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GROUP SIZE AND MOVEMENTS OF A DISPERSED, LOW DENSITY GOAT POPULATION WITH COMMENTS ON INBREEDING AND HUMAN IMPACT

Christian A. Smith, Alaska Department of Fish and Game, Ketchikan, AK 99901

Kenneth J. Raedeke, University of Washington, Seattle, WA 98195

ABSTRACT

The population of mountain goats (Oreamnos americanus) on the Cleveland Peninsula in south coastal Alaska consists of some 50 to 70 animals living in groups with a mean size of 6.4 goats. Sub-populations occupy relatively small patches of habitat consisting of slides, rock outcrops or forested areas exceeding 40 degrees mean slope on discrete ridge complexes separated by forested valleys ranging from 0.8 to 2.4 km wide.

Radio-telemetry studies revealed that females were sedentary and exploited small home ranges. Conversely, most males made extensive movements associated with the rut, crossed low elevation valleys, and interacted with several groups.

The small size and patchy distribution of groups creates high potential for inbreeding or periodic local extinction. Exchange of genetic material between groups and optimum productivity occur only because of the inter-ridge movements of males during the rut. Despite the atypical nature of the goat habitat in this area, no unnatural barriers to such movement currently exist.

Within the next 5 years, timber harvest activity will begin on the Cleveland Peninsula. Due to the distribution of commercial timber, virtually every valley eventually will be roaded and/or logged. Habitat alteration, human activity and illegal hunting are expected to reduce inter-ridge movement by males and increase mortality. This could lead to reproductive isolation and instability of groups. The combined effects of genetic isolation and human harassment/mortality may lead to extirpation of many, if not all, sub-populations in the area.

INTRODUCTION

With the settlement of native land claims in 1971[1] and the national interest lands issue in 1980[2], many legal obstacles delaying resource

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1. Alaska Native Claims Settlement Act of 1971. United States Congress.
2. Alaska National Interest Lands Conservation Act of 1980. United States Congress.

development in Alaska have been removed. In the southeast Panhandle, these acts have resulted in accelerated mineral and timber extraction on lands not designated as wilderness. Accordingly, wildlife biologists are under increasing pressure to gather data necessary to minimize and mitigate habitat losses resulting from human activities.

In anticipation of impending logging activity on the lower Cleveland Peninsula, the Alaska Department of Fish and Game, the U.S.D.A. Forest Service and the University of Washington have undertaken a 3-year cooperative study of mountain goat (Oreamnos americanus) ecology and habitat use in this area. The primary objectives of this work are to determine distribution and abundance of goats, identify their movement patterns and critical habitats and to evaluate their food habits. The information gathered is to be used in timber sale and road layout planning to minimize impact of timber harvest activities on goats.

Fox and Raedeke (1982) have analyzed the distribution of vegetation and terrain types on a portion of the area and using telemetry data reported by Smith (1982) have made preliminary estimates of important goat habitat. This work revealed that distance to cliffs (i.e. broken terrain with slopes greater than 50°) was the most important factor in determining goat use of the area. Fox (1981) and Schoen and Kirchoff (1982) identified the same relationship in the Juneau vicinity and determined that goats make little use of forested areas over 500 m from cliffs.

The distribution of goats on the lower Cleveland Peninsula is closely tied to specific, isolated patches of escape terrain within the forest. This has significant consequences with respect to breeding in this population. The purpose of this report is to evaluate distribution and movements of goats in this area with reference to reproductive biology.

P. Harrington (USFS) and R. Wood (ADF&G) were instrumental in organizing agency funding of this study and collected some of the initial data. H. Hase, B. Marr and M. Tehan assisted in the 1980 field surveys and J. Schoen, S. Brainerd and L. Smith assisted with the capture of goats.

STUDY AREA

The lower Cleveland Peninsula (Figure 1) is located approximately 40 km northwest of Ketchikan, Alaska within the Tongass National Forest. The climate is influenced by maritime weather which produces relatively cool summers and mild winters for this latitude, as well as an average of 380 cm of precipitation per year. Although warm temperatures occasionally eliminate snow cover below 100 m elevation during winter, snowpack above 600 m often exceeds 2 m from December through March.

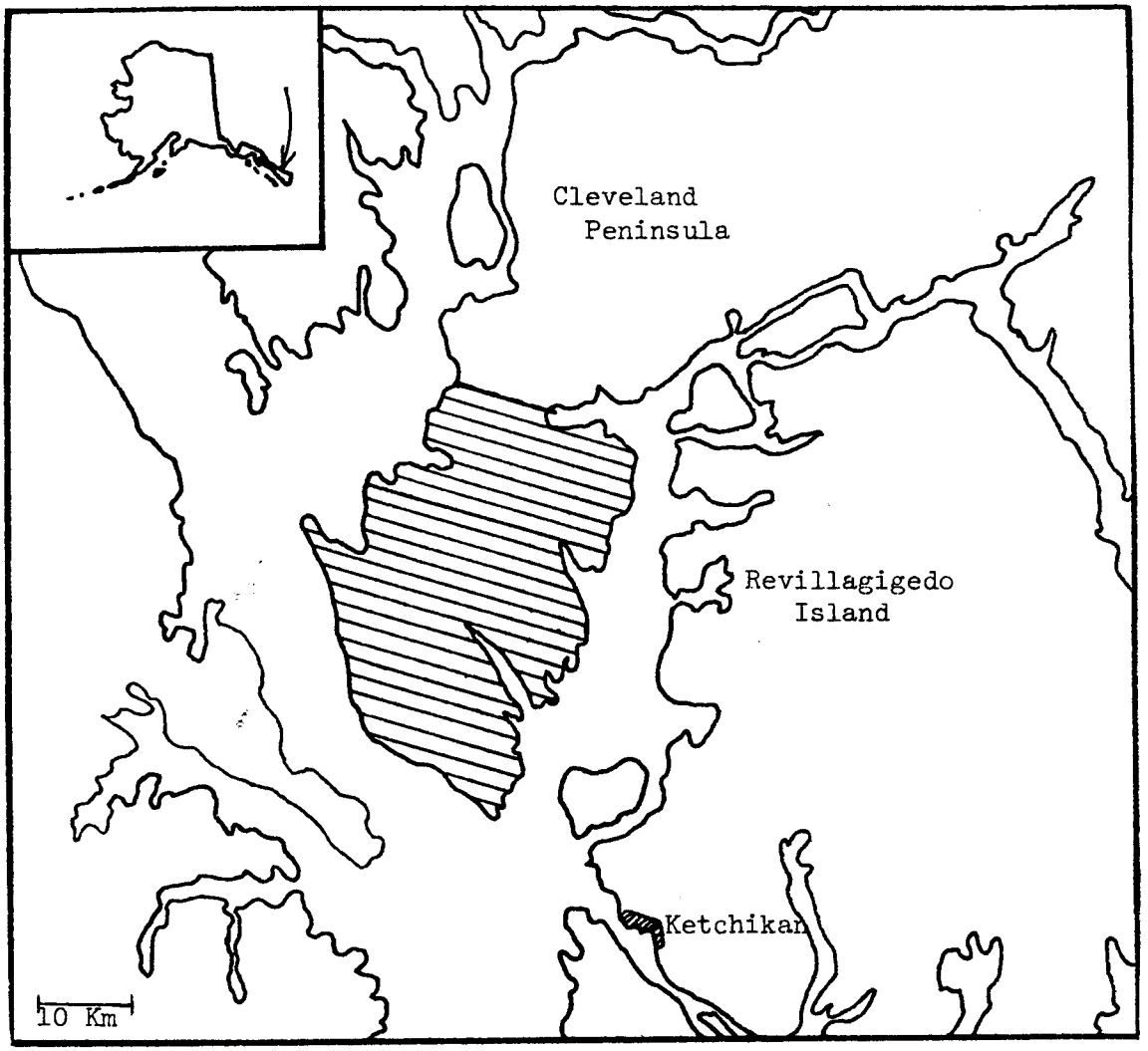

Figure 1. Location of the lower Cleveland Peninsula study area (shaded portion) in southeastern Alaska.

The topography is characterized by rolling ridges with scattered steep slopes and elevations ranging to 960 m. The predominant vegetation is western hemlock - Sitka spruce (Tsuga heterophylla - Picea sitchensis) forest (Harris and Farr 1974), which completely covers most ridges. Breaks in the forest cover are provided by rock outcrops, slide zones, poorly drained muskegs and limited alpine meadows near some ridge tops. Fox and Raedeke (1982) provide a quantitative analysis of vegetation types.

METHODS

Distribution, size and composition of groups were determined by on-ground observations and aerial surveys during summer 1980 and through observations incidental to telemetry flights from 1980 to 1982. Data presented represent maximum number of goats observed at one time on each ridge complex over the course of the study, exclusive of known mortality, emigration or duplications of radio collared males. Local residents were also interviewed regarding historic goat numbers and distribution.

Goats were captured using standard helicopter darting techniques (Schoen and Kirchoff 1982) with "Cap-Chur" (Palmer Chem. Co., Douglasville, Ga.) equipment and M99, etorphine, (D-M Pharmaceuticals, Rockville, Md.) between 9 and 24 August 1980 and 28 July and 13 September 1981. Captured animals were sexed, aged, measured and fitted with radio-transmitter collars (Telonics, Mesa, Az) in the 150.000 - 151.000 MHZ. range.

Telemetry flights were made in a PA-18-150 Super-cub equipped with dual, twin element yagi antennae. Regular tracking began in November 1980 and is continuing as of this writing. Flights were made once weekly or as often as weather permitted. Relocations were recorded using an x-y coordinate grid system with grid interval equal to 0.16 km (0.1 mile).

The rutting season in goats is generally believed to occur between late October and early December, with a peak in late November (Brandborg 1955, Geist 1964 Chadwick 1973). For purposes of this report, movements made between 20 October and 15 December were considered to be associated with the rut.

RESULTS

GROUP SIZE AND DISTRIBUTION

The lower Cleveland Peninsula supports 8 groups of goats, having a mean size of 6.4 (Table 1). Figure 2 illustrates their midsummer distribution.

Table 1. Minimum group sizes and compositions for mountain goats on the lower Cleveland Peninsula, summer 1980 and 1981.

Ridge Complex	Adult Male	Adult Female	Adult Unknown	Kids	Total	Year
Port Stewart Ridge	1	2	1	1	5	1981
Mt. Burnett/South Ridge	3	1	3	1	8	1980
Helm Bay North Ridge	2	-	-	-	2	1981
Bear Lake West Ridge	4	6	2	5	17	1980
Bugge Ridge	3	-	3	-	6	1981
Niblack Peak	1	-	4	-	5	1981
Bald Ridge	-	3	1	2	6	1981
Caamano Ridge	2	-	-	-	2	1981
Total	16	12	14	9	51	
$\bar{x}$	2.00	1.50	1.75	1.13	6.38	

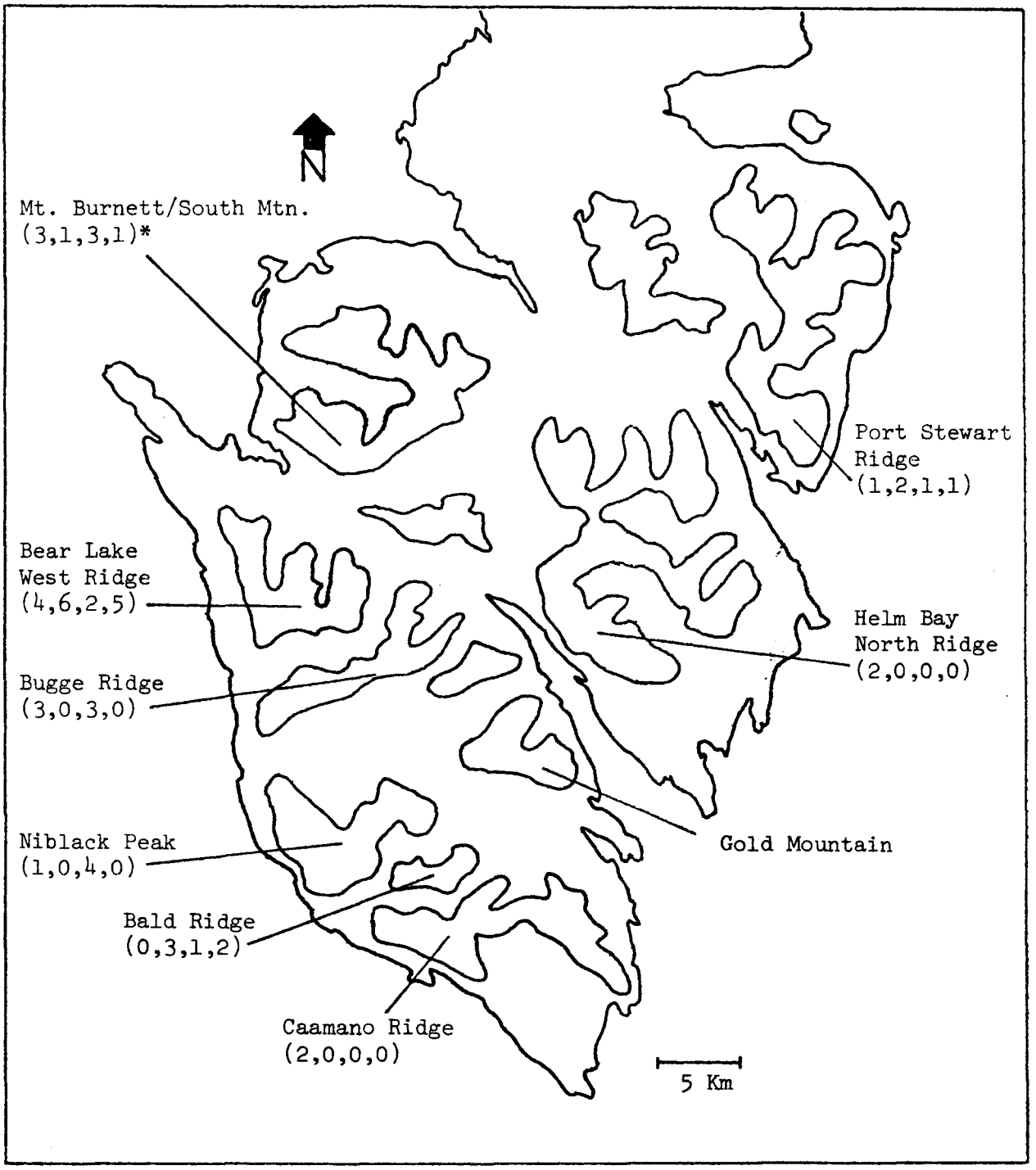

Figure 2. Midsummer distribution, minimum size and composition of mountain goat subpopulations on the lower Cleveland Peninsula. Ridge complexes differentiated by the 330 m contour. *(Males, females, Sex/Age unknown, Kids).

One additional ridge, Gold Mountain, was said to have supported goats in the past, but since the mid 1950's the only sighting reported to us was of a lone goat in July 1981 (H. Ludwigsen, pers. comm.).

Kids comprised 19.4 percent of the population in the 1980 sample (n=31) and 15.0 percent in 1981 (n=20). These figures are slightly lower than those determined for other populations in the Ketchikan vicinity which averaged 25.8 percent kids in 1980 and 24.9 percent in 1981 (ADF&G unpubl. data).

INDIVIDUAL MOVEMENTS

Eleven goats (7 females, 4 males) were captured and radio collared in 1980 and 1981. During the breeding season in 1980, the movements of 6 female and 3 males were documented. In 1981, 4 females and 3 males were followed during the rut.

Convex annual home range polygons of the radio collared female goats are illustrated in Figure 3. With the exception of the emigration of #9, no female left the ridge complex on which she was marked. Conversely, 3 of the 4 males were found to make repeated movements across low elevation timbered valleys during the November-December rut (Figure 4.) At other times, males used small seasonal ranges on single ridges (Smith 1982). The only male which did not move between ridges during the rut may have been suffering from physical disability. He died at age 10 apparently of malnutrition the following February in spite of the fact that the winter of 1980-81 was extremely mild.

DISCUSSION

The size and distribution of these goat sub-populations have particular consequences for their stability and breeding biology. Although estimated minimum group sizes may be conservative, it is evident that some of these sub-populations are at the lower end of the range of viable group sizes. Loss of only 2 members could represent 25-100 percent mortality in all but the Bear Lake Ridge group. Furthermore, some groups may lack sufficient adults of both sexes to be reproductively self sufficient at this time. Inter-ridge movements by males during the rut are important in optimizing productivity in existing groups. Without such movement, females may pass the rut without being bred as noted for isolated females in Idaho (Brandborg 1955, p.92).

Although dispersal of females could eventually result in establishment of viable sub-populations on ridge complexes which are currently vacant or occupied solely by males, female goats are generally traditional in range use and do not often explore new areas (Brandborg 1955, Chadwick 1973, Smith 1976, Kuck 177, Rideout 1977, Schoen and Kirchoff 1982). The 1 subadult female which did disperse during this study, moved 75 km to the higher ridges on the upper Cleveland Peninsula rather than to another

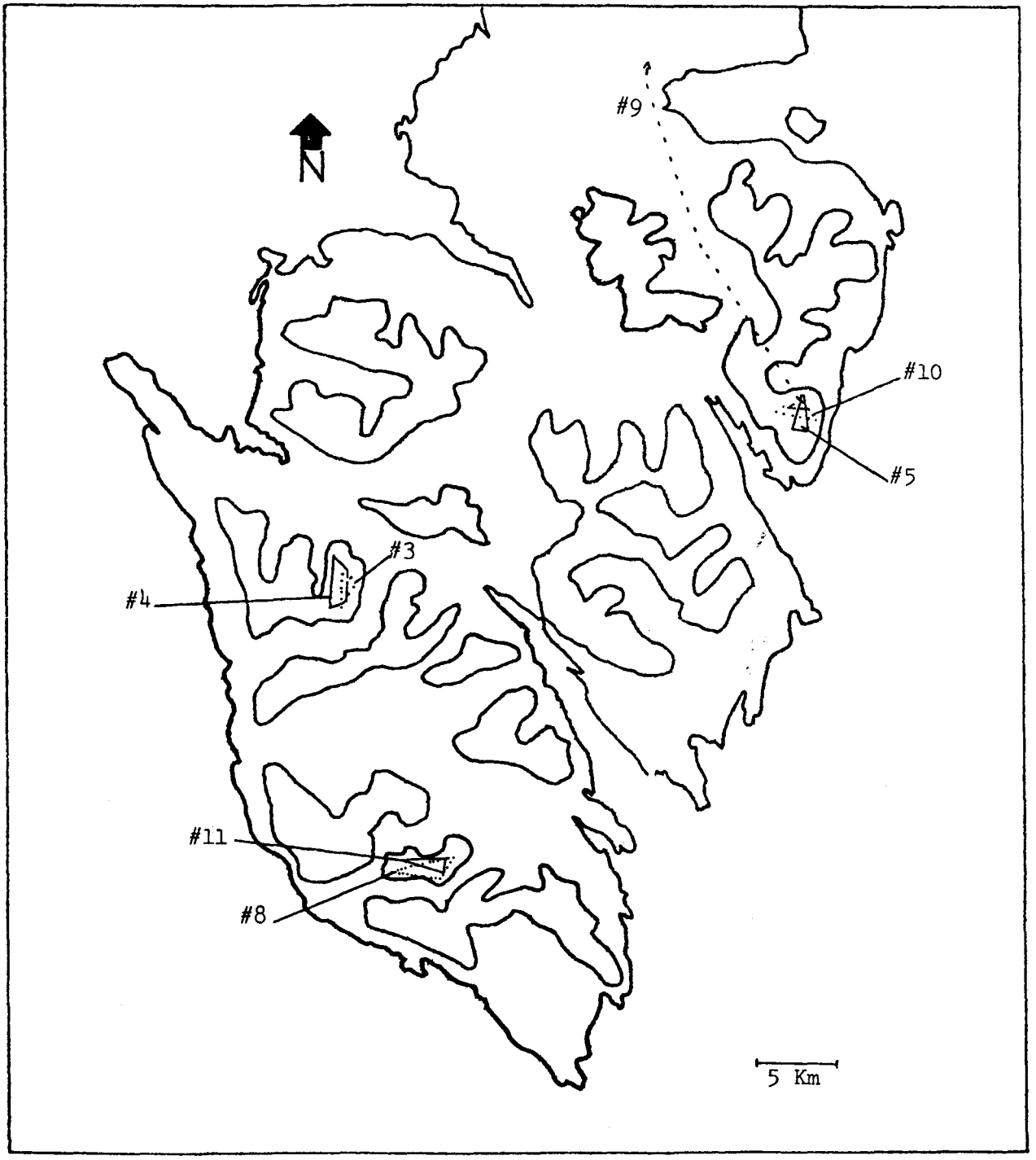

Figure 3. Home range polygons of radio-collared female mountain goats on the lower Cleveland Peninsula, August, 1980 - February 1982.

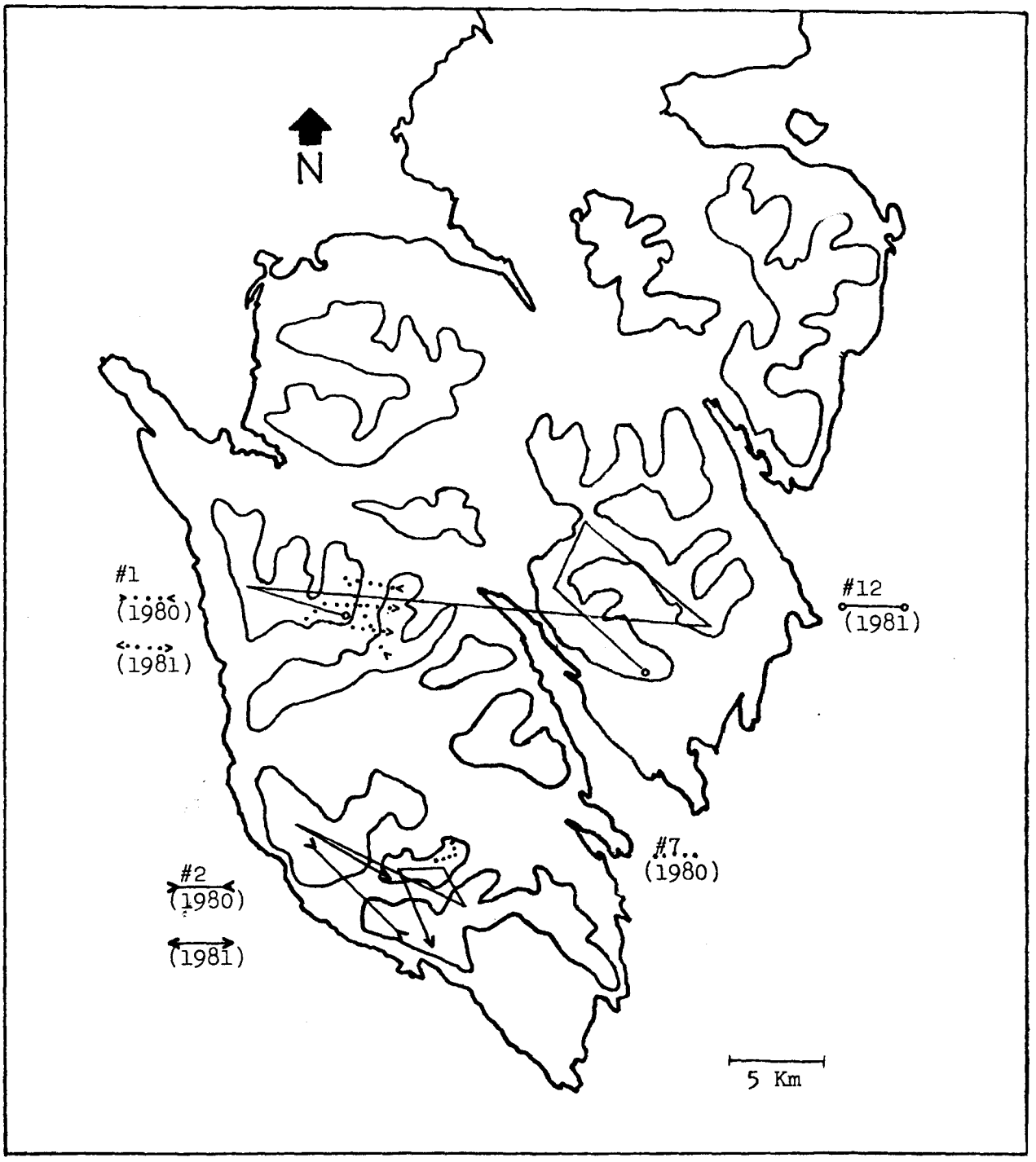

Figure 4. Movements of radio-collared male goats on the lower Cleveland Peninsula, October 20 - December 15, 1980 and 1981.

patch of habitat on the lower peninsula. The lack of observations of goats on Gold Mountain for over 20 years may indicate that once vacated, ridges on the lower Cleveland Peninsula will be recolonized very slowly.

Several authors have commented on the tendency of male goats to move between ridges occupied by females during the rut (Geist 1964; Chadwick 1973, p. 54; Smith 1976, p. 167). Geist (1971, p.90) and Rideout (1977) have suggested there are outbreeding benefits of this behavior to sheep and goat populations which frequently disperse into scattered groups of closely related females with which males associated primarily during the rut. Goats on the lower Cleveland Peninsula generally follow this pattern. Nevertheless, inbreeding cannot be discounted in this population.

Assume for example, that the reproductive portion of this population (i.e. goats over 2 years of age) consists of 12 males and 20 females which freely, and randomly interbreed. Such a population would have an effective population size, "N_e" of 30, (Wilson 1976, p. 77). Allowing for a limited amount of immigration to the population from surrounding areas, such a population can be estimated to have an average coefficient of genetic relationship, "r", of approximately 0.35 (Brown 1974, p.70). From this "r", it is possible to calculate the inbreeding coefficient, "F:, which equals 0.26. Due to the sedentary nature of females, these goats obviously violate the assumption of free genetic exchange, so this estimated "F" value is conservative.

Theoretical arguments (Crow and Kimura 1970, Wilson 1975) supported by empirical data (Preobrazhenskii 1971, cited by Geist 1971; Ralls et al. 1980) indicate that inbreeding in ungulates reduces juvenile survival and reproductive performance of adult females. Ralls et al. (1979) demonstrated that "F" values as low as 0.25 resulted in significantly reduced reproductive success in 15 of 16 ungulate species studied. Thus inbreeding may play a role in the below-average percentage of kids on the lower Cleveland Peninsula compared to larger nearby populations. Deleterious effects of limited genetic variability may compound small group size on the lower Cleveland Peninsula. The inter-ridge movements by males serve to insure genetic exchange between groups, and any decline in "effective population size" as a consequence of increased mortality or reduced movement of males beteween ridge complexes will intensify potential complications of inbreeding and decrease viability of sub-populations.

To date human impact on this population has been minimal. Although the area is open to hunting from 1 August to 31 December, harvest has averaged less than 1 goat per year since 1975 (ADF&G unpubl. data). Habitat alteration in the past was confined to small scale placer mining and logging of a few select spruce stands along the shoreline. Future human impacts may be substantial.

Current plans for logging on the Cleveland Peninsula call for the annual construction of 25 km of road and harvest of 15 million board feet

of timber per year over the period 1985-2015, with slightly less activity over the remaining 70 years of the rotation. Due to the distribution of commercial timber, virtually every valley eventually will be logged and/or roaded to some extent. There will be 100-120 people involved in harvesting this timber.

Chadwick (1973) demonstrated that goats may abandon habitat, at least temporarily, as a result of road building activity. Similar responses by goats on the lower Cleveland Peninsula could have grave results. Female goats forced to abandon one ridge could spend substantial time searching unfavorable forest areas for another patch of suitable habitat. During this time they would be relatvely vulnerable to predation by bears (Ursus arctos and U. americanus) and wolves (Canis lupus).

Furthermore, although no reliable estimates can be made of carrying capacity of individual ridges, observations indicate that many of the preferred browse species (eg. Vaccinium spp.) show substantial hedging in some areas (ADF&G unpubl. data). If existing groups are currently limited by available forage resources, goats displaced from one ridge might not be able to survive even if they located another patch of occupied habitat.

Road construction, logging activities and slash in clear cuts may also affect the movements of males during the rut directly by creating barriers or indirectly as a result of human harassment or killing of goats. Although the hunting season will be permanently closed as soon as development begins, illegal hunting can be expected to occur. Given the limited number of animals in this population, even occasional poaching along the road system could substantially alter gene flow between, or viability of, sub-populations.

The goats on the lower Cleveland Peninsula exist at the marginal end of the scale in group size, available habitat and, possibly, genetic variability. Maintenance of sub-populations is tenuous under optimal conditions. Human activity of the magnitude currently planned for the area may have significant effects on mortality and inter-ridge movements by males during the rut and thus eventually result in the elimination of several, if not all, sub-populations.

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CONFERENCE DISCUSSION

Questions regarding this paper were answered by Lyman Nichols, Jr., who read the paper.

Q. I have a question for you Lyman. What do you suppose would be the limiting factor for those goat herds, those small pockets of goats?

Ans. Apparently the limiting factor is lack of suitable habitat. They have occupied just about everything that is suitable, all the little cliffs. They just don't have a large area of habitat.

Q. O.K. then you are identifying cliffy areas as suitable habitat.

Ans. Yes.

Q You don't feel that logging or opening up some of those areas will make the goats more likely to expand?

Ans. That's a good question. We don't really know. There is a study going on near Ketchikan to try determining that. Logging might open it up for movement but it will also open it up to predation, make it easier for wolves to travel, and also easier for poaching to occur.

Q Lyman, we have a similar situation on coastal B.C., similar to what Chris has in Alaska. We also have logging that has advanced probably 15 or 20 years further along than what you people have and we are finding through tracks and signs that goats are getting down into the logging slashes and they are moving across them. Regarding the question that was just broached about the opening up of some of these areas by logging, which may increase in the future, most of the evidence we have on coastal goats is similar to the stuff we have for black-tail deer. That is, the requirement of mature timber as habitat, and once that mature timber is removed, most of the goat populations decline similar to our black-tail deer populations, so without mature timber in those coastal snow situations you really aren't going to have goat populations. But, as I said, we are noticing goats moving across the logging slashes, and if you can modify the logging at all, I think you can preserve some of those forested winter ranges and possibly maintain some of those corridors for, especially the males, to move across.

Q Is it snow or the food supply that is limiting?

Comment: It's both. It's snow depth. We have had incidences of snow depths of 5 to 12 feet on our goat winter ranges, coastal snow that you can't even move through, it's so dense in terms of moisture. So definitely it's snow type and snow depth, but it's also food supply because they basically are living on conifers and arborial lichens that come out of the mature trees. There is virtually nothing available on the ground during those types of winters.

Ans. That's basically what is happening in Chris's area. He mentions heavy snow depth, 6 feet or there-abouts, but frequent lack of snow altogether below 600 feet of elevation so snow probably would not limit goats if they could get across the valleys. In my study area, I have part of my goats wintering in a coastal area, and they are wintering partly within and very dependent on dense conifers for snow shelter. I think if the conifers were gone, those goats would be out of luck.

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