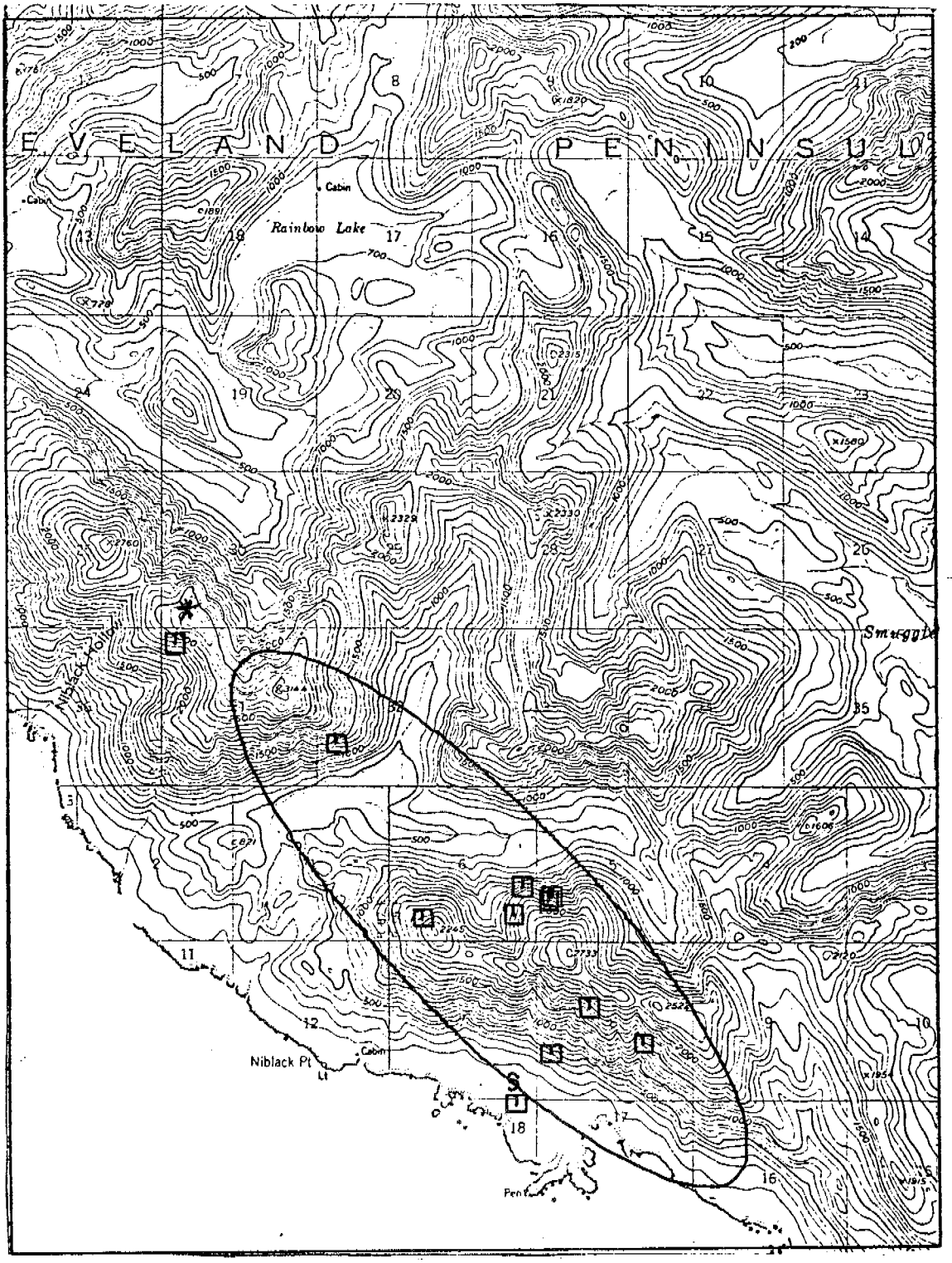

Fig. 8. Capture location (*) and winter radio-locations of goat .221; winter home range 5,056.0 ha.

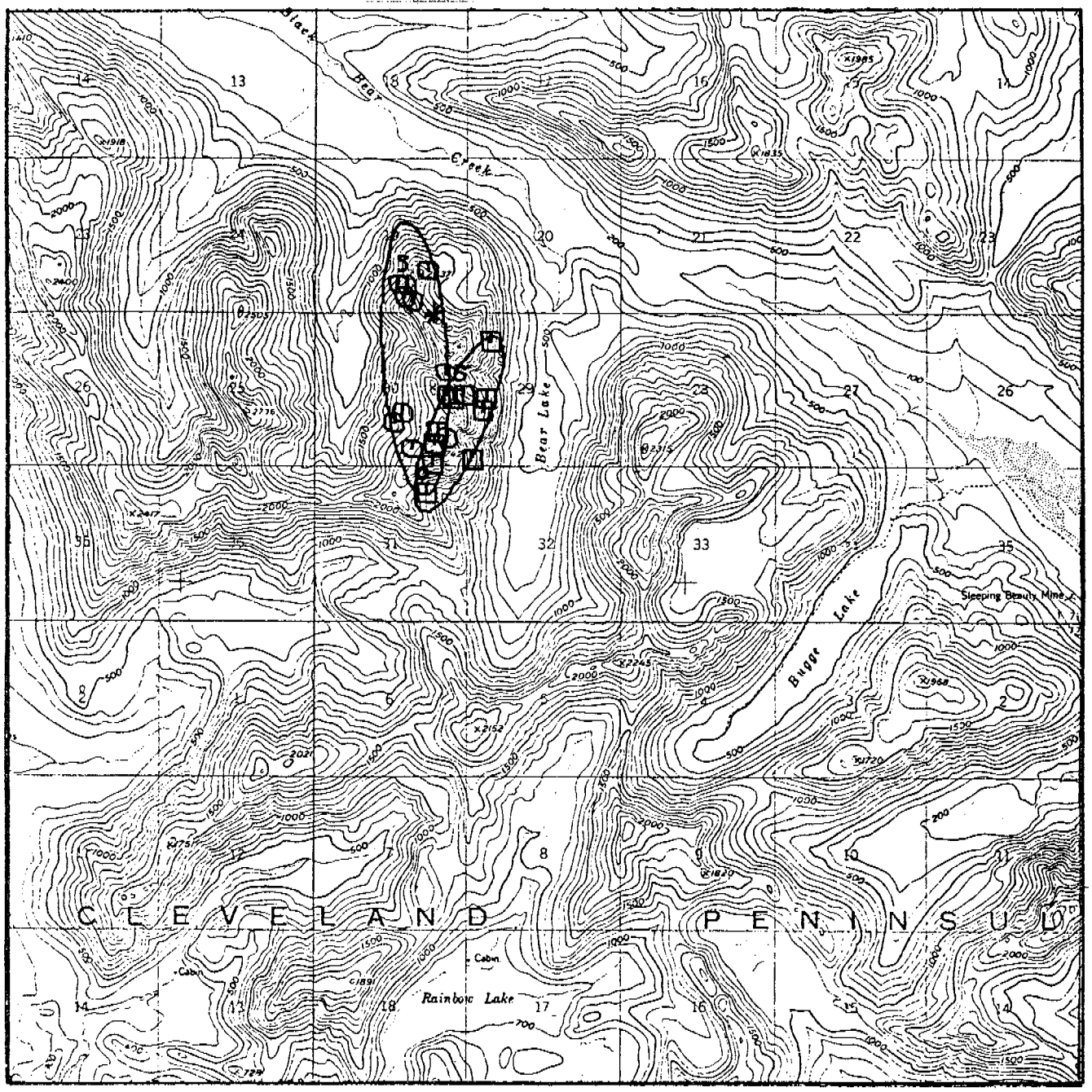

Fig. 9. Capture location (*) and winter radio-locations (▣) of goat .231; winter home range 624.7 ha. Also, capture location (o) and winter radio-locations (▣) of goat .291; winter home range 342.2 ha.

was severe physiological stress and nutritional deficiency due to advanced age. Although her teeth were not excessively worn and her rumen was full of apparently normal ingesta, her femur marrow was pale and gelatinous and she had no fat reserves. Minor hemorrhaging was evident in the pericardium and bronchial region, but no other anomalies were noted.

Goat No. .291: This 6.5-year-old female was captured west of Bear Lake (Fig. 9) on 8 August. Like goat .231, she remained on the same ridge complex using a home range of 342.2 ha. Her home range slope faced east and was structurally and vegetatively more complex than that of goat .231, with interspersed forests, slides and rock outcrops. In addition, she used a wider range of elevations than goat .231. Spring-summer locations were within her winter home range.

Selected Habitat Characteristics

Of the 80 radio relocations made during the winter period, 73 provided accurate habitat information which can be used in the analysis of habitat selection. Relocations of goats .190 and .200 have been excluded due to the timing and uncertain circumstances surrounding their deaths. Locations during the spring-summer period are too limited to be used to draw quantitative conclusions about habitat selection at this time of year.

Elevation

Table 2 presents the results of analysis of elevations used by goats in winter 1980-81. The mean elevation used, 538.7 m (1767.4 ft) reflects the relatively mild nature of the winter, and the small standard deviations indicate that most goats had little up and down slope movement.

Slope, Aspect, and Terrain Type

Fig. 10 illustrates goat use of slopes of various steepness. From this it can be seen that during this winter goats primarily used slopes of 46 to 75°. Fig. 11 illustrates goat use of various aspects during the winter and reveals that no clear preference was shown for any aspect. Nearly 73% of all relocations were in broken terrain. This is a minimum estimate because some relocations in forested areas may have been incorrectly classified. When canopy coverage exceeded 80%, it was difficult to accurately determine terrain type, and what appeared to be smooth may, in fact, have been very broken. This was the case when searching for the remains of goat .200.

Habitat Type, Patchiness, and Canopy Cover

Fig. 12 illustrates goat use of several habitat types. Even in this mild winter, the majority of relocations occurred in old-growth forest. Subalpine, alder slides, and rock/cliff types were used to a much lesser extent. Fig. 13 demonstrates that

Table 2. Mean, Standard Deviation and Range, in Meters, of Elevations Used by Mountain Goats on the Cleveland Peninsula, November 1980 - April 1981.

Goat	Mean Elevation	Standard Deviation	Minimum Elevation	Maximum Elevation	(N)
.150	579.1	59.0	487.7	670.6	9
.162	562.2	50.8	487.7	609.6	9
.170	545.3	81.3	487.7	609.6	9
.181	534.9	117.3	304.8	762.0	10
.211	572.2	94.9	365.8	701.0	9
.221	397.2	200.5	9.1	670.6	9
.231	590.6	122.3	458.2	762.0	9
.291	528.3	144.6	304.8	731.5	10
TOTAL	538.7	125.9	9.1	762.0	73

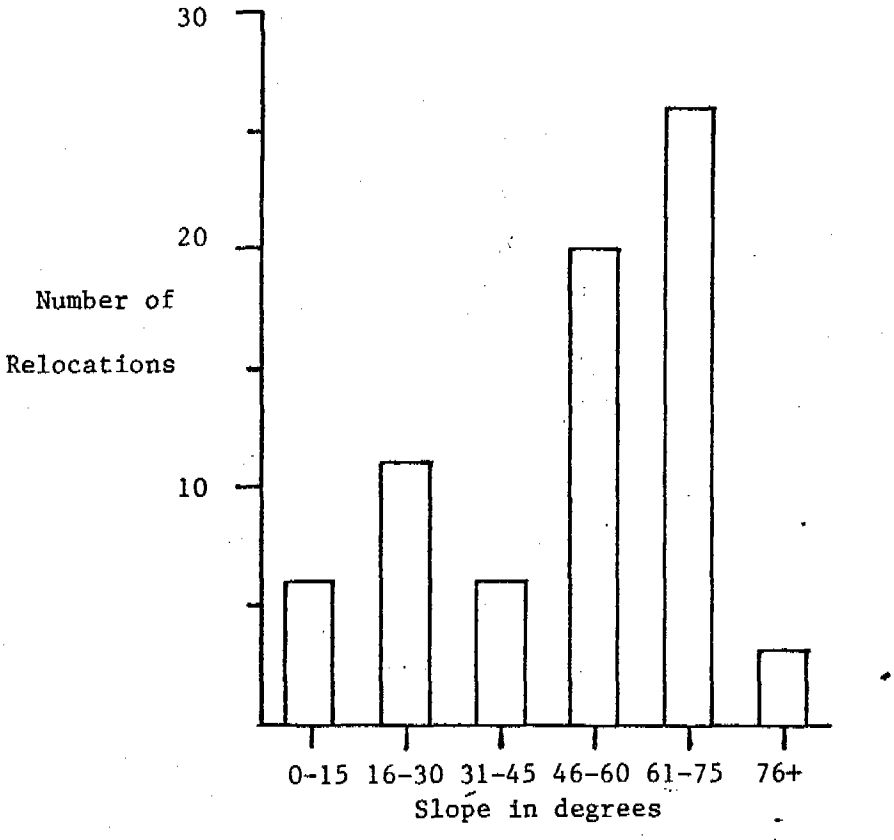

Fig. 10. Use of various slope categories by radio-collared goats.

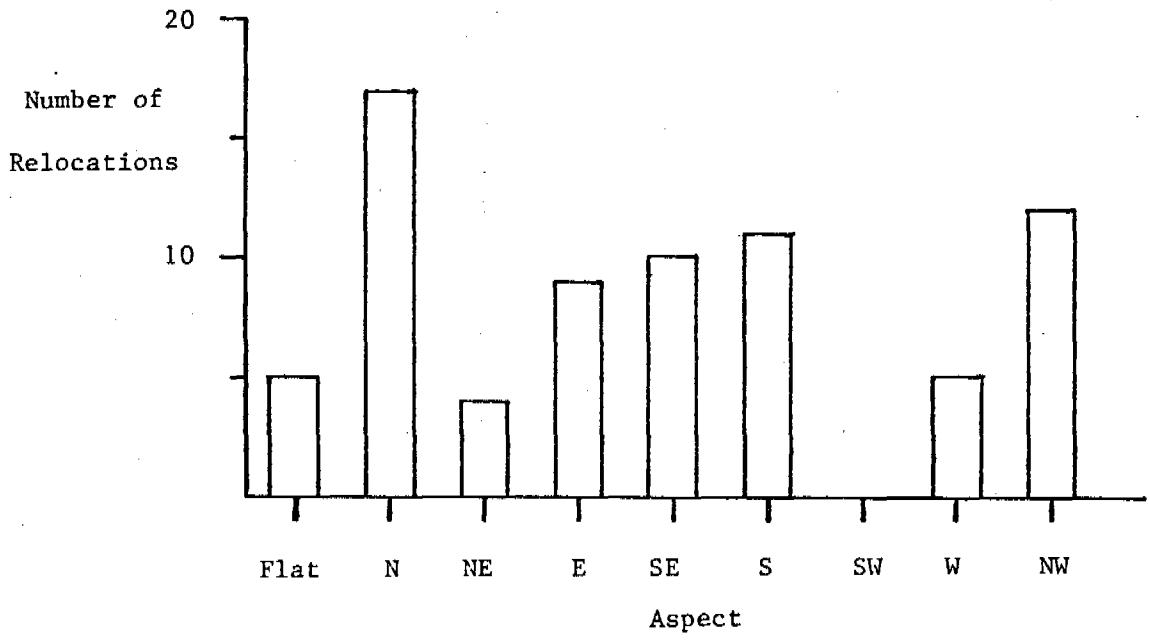

Fig. 11. Use of various aspects by radio-collared goats.

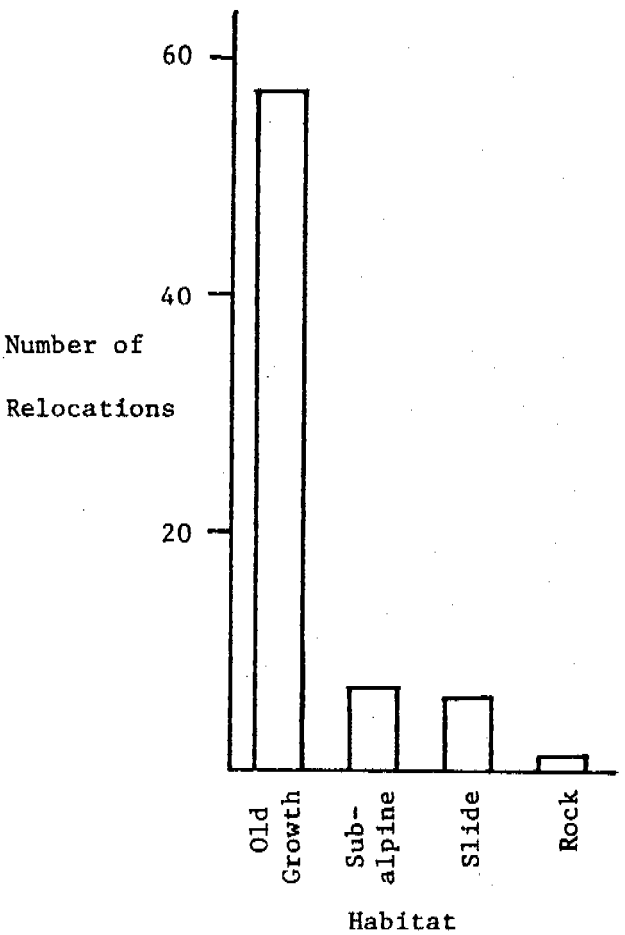

Fig. 12. Habitat types used by radio-collared goats.

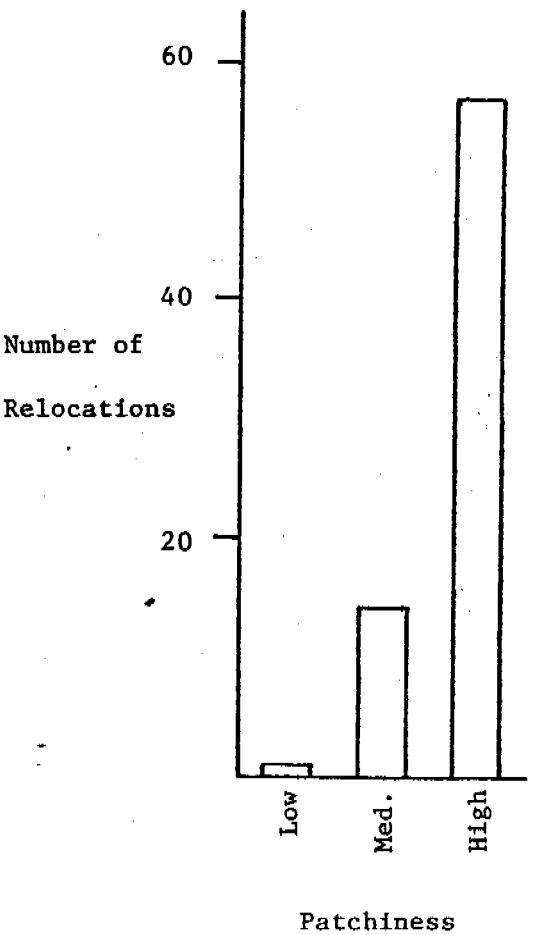

Fig. 13. Habitat patchiness at radio-locations.

patchiness or diversity of habitat types was often great in areas utilized by goats. This characteristic is a function of the climax forest and topographic variability. Fig. 14 indicates that most use of forested habitat occured in stands with 46-60% canopy cover. Such stands are typical of the steep slopes often used by these goats.

Snow

Snow cover was intermittent and appeared to be insignificant in affecting goat movements in winter 1980-81. Maximum snow depth on the ridge tops never exceeded 10 inches. The steeper slopes frequented by the goats were usually snow free.

DISCUSSION

Data gathered thus far in this study are too limited to allow critical analysis of factors influencing movements and habitat use by goats. In addition, the abnormally low snowfall in winter 1980-81 may make this year's results invalid indicators of habitat preferences under more normal winter weather conditions. Nevertheless, tentative patterns can by seen and some hypotheses can be generated which could be tested using data collected in the future.

There appear to be distinct differences in movements and home range size associated with sex in this goat population. Both surviving males were found to move between major ridge complexes, whereas all females remained on the ridges where they were captured. Initial inter-ridge movement by males is thought to have occurred at the onset of the rutting period. This sexual disparity in movements has been reported in several other populations (Geist 1964, Smith 1976, Rideout 1977) and has been theorized to have genetic implications (Rideout 1977). Movement by males between ridge complexes on the lower Cleveland Peninsula may be especially important in preventing problems associated with inbreeding (e.g. reduced fertility [Preobrazhenskii 1961]) due to the population's unusual distribution: isolated subpopulations of 5-20 goats on individual ridges separated by wide timbered valleys (Raedeke 1980).

When comparing this year's results regarding characteristics of selected habitat with other studies, several similarities and notable differences were found. As reported by Schoen (1979) and many other investigators, goats were generally found in relatively steep, broken terrain. This reflects the species' physical and behavioral adaptation to mountainous habitat. Unlike other populations, however, lower Cleveland Peninsula goats were not found to favor southern aspects. This may have been an artifact of the limited sample or due to the mild nature of the 1980-81 winter. It is also possible that the goats' dependence on steep, broken terrain and the limited distribution of this preferred cliff habitat regulates goat distribution in this area.

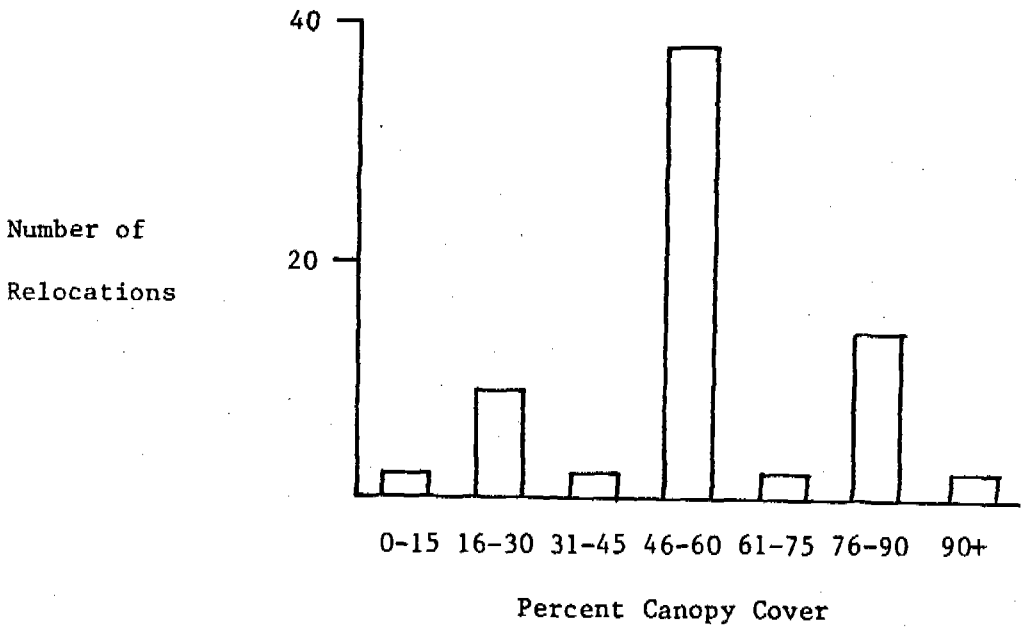

Fig. 14. Percent canopy cover at radio-locations.

Despite the mild temperatures and light snowfall during winter 1980-81, the goats on the lower Cleveland Peninsula made extensive use of forested habitat with moderate canopy coverage, and with the exception of 1 juvenile male, occupied small winter home ranges. The former tendency may be partially due to the extensive nature of timbered habitat and limited acreage of high elevation alpine areas. The use of small winter home ranges may be a function of the patchy distribution of escape terrain or may indicate that goats in this area restrict activity in winter due to inherent physiological changes independent of the impact of snow, as has been shown for some other ungulate species (Silver et al. 1969, Bandy et al. 1970, Schwartz, et al. 1981, W. Regelin, Pers. Commun.). In a normal winter when heavy snowfall is a factor, however, it is expected that these animals will occupy home ranges including old-growth forests at lower elevations.

ACKNOWLEDGEMENTS

Paul Harrington was instrumental in initiating this study and made the first complete radio-tracking flight. Ken Raedeke, John Schoen and Mike Tehan captured the goats. Bob Wood flew several of the tracking flights prior to my move to Ketchikan, which helped assure data collection through the winter. Dick Hamlin was an excellent and eager pilot whose skill and knowledge of the study area made him an asset to the project.

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