DOMINANCE, LEADERSHIP AND GROUP COHESION OF MOUNTAIN GOATS AT A NATURAL LICK GLACIER NATIONAL PARK, MONTANA[1]

Francis J. Singer

Glacier National Park
West Glacier, Montana 59936[2]

Abstract: Social behavior of mountain goats (Oreamnos americanus) visiting a natural mineral lick along U. S. Highway 2 in Glacier National Park was observed in 1975. Group size during 118 observed movements ranged from 1 to 47 and averaged 6.7 goats. Nannies with kid at side led more groups during movements (47.5 percent) than other classes. They were the most important leaders since they led larger groups of mixed classes. Billies, nannies, and nannies with kid at side were the dominant classes of goats at the lick. Nannies, two-year-old females, and yearlings were involved in more dominance interactions at the lick than expected by their proportion of the observed population. Dominance and leadership were not equivalent; nannies with kid at side were dominant less than they were leaders, while nannies and adult billies were dominant more than they were leaders. Group cohesion was low in movements to and from the lick; marked goats were re-observed in the same group only 21 percent of the time. Learning was suggested by choice of crossing routes, altered crossing routes after a disturbance, and leadership by adult nannies with kid at side.

A study was made of the behavioral reactions of mountain goats (Oreamnos americanus) to U. S. Highway 2 and a viewing area for visitors in Glacier National Park, Montana (Singer 1975). Mountain goats cross the highway and pass near the viewing area to visit a natural mineral lick located along the banks of the Middle Fork of the Flathead River (Fig. 1). Information on leadership, dominance relations, and group cohesion of goats was gathered incidentally to the highway study. The study period was from March through mid-September 1975.

Some aspects of social behavior in mountain goats have been described by Brandborg (1955), DeBock (1970), Chadwick (1973), and Rideout (1974). Rutting behavior was described by Geist (1964). Geist (1974) theorized that exploitation by ungulates of plant communities with characteristic stability selects for varying levels of cohesion between individuals, leadership, gradual disassociation of mother and young, and home range traditions. Quantitative data are lacking on these aspects of social behavior in mountain goats.

Group characteristics and social interactions of mountain goats at natural licks undoubtedly differ from behavior on the range. For example, male groups visit licks earlier than female/young groups (McCrory 1975, Singer 1975), and visits to licks by many goats results in larger concentrations in a small area than would occur on feeding ranges. Visits to a lick are an important aspect of the ecology of mountain goats. For example, Hebert and Cowan (1971) felt that all or most mountain goats over one year of age travel to natural licks. Therefore, the social behavior of goats at a natural lick is presented here as a special but important aspect of mountain goat ecology.

METHODS

Mountaing goats were observed over a period of 90 days (280 hours) at the Walton Goat Lick from inside a vehicle parked in the viewing area, with use of a 20 - 60X spotting scope. Twenty-seven goats were recognizable; 14 by natural deformities, and 13 by artificial dye. Mountain goats were classified as adult billy, two-year-old male, yearling, kid, adult nanny with kid at side, and adult nanny (without kid).

Licking times and dominance/subordinance interactions were recorded for each sex and age class of mountain goats. Dominance displays included "present-threat", "rush-threat", and "attack", as

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[1]Study funded by the Federal Highway Administration and Glacier National Park, West Glacier.
[2]Present address: Uplands Field Research Laboratory, Great Smoky Mountains National Park, Gatlinburg, Tennessee 37738.

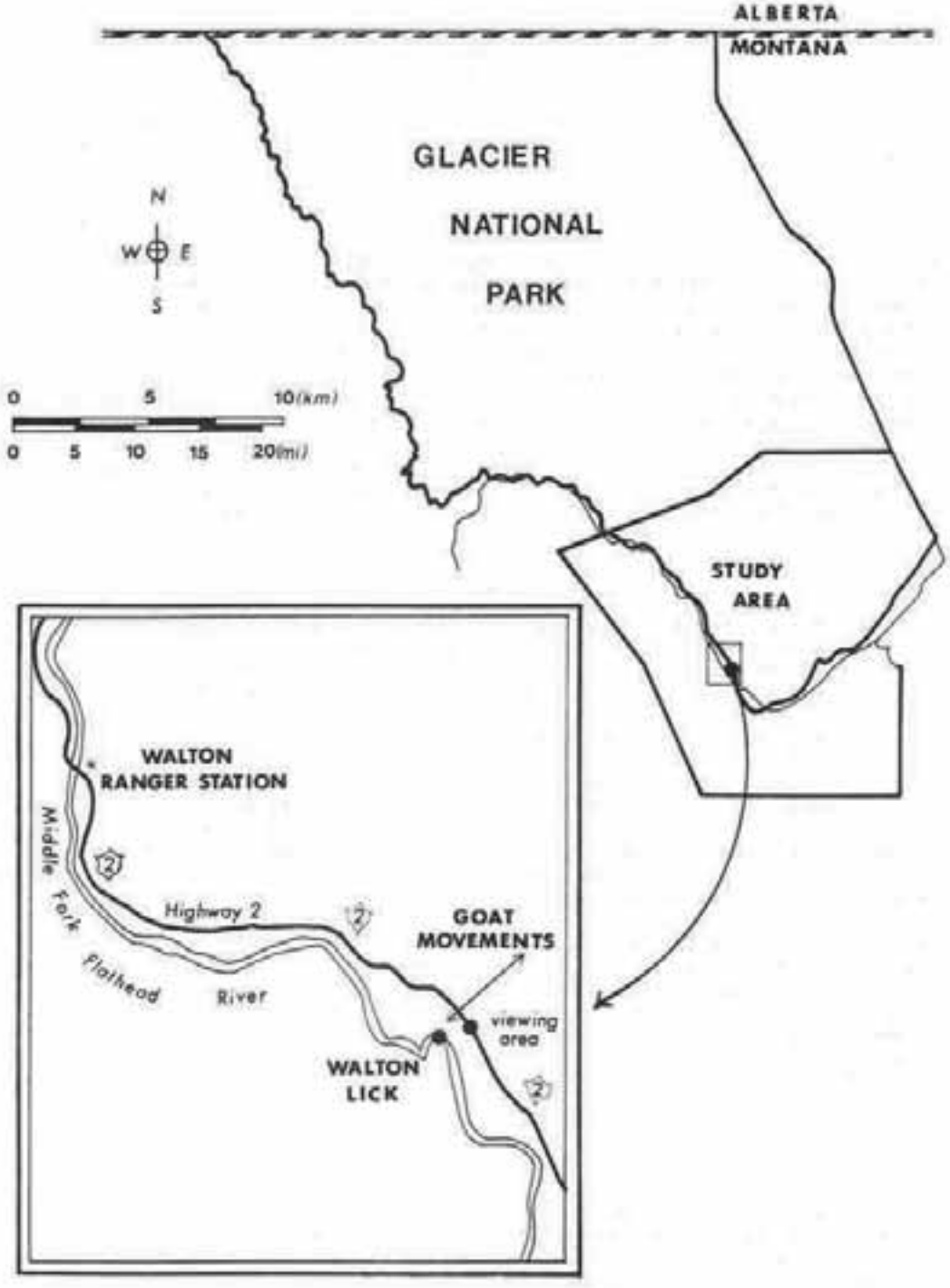

Figure 1. Map indicating study area in the Middle Fork of the Flathead River drainage and primary movement area for mountain goats visiting the Walton Goat Lick.

described by Geist (1964). Only decisive aggressive encounters, where one animal retreated, were recorded as indicators of dominance.

STUDY AREA

The Walton Goat Lick, elevation 6,343m, is an exposure of the Roosevelt Fault which parallels the Middle Fork of the Flathead River and is composed primarily of gypsum, kieserite, and other sulfates. Topography of the area is precipitous, with the floors of steep, narrow valleys at 1,030 to 1,280m elevation, and the peaks and ridges of uplands at 2,133 - 2,048m elevation. Valley sides are mantled by soil, talus, and glacial debris, and outcrops are topical, often occurring only at higher elevations on peaks and ridges (Ross 1959). Outcrops and mountain goat habitat are more abundant to the east along the Lewis overthrust.

Mountain goats pass near the visitor viewing area in regular movements between the Walton Goat Lick and feeding areas at higher elevations (Fig. 1). The lick is located 300m from the viewing area and 100m below the highway.

RESULTS

Mountain goats migrated to the Walton Goat Lick primarily along traditional, well-worn trails on upland crests that stretched up to 10km from the lick. Goat use of these trails and the lick has been regularly observed by Park Rangers at nearby Walton RAnger station since the park's creation in 1910 (Glacier National Park records, 1910 - 1975). Observations were also made (n = 16 goats) of mountain goats arriving at the lick through extensive forested cover. A total of 118 movements to and from the lick by 793 goats were observed in 1975. Observational evidence indicated that a minimum of 89 different goats used the lick, while transiency of the use suggested that as many as 200 different goats may have used the lick; recognizable goats visited the lick for an average period of only 8.6 days (n = 62 observations, range 1-35, SD = 8.2) (Singer 1975).

Mountain goats known to be migrating to the lick region for the first time were in small groups ($\bar{X}$ = 1.6 goats, n = 10), but while at the lick integrated into larger but still tightly-spaced groups ($\bar{X}$ = 6.7 goats, n = 118) in local movements at the lick region. The only goats which did not integrate into the larger groups were first arrivals at the lick and yearlings. Goats just arriving at the lick and apparently yearlings (Chadwick 1973) experience a greater lick drive.

Nannies with kid at side led more groups during movements than any other classes, leading 47.5 percent of the total observed movements. Nannies with kid at side were also the most important leaders, since they led the larger groups of mixed classes (Table 1). Mountain goats moving off the lick often hesitated and waited to join a group, particularly when the group was led by a nanny with kid at side. When groups were split by a passing vehicle, the remainder, hesitating near the road, often waited until a second nanny with kid at side assumed leadership. Other classes were observed standing above the highway crossing area for long periods when traffic volumes and visitor levels were high, but would immediately follow behind the first nanny with kid at side that moved by. Ability of a group to successfully cross the highway versus reluctance to cross or unsuccessful crossing was significantly associated (X^2 = 8.39, $P < 0.025$) with sex and age of the leader, the most successful leaders being adult nannies with kid at side.

Nannies with kids did not solicit companions, although other classes, particularly juveniles (i.e. yearlings and two-year-olds) often did. Soliciting of companions was apparent when goats led away but frequently hesitated and looked back towards other goats. In five observations, yearlings that were unable to solicit companions returned to the lick. Nannies with kid at side were often aggressive leaders and would threaten or chase other goats which attempted to shift position and assume leadership.

DOMINANCE

Dominant classes of goats or those goats which won more interactions than they lost were adult billies, nannies with kid at side, and nannies (Table 2). Classes of goats which were involved in more interactions than would have been expected by chance (X^2 = 87.2, $P < 0.001$) included nannies, two-year-old females and yearlings. These classes were regularly approached by all other goats, including those in their own sex/age class. Nannies with kid at side and adult billies interacted as often as expected, but interactions tended to be between or within their own classes; most other classes clearly avoid interactions with adult nannies with kid at side and adult billies by moving away after staring at them. Kids were sheltered from many interactions by their nanny.

Table 1. Comparison between groups led by the various sex and age groups of mountain goats during 118 crossing attempts of Highway 2.

Sex and Age of Leader	GROUP TYPE							
	Kid	Yearling	Female	Nanny with kid	Male	Mixed	Unidentified Group	Total
Kid	1							1
Yearling		3				1		4
2-Yr Female			2					2
2-Yr Male					8			8
Adult Billy					26		3	29
Adult Nanny			7			4		11
Nanny with kid					15	35	6	56
Unidentified Adult							7	7
Total								118

Table 2. Comparison of the percent of dominance interactions won and the number of interactions involved in between sex and age classes at the Walton Goat Lick. Expected values are based upon sex and age ratios in the lick population. An "*" indicates a statistically significant difference between the observed and expected values ($P < 0.05$).

Sex and Age Class	Number Won	(Percent)	No. of Interactions Involved in (expected)
Kid	0	(0)	63 (72)*
Yearling	3	(6.3)	48 (31)*
Two-year-old Male	3	(16.7)	18 (13)
Two-year-old Female	3	(18.8)	16 (8)*
Adult Nanny	26	(58.7)	46 (25)*
Adult Nanny with kid	53	(84.1)	63 (72)
Adult Billy	60	(89.6)	67 (49)
Total	148		270 (270)

Aggression and dominance interactions increased as the lick area decreased. The entire lick deposit was utilized during or after a rain. By late summer, the active lick area had decreased from 3.600m to only wet seeps (about 360m^2); consequently competition and dominance interactions increased. Five goats, including one adult billy and four two-year-olds, were actually excluded from the lick at a time when 57 goats were present. Chadwick (1973) found that aggression rates in mountain goats increased as group size increased.

Dominance appeared to infulence leadership, but the two factors were not entirely correlated. For example, adult billies and nannies with kids were two most dominant classes (Table 2) and

these two classes led more groups than others (Table 1). The dominant goat was also the leader in 13 (68 percent) of 19 movements wher the complete dominance relations of the group were known. In some cases, subordinate classes led dominant animals; for example, in two instances I observed two-year males leading adult billies, and in one case, a yearling leading an adult billy. Leaders were likely to lead groups of the same class as themselves, with the exception of adult nannies with kids, which led 35 (87.5 percent) of the mixed groups observed (Table 1).

GROUP COHESION

New arrivals to the lick initially avoided other goats but eventually integrated into the group(s) present and adopted their regular movements. Cohesion was low in these groups of goats. Marked goats re-observed in groups (n = 48) were in different groups 38 (79 percent) times and in the same group only 10 (21 percent) times. In some cases small groups remained apart from larger groups; nine observations were made of small cohesive groups passing intact through larger groups. A single adult billy never joined a group during four days he was present at the lick.

Goats were likely to be re-observed in the same group type; i.e. kid, yearling, female, nanny with kid, male, or mixed group. Marked goats were re-observed in the same group 35 (73 percent) times and in a differnet group type 13 (27 percent) times.

DISCUSSION

Traditional use of the Walton Goat Lick by mountain goats was indicated from National Park Service records and regularly-used trails leading to the lick. Animals older than three years of age led most (96 percent) of the observed movements. Similar results have been reported for bighorn sheep (Ovis canadensis), and camels (Geist 1971, Gauthier-Pilters 1974: 547). Older sheep lead groups to traditional ranges while older camels lead groups to traditionally used water wells along trails.

The stress of passing vehicles and visitor disturbances may have caused a greater reliance upon adult nannies with kid at side for leadership; however, this reliance upon productive females is also reported for undisturbed mountain goat populations (Chadwick 1973, Bannner 1976). Adult female reindeer (Rangifer tarandus), often productive females, are typically leaders in wild herds; aspects of maternal behavior appear to parallel the leader role (Thompson 1975). The capabilities of experienced leaders makes leadership a highly adaptive process in reindeer and, similarly, in mountain goats. The oldest of females probably predominate in leadership roles in wild deer (Taylor 1956), moose (Altmann 1956), and red deer (Darling 1937) and may be the leader to emerge in critical situations in reindeer (Naumov and Baskin 1969).

Several sources of evidence suggested habitation by mountain goats to the traffic and visitor disturbances at the Walton Goat Lick: 1) the rate of successful crossings increased as the season progressed; 2) goats rapidly shifted to routes with better cover, or routes that were otherwise shielded; and 3) goats rapidly became conditioned to associate the highway and highway noise as a threat (Singer 1975). Child (1975) reported that crossing success of caribou (Rangifer tarandus granti) repeatedly crossing a simulated pipeline in Alaska suggested that, through learning, the caribou were beginning to recognize crossing facilities as avenues of access to the other side.

Leadership and dominance were not directly correlated at the Walton Goat Lick, although both dominant classes and dominant individuals were more likely to lead. In a small number of groups where the dominance relations were known, the dominant animal was also the leader in 68 percent of the cases. Stewart and Scott (1969) found that while age was a factor favorable to dominance in domestic goats (Capra hircus) and of somewhat lesser importance in leadership, the two phenomena were largely independent in individual cases. Similar lack of relationship between dominance and leadership has also been found in domestic sheep (Scott 1945) and cattle (Kilgour and Scott 1959).

Group sizes in movements to and from the natural lick were significantly larger than for goat groups on the range or for groups of goats migrating to the lick. Increase in group size in elephants (Loxodonta africana) was related in a direct way to increasing frequency of contacts at higher densities (Laws 1974).

Little cohesion was observed in groups of mountain goats at the natural lick. This may have been related to the differences in lick drives between sex and age classes and individuals, which would tend to split groups migrating to the lick and groups leaving the lick. In addition, mountain goats arriving at the lick followed a stronger leader stimuli, which tended to split groups. For example, juveniles arriving at the lick together rapidly shifted to follow larger groups led by adult nannies with kid at side. The groups were tightly spaced and well integrated and for those reasons were not considered mere aggregations. The social situation at the lick is a unique but very important part of the yearly biology of mountain goats in this region. Lick use significantly mixes mountain goats from different locations, and thereby might serve to increase

genetic interchange.

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