STRATEGY OF RESOURCE USE BY MOUNTAIN GOAT NURSERY GROUPS[1]

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Abstract: Observations of two populations of mountain goats were recorded near Crande Cache in western Alberta in 1974 and 1975 to determine the habitat preferences of nursery groups. Each observation was classified according to the following habitat parameters: cover type elevation, slope, aspect and distance to rock-gravel cover type. They activity of goats during an observation was recorded as feeding, bedded or escape. Over 400 observations were recorded during this investigation and about one half of these were of nursery groups. Foraging activity prevailed on level, high elevation areas most distant from rock-gravel cover types. Bedding and escape activity were associated with steep, rock-gravel areas. There were also pronounced seasonal changes in habitat selection during the period from late spring to early fall. Security and refuge seemed to be critical factors in the selection of habitat parameters by nursery groups. Foraging excursions onto less secure habitat were common only in late summer. Knowledge of the resource strategy of this species is of immediate concern in view of the imminent development of coal deposits in the east slopes of the Rocky Mountains in Alberta.

In recent years more and more studies have examined habitat selection by wild ungulate populations (e.g. Hirst 1975, Peek et al. 1976, Shannon et al. 1975). Saunders (1955) and Hjeljord (1973) have investigated habitat and food selection by mountain goats (Oreamnos americanus). Investigations of habitat use are important in assessing the impact that may accrue to wildlife use by ungulates (including the present one) are not experimental but simply report non-manipulative observation of habitat use. Thus we can only hypothesize about habitat or forage requirements based upon observed preferences.

In this paper I have attempted to assess the habitat use by mountain goat nursery groups and to demonstrate that certain environmental variables may be selected differently by nursery groups at different times of the year and during different activities. I have also attempted to explain variation in habitat selection in terms of varying requirements for security and forage. In Alberta the major threat to mountain goats at the present time is the loss or disturbance of ranges that are occupied by goats through exploration and extraction of coal deposits. By recording the habitat preferences and describing a strategy of resource use by nursery groups I hope that it will be possible to minimize conflict between resource development and mountain goat requirements.

I wish to acknowledge the field assistance of James Stelfox and to thank Jan Murie and Fred Zwickel for helpful discussions about habitat selection by wildlife populations. I also wish to thank those in the Wildlife Services section of the Alberta Fish and Wildlife for logistical support in the field.

STUDY AREA

I recorded observations of mountain goats on three adjacent areas in west central Alberta. Mount Hamell (see Fig. 1, Samuel et al., these Proceedings) the Goat Cliffs and Grande Mountain are situated on the eastern edge of the Rocky Mountaings. The elevation here ranges from 3000 feet (914 meters) at the Smoky River up to 7000 (2134) at the summit of Mount Hamell. The Smoky River flows north between Mount Hamell on the west and Grande Mountain and the Goat Cliffs to the east. It is unlikely that regular movement of goats (particularly nursery groups) occurs across the Smoky River, but I feel that some goats may have moved between Grande Mountain and the Goat Cliffs and that this is possibly a more regular movement route. Table 1 lists the estimated goat populations for each side of the Smoky River in 1974 and 1975 (ie. the estimate for Grande Mountain has been combined with that for the Goat Cliffs). Kerr (1965) reported a decline from 80 to 55 goats on Mount Hamell between 1962 and 1963. That population has declined even further since that time.

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Table 1. Summary of population estimates for two study areas in 1974 and 1975.

	Hamell		Goat Cliffs	
	1974	1975	1974	1975
adult male	8	10-13	8	8-10
adult female	12	13	11	10
two-year-old	7	2	7	3
yearling	3	5	1	2
kid	9	9	3	8
total	32	39-42	23	31-33
Kids/100 nannies	75	69	27	80

These areas are located near the new town of Grande Cache just north of the Willmore Wilderness Park in an area that has recently been developed for rich coal deposits. Several active underground mines and a preparation plant are situated adjacent to these study areas.

METHODS

Field observations were recorded during the summer and fall of 1974 and the summer of 1975. Daily observations were conducted from base camps located on each study area. The location, age and sex were specified when possible for each animal observed or otherwise listed as unclassified. For the purpose of this study a nursery group was defined as any group of goats that included at least one kid. Other individuals in a group may have been of any age or sex cohort, although adult billies were uncommon in nursery groups.

I chose the following habitat parameters as variables that might be relevant to the distribution of mountain goat nursery groups: vegetative cover type, elevation, slope, aspect and distance to the rock-gravel cover type. Each of these variables was plotted on a separate map of the study area. A grid overlay system was established for the maps and each point on the grid was classified for the habitat variables mentioned. Nursery group locations were also identified by coordinates of the grid, allowing a fairly accurate identification of the variables at the point of each nursery group observation.

I identified seven categories of cover type. The deciduous and conifer cover types were situated at lower elevations. The conifer stands (mainly spruce Picea glauca X P. engelmannii) were most often located on north facing slopes while the deciduous forest (mainly poplar Populus balsamifera or dense alder thickets Alnus crispa) were situated on south facing aspects. The grassland was a scarce type on all areas. This too was found at lower elevations of about 3500 to 4500f(1068-1373m). The burn type was situated at higher elevation, usually above 5000f(1525m). These were older burns that have shown very little regeneration of their previous conifer stands but now support a productive grass-herb-shrub vegetation. This cover type was usually characterized by a relatively deep soil layer compared to the other cover types at the same elevation. The subalpine ridge type was another high elevation cover type, usually situated above 4500f (1373 m), and was spatially associated with the rock-gravel type. The species composition of the vegetation on the subalpine ridge was very similar to that of the burn, but the biomass productivity and soil thickness were much less. The alpine tundra type was situated above 6000f(1830 m). Grasses, sedges and small dicot herbs were prevalent on this type. The rock-gravel cover type was characterized by little or no vegetation cover. The slope on this type was usually very steep and the soil unstable.

Elevation was divided into 500 foot (153m) intervals between 3500 and 6500f(1068-1983 m) from the national topographic map series (1:50,000 scale). Slope was estimated for 15^{0} intervals between 15 and 75 degree slopes. I divided the aspect of the study areas into north, south and east facing and a high elevation exposed aspect. The west facing aspect was not represented here. Finally the distance to the closest rock-gravel cover type was considered for each observation. The distance was determined from the grid system used to plot observations and habitat variables. Consequently the category intervals are a function of the distance between grid points (approximately 206 m) and the first category of the distance variable is equivalent to the rock-gravel cover type. The habitat parameters considered here do not vary independently of each other. This must be considered when interpreting the results in the following sections.

RESULTS

Observations of nursery groups on these areas centered around key zones of steep rock-gravel. On Mount Hamell, Hell's Canyon formed the most prominent relief and was the central area used by goats. On the Goat Cliffs, observations of nursery groups centered on two adjacent drainages that converged on the Smoky River. These areas accounted for about 50 percent of all nursery group observations; however, the dependence on the rock-gravel cover type by nursery groups was not consistent throughout the summer period. The predominant activities on this cover type were security oriented (ie. bedded and escape). Use of areas at greater distances from the rock-gravel cover type at higher elevations and on the most gentle slopes were associated with foraging activity. There was a significant association, using and R. x C contingency chi square test ($p < 0.05$ and in most cases $p < 0.005$) between each of the habitat parameters and nursery group activity and the habitats that were used each month.

Resource Use and Activity

I examined the use of each habitat variable to see if there were differences in habitat preferences associated with the activity of nursery groups. Three activity classes accounted for almost all observations recorded. These were feeding, bedded and escape. Fig. 1 show the proportion of observations in each activity category for the vegetative cover type ($p < 0.005$). The smallest proportion of feeding activity occurred on the rock-gravel type. The nominal characteristic of the cover type variable prohibits a sequential interpretation of the categories. That is, the activity of nursery groups on each cover type cannot by ranked according to any value of each cover type.

The activity of nursery groups varied significantly ($p < 0.005$) at different elevations (Fig. 2). The interval characteristic of this variable permits a sequential interpretation, not possible for cover type or other nominal variables. Foraging activity prevailed at higher elevations and bedding decreased. There were no major changes in the proportion of escape activity except at the lowest elevation where the small sample of two observations reduced the significance of this category.

The proportion of observations in each activity on the different slopes is shown in Fig. 3 ($p < 0.005$). Feeding activity was greatest on the most gentle slopes and least on those areas with a slope of greater than 30 degrees. Conversely, bedding activity was least on the more level areas.

The effect of aspect on nursery groups activities should be considered in terms of the effect that aspect has on other factors such as the incidence of radiant energy, vegetation type or snow cover. On the basis that the amount of radiant energy received is greater on south facing that on east facing slopes and greater on east facing than north facing slopes, then it is probable that incident radiation was favoured in the selection of foraging sites by nursery groups (Fig. 4, $p < 0.005$). Minor variation in bedding and escape activity were recorded on each aspect. The small proportion of escape and bedded activity on the exposed slope may reflect the association of this type with high elevation, level areas.

Nursery group activities varied significantly as the distance from rock-gravel cover type increased (Fig. 5, $p < 0.005$). Foraging activity became more prevalent and bedding activity decreased as the distance from rock-gravel cover increased. Escape activity was most frequent on the rock-gravel cover type but remained fairly constant at increasing distances.

Seasonal Patterns of Resource Use

Since observations were only recorded during the summer and fall periods this examination does not extend to the complete annual cycle of habitat use. Observations from all study areas and two years of data are combined to increase sample sizes in this analysis and were divided into monthly intervals.

The most interesting changes in habitat use were associated with cover type, elevation and distance to the rock-gravel cover type. Variation in the seasonal use of cover types occurred on the rock-gravel type, tundra type and the burn cover type (Fig. 6, $p < 0.005$). This variation may have been associated with the selection of other habitat variables such as elevation or distance from the rock-gravel cover, that co-vary with cover type, but may also reflect differences in forage availability or quality on these types as the season progresses.

I observed a significant trend in the seasonal use of different elevation classes by nursery groups (Fig. 7, $p < 0.005$). There was a consistent increase from May to October-November in the proportion of nursery groups observed above 5000f (1525m). Observations in the highest category (ie. above 6000f (1830m) occurred only in July and August. In the previous section I established that the majority of observations at higher elevations were associated with feeding activity.

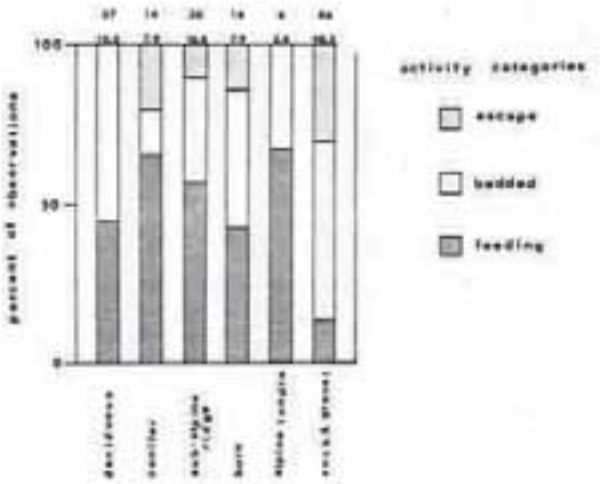

Figure 1. Activity of subunit groups on each forest type.

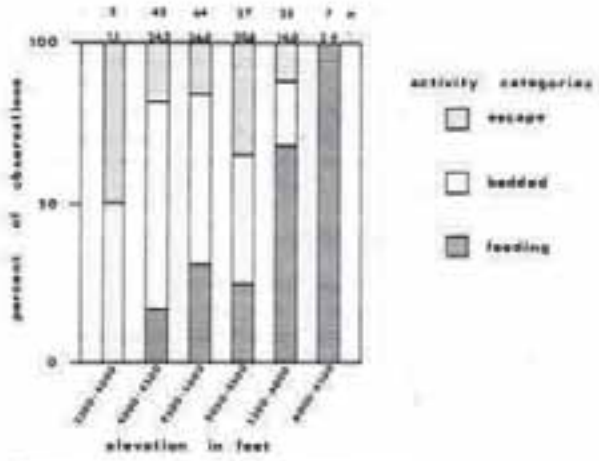

Figure 2. Activity of subunit groups on each elevation category.

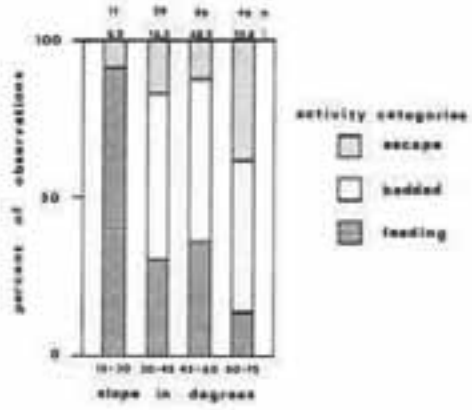

Figure 3. Activity of subunit groups on each slope category.

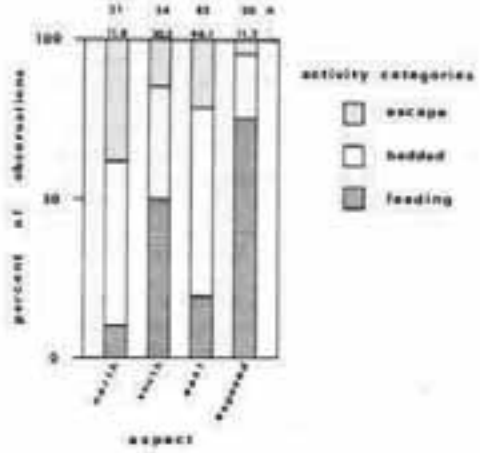

Figure 4. Activity of subunit groups on each aspect.

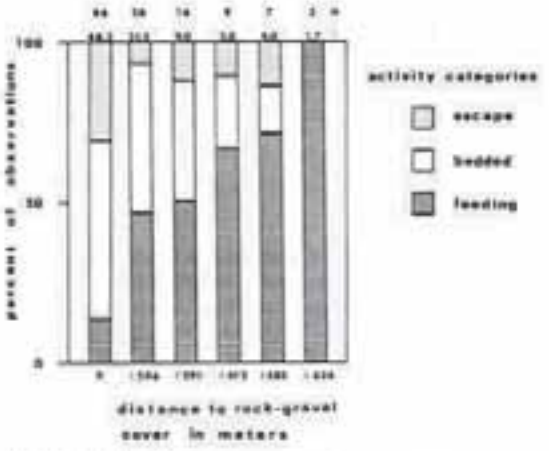

Figure 5. Activity of nursery groups at different distances from the rock-gravel cover type.

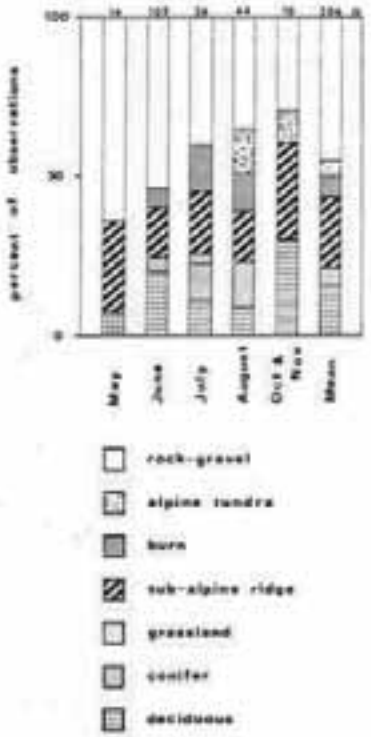

Figure 6. Monthly distribution of nursery groups with respect to cover type.

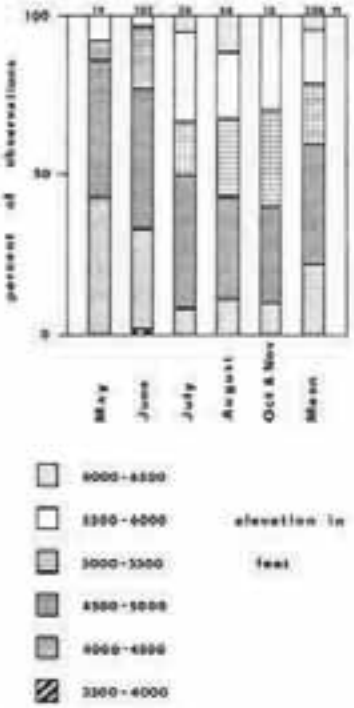

Figure 7. Monthly distribution of nursery groups with respect to elevation.

Figure 4. Model describing the factors influencing habitat preferences of mountain goat nursery groups.

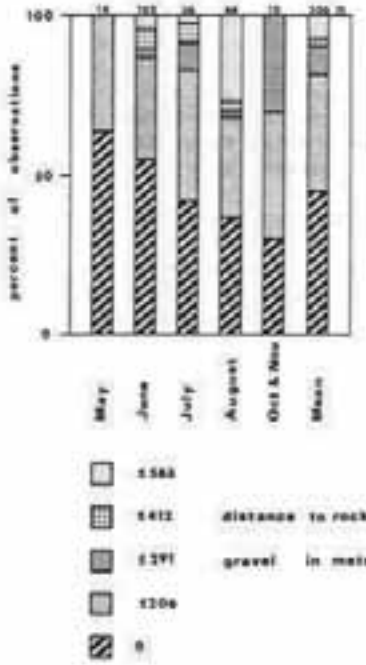

Figure 8. Monthly distribution of nursery groups with respect to distance to the rock-gravel cover type.

There is also a notable seasonal trend towards increasing use of habitat at greater distances to the rock-gravel cover type during the summer (Fig. 8, $p < 0.005$). The greatest proportion of observations in the most distant category occurred in August. I have also indicated in the previous section that feeding activity was the most prevalent activity in the most distant categories.

DISCUSSION

Strategy of Resource Use

The term "strategy of resource use" is used here as a synonym for ecological niche; however, the former term is preferred in this context because it emphasizes the active selection of environmental factors. The idea of a strategy is helpful since it implies a flexible complex niche. This is particularly relevant in a variable and discontinuous habitat such as that occupied by mountain goats. The resource components of the niche have physical, biological and temporal dimensions.

I have prepared a simplified model (Fig. 9) of the strategy of resource use by mountain goat nursery groups that is based on the dichotomy between the need for security and that for forage as factors determining habitat use. It might be argued that the balance between these factors depends upon the existing level of predation. Although several terrestrial predator species (i.e. grizzly bear Ursus arctos, wolf Canis lupus, coyote Canis latrans, and lynx Lynx canadensis) were present no interactions with mountain goats were observed. Golden eagles Aquila chrysaetos were abundant and occasionally made threatening stoops at nursery groups. I would suggest that the requirement for security is reinforced by low levels of predation by terrestrial carnivores and that the refuge strategy of nursery groups is less effective against avian predators as large as eagles.

A major limitation of the resource strategy of nursery groups may be associated with the fact that almost 95 percent of the observations occurred within 412 m of the rock-gravel cover type. Consequently the selection of forage would be restricted to those areas within about 400 m of rock-gravel cover type. This distance may be quite flexible. Murie (1944, p.142) noted that in the presence of heavy wolf predation, Dall sheep (Ovis dalli) range was restricted to the rugged cliff areas, and that in the absence of wolves the sheep moved onto much less secure habitat.

In conjunction with the hypothesis that use of steep rock-gravel areas is associated with the need for security it follows that use of level areas at longer distances from rock-gravel areas are usually associated with highly motivated foraging activity. This is supported by the observation that feeding activity prevailed on those areas.

Seasonal variation in habitat use was possibly due to variation in forage availability and quality on different habitats and differences in security requirements associated with kidding, growth and development of the kids. Nannies typically gave birth to kids on the most rugged portions of the cliff areas and only moved off cliffs after their kids had developed greater physical strength and coordination. As the season progressed the frequency and extent of foraging excursions by nursery groups increased due to the reduction of the need for security. Consequently there was a shift to habitats at greater distances from the rock-gravel type during July and August by nursery groups.

Johnston et al. (1968) showed that the palatability of forage was greater at higher elevations, thus the availability of better forage at higher elevations may encourage feeding activity on these areas. It was apparent that the "green-up" of vegetation in the spring progressed from the lowest deciduous forests in May up to the higher elevations. Consequently the maximum palatability of forage would also progress seasonally up to higher elevations during the summer. This would account for the increased use of tundra and burn types in July and August.

At the present time in Alberta large areas of the eastern slopes of the Rocky Mountains have been leased for extraction of coal deposits. Much of this area corresponds to the areas of major ungulate concentrations and some leases are even situated in alpine zones. There exists a serious potential for conflict between the habitat requirement of mountain goats and other ungulates and the development of non-renewable resources. Detailed knowledge of the habitat use and resource strategy of mountain goats may permit the establishment of spatial and temporal constraints upon future development in order to minimize the impact upon wild populations.

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