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Mountain goat responses to helicopter disturbance

Steeve D. Côté

Abstract Mountain goat (*Oreamnos americanus*) responses to helicopter traffic were investigated at Caw Ridge (Alberta) from June to August 1995. A population of 109 marked individuals inhabited the ridge during the study. As measured by their overt responses, mountain goats were disturbed by 58% of the flights and were more adversely affected when helicopters flew within 500 m. Eighty-five percent of flights within 500 m caused the goats to move >100 m; 9% of the flights >1,500 m away caused the goats to move similar distances. Helicopter visibility and height above ground, number of goats in the group, group type (bachelor or nursery), and behavior of groups just prior to helicopter flights did not appear to influence reactions of goats to helicopters. Helicopter flights caused the disintegration of social groups on ≥5 occasions and resulted in 1 case of severe injury to an adult female. Based on these observations, restriction of helicopter flights within 2 km of alpine areas and cliffs that support mountain goat populations is recommended.

Key words behavior, disturbance, helicopter, mountain goat, *Oreamnos americanus*

Helicopters commonly are used in wildlife management and industrial development activities (Klein 1971, Miller and Gunn 1980, Thompson and Baker 1981). Exploration for petroleum and natural gas on the eastern slopes of the Canadian Rocky Mountains have relied heavily on helicopters for the past 40 years (Penner 1988). Such exploration often requires numerous flights in the same area because ground operations (e.g. slashing, drilling, placing geophones) need aerial assistance (Joslin 1986). Thus, wild animals in the vicinity are frequently exposed to helicopter flights.

Effects of aircraft overflights on the behavior of bighorn sheep (*Ovis canadensis*; MacArthur et al. 1979, Krausman and Hervert 1983, Stemp 1983, Bleich et al. 1990, 1994; Stockwell et al. 1991), caribou (*Rangifer tarandus*; McCourt et al. 1974, Calef et al. 1976, Miller and Gunn 1979, Gunn and Miller 1980, Gunn et al. 1983, Valkenburg and Davis 1983, Harrington and Veitch 1991), mountain goat (Foster and Rahs 1983) and muskoxen (*Ovibos moschatus*; Miller and Gunn 1979, 1980; Miller et al. 1988) have been reported. In most cases, reports show an inverse relationship between intensity of responses and altitude of a helicopter above animals. Close-range flights typically elicit strong negative responses in ungulates, but few studies have investigated effects of horizontal distance of aircraft to the animals (Miller and Gunn 1979, Foster and Rahs 1983, Stockwell et al. 1991). There is no evidence that wild un-

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gulates habituate to repeated helicopter overflights (Miller and Gunn 1980, Bleich et al. 1990). Though mountain goats are believed to be sensitive to human disturbance (Pendergast and Bindernagel 1977, Joslin 1986), few attempts have been made to record their responses to helicopter overflights systematically (Geist 1971, Foster and Rahs 1983).

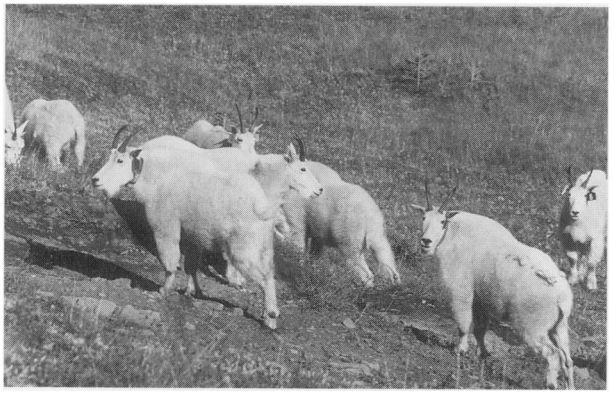
The goals of this study were to determine whether low-flying helicopters modified mountain goat behavior and to provide data for guidelines on the use of helicopters in mountain goat habitats. I evaluated goat responses to distance from the helicopter, direct sighting of the aircraft, helicopter height above the animals, group size, group type and pre-flight activity.

Study area

This study was conducted at Caw Ridge (54°N, 119°W) in west-central Alberta, Canada. The study area is a gently rolling mountain complex in the front range of the Rocky Mountains. The mountain goat population used about 21 km^2 of alpine tundra and open subalpine spruce (*Picea engelmanii*) forest, ranging in elevation from 1,750 to 2,170 m with timberline at about 1,900 m. The area includes only a few short cliff faces and does not have extensive steep escape terrains. A more detailed description of the study area is provided by Festa-Bianchet et al. (1994).

Methods

A mountain goat population of 109 animals (98 marked), including 9 adult males, 43 adult females, eight 2-year-old males, ten 2-year-old females, 2 yearling males, 13 yearling females, and 24 kids inhabited the ridge during the study. Fourteen animals were fitted with radiocollars to facilitate locating groups. I tried to find and observe each goat at least once a week. Priority of observation was given to the groups that had not been observed for the longest period of time. I used spotting scopes (15 x 45X) to sample goat behavior from the ground at distances ranging from 200 to 700 m. Observations reported here extended from 26 June to 26 August 1995 with peak flying activities occurring between 15 July–5 August. Exploration companies used 2 types of helicopters: Bell-206B turbo (n = 18 flights) and Bell-212 (twin engine; n = 57 flights). I observed helicopter flights opportunistically with no control over when and where helicopters flew.



For each flight, I noted the date, time, helicopter model (206 or 212), and whether the aircraft was carrying a drill (in a net), or not. I recorded group size, group type (bachelor [adult male(s) only], nursery [including adult females, juveniles, and kids]), behavior of animals immediately prior to the flight (active or bedded) and goat responses to the flight. I also visually estimated helicopter height above the ground (<100 m or >100 m) and evaluated the shortest horizontal distance between goat groups and a helicopter (<500 m, 500–1,500 m or >1,500 m) using topographic maps. Flights at <100 m above ground generally represented helicopters working on cut lines while those at >100 m represented flights occurring between lines or base camp. I considered flights at <500 m as the first category of horizontal distance sampling because they were generally over goat alpine habitats. Most of the flights at >500 m occurred over forests. Finally, I determined whether the aircraft was visible to the animals.

Mountain goats that continued their activities during the preflight period, or were alert for <2 minutes or moved <10 m, were classified as not disturbed or lightly disturbed (a single category for analysis). Alert goats stood, raised their ears, and usually looked towards the approaching helicopter. Goats that moved 10–100 m or were alert >2 and <10 minutes were considered moderately disturbed. Goats that walked or ran >100 m or were alert for >10 minutes were considered greatly disturbed. I recorded group responses rather than individual responses because events happened too quickly to observe animals individually. Consequently, I did not distinguish individual responses of marked goats. I considered that a group changed its behavior when at least 1/2 of the individuals did so. In >90% of cases, >75% of animals in a group reacted similarly.

Preliminary G tests were used to compare frequency distributions of goat reactions to helicopter model (206 vs. 212) and presence or absence of a sling (Sokal and Rohlf 1981). Because neither variable affected goat reactions to helicopters (P = 0.3), I pooled data from all flights and used log-linear analysis to assess the

effects of remaining variables and interaction terms on goat responses. I controlled for distance effect when analyzing the other variables because cell counts were unbalanced for close and distant helicopters. All analyses were conducted with S-Plus 3.3 (StatSci, a division of Mathsoft, Inc. 1995, Seattle, Wash.).

Results

Responses of 84 groups to helicopters were observed on 74 occasions. Twenty-nine different groups were sampled. Mean group size was 45 (SD = 41) animals. Individual goats often moved between groups. I usually recorded 1 group response/day, but occasionally I sampled the same group >1 time/day. For these cases, I waited until the goats had recovered their normal activity before recording a new response. Furthermore, there was no difference between goat reaction to the first flight of the day and subsequent flights (n = 81, G = 0.39 , 2 df, P = 0.8), indicating that the effects of flights occurring in the same day were likely independent.

Over the entire study, 42% of mountain goat groups observed during helicopter flights were considered lightly disturbed, 26% were moderately disturbed, and 32% were greatly affected by the presence of the helicopter.

The distance between the helicopter and the animals was the most important factor affecting goat behavior. Mountain goats were greatly disturbed by 85% of helicopter flights <500 m compared to only 9% of flights >1500 m (Table 1). All flights <500 m caused at least a moderate reaction, and 63% of flights >1500 m were classified as not disturbing or lightly disturbing.

Once I accounted for the effect of distance of goats from a helicopter, then direct sighting of the helicopter and height above ground, group size, group type (nursery or bachelor group) and behavior of goats before a helicopter flight had no significant effect on goat reactions ($0.14 < P < 0.98$). No interaction terms of the above variables significantly affected the response of goats ($P > 0.4$). However, some cell counts were low and therefore may have precluded detecting differences.

Table 1. Influence of helicopter distance on mountain goat responses to helicopter flights at Caw Ridge, Alberta, June–August 1995.

	Mountain goat reaction[a]			
Distance	Light	Moderate	Great	*P*
<500 m	0	3	17	0.0002
500–1,500 m	0	3	4	
>1,500 m	34	15	5	

[a] Mountain goats that continued their activities during the preflight period or were alert for <2 minutes or moved <10 m were classified as lightly disturbed. Goats that moved 10–100 m or were alert >2 and <10 minutes were considered moderately disturbed. Goats that walked or ran >100 m or were alert for >10 minutes were considered greatly disturbed.

Helicopter traffic caused a group to split up on 5 occasions (7% of flights). Once, a 2-year-old male was grazing about 50 m from a nursery group of 10 individuals when a helicopter suddenly appeared at <200 m. The young male ran >1 km in the opposite direction of the nursery group. Several flights occurred in the hours following the incident, and the young male never returned to his group but joined another group of 91 individuals 2.5 days later. Two other nursery groups were separated by helicopter flights: a herd of 90 goats and a group of 4 females, 2 juvenile males and 3 kids. They both split roughly in half (4–5 and 44–46) and reassembled 28 hours and 8 hours later, respectively. Two different male groups (1 with 2 individuals and 1 with 3) separated for ≥2 days following helicopter approaches.

On another occasion, a helicopter approached a herd of 54 goats and flew along side of them at a distance of approximately 100 m. The entire group immediately fled to a rocky cliff situated <150 m. A marked 3-year-old female broke her right hindleg during the incident. After her injury, she was separated from the main group periodically for ≥70 days.

Discussion

For 1/3 of the flights, animals reacted to the aircraft by assuming alert and standing behavior for >10 minutes or moving >100 m. A typical reaction began with the animal standing and raising its ears while looking in the direction of the helicopter. If the helicopter approached, the animal would run to safer terrain such as a cliff and face the helicopter. Mountain goats rely on rocky cliffs for security (Geist 1971, Fox and Streveler 1986). Once goats reached a cliff, they habitually did not go further. This escape behavior had an important implication in the context of petroleum and natural gas exploration which required repeated flights in the same area. Usually such activities included flying along cut lines slinging new drills and collecting the ones just used. Because goats tended to remain in nearby cliffs, instead of escaping some distance away, they were exposed to stress from helicopter disturbance for a prolonged period of time. Therefore, when the escape terrain was close to the cut line, a helicopter could remain in the

vicinity of the goats for several hours. In these situations, I noted panic behavior with animals staying alert for several hours without attempting to forage.

Prolonged disturbance could have severe consequences on daily energy intake of goats, especially for kids and nursing females, because seismic operations are normally conducted during the lactation period. Furthermore, reaction to helicopters can increase energy expenditure, reduce fat accumulation, or change animal physiological condition (MacArthur et al. 1979), factors that may affect survival or reproduction (Calef et al. 1976, Joslin 1986, Harrington and Veitch 1991).

In our study, the distance between mountain goat groups and the helicopter was the most important factor affecting their behavior. Goats appeared to be more sensitive to helicopter traffic than other open-terrain ungulates; 37% of flights at >1500 m caused at least a moderate reaction. Foster and Rahs (1983) found mountain goats were affected by flights within 1 km, the recommended flight distance from caribou and muskox (Miller and Gunn 1979), and responded beyond the disturbance distance threshold of 250–450 m observed for desert bighorn sheep (Stockwell et al. 1991).

Extensive studies on caribou and muskoxen found no evidence that exposure to helicopter harassment caused any injuries or herd splintering, but mentioned the potential impact of these factors (Jonkel et al. 1975, Calef et al. 1976, Miller and Gunn 1979, 1980). The group splinterings I observed suggest that mountain goats may be more sensitive to disturbance than other ungulates and that special care should be taken in the management of this species.

Management implications

In view of the intensity of petroleum and natural gas exploration and other activities requiring heavy helicopter traffic, the following recommendations should be considered within mountain goat range in the Rocky Mountains.

Helicopters should remain ≥2 km away from goat herds. Seismic lines should not be created in goat habitats such as alpine tundra, cliffs and open forest close to timberline. A practical guideline would be to establish a buffer zone of 2 km around alpine areas and cliffs known to support mountain goat populations, and to direct aerial traffic away from goat alpine habitat to minimize disturbance. In cases where helicopters must infringe on goat habitats, aircraft should stay ≥300 m above ground level and not land on treeless ridges (Calef et al. 1976, Miller and Gunn 1979).

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