Roger A. Hoffman,[1] and **R. Gerald Wright,** Cooperative Park Studies Unit,
Dept. Wildlife Resources, University of Idaho, Moscow, Idaho 83843

Fertility Control in a Non-Native Population of Mountain Goats

Abstract

Because hunting and trapping are not always available to restrict overabundant wildlife populations, it is often necessary to find alternative methods of control. Our purpose in this study was to test the efficacy of two fertility control techniques on a non-native population of mountain goats in Olympic National Park, Washington. Females were treated with silastic implants containing megestrol acetate, males in a different population were chemically vasectomized. Reproductive success of treated females was reduced compared with untreated females in each year of study, and in over 40 goat years only 10 percent produced young. Although males were permanently sterilized as a result of this treatment, reproductive success of female goats within the same area was not affected. The tested procedures, while potentially effective in controlling the numbers of mountain goats, require capture of the animals to be treated and are therefore very expensive. These factors will probably limit widespread operational application of this technique. This method of control may however provide a valuable alternative in those situations where transplantation is not feasible and where policies or political factors hinder or prevent the use of lethal control methods.

Introduction

Overabundant or undesirable wildlife populations traditionally have been controlled through hunting and trapping. In many situations, however, these options are neither available nor desirable. For example, hunting and trapping are not acceptable techniques for population control in national parks. Animal welfare groups and the general public often object to any type of lethal control. Hence, more benign methods of population regulation must be sought. Such a situation exists with mountain goats (*Oreamnos americanus*) in Olympic National Park.

Although mountain goats are native to many mountainous areas of northwestern North America, the Olympic Peninsula was never colonized. About 12 mountain goats were introduced to the Olympic Mountains by local sportsmen between 1925 and 1929. Olympic National Park was established in 1938, encompassing most of the mountainous area of the Olympic Peninsula. The introduced mountain goat population flourished when afforded protection, and today over 1,000 mountain goats are present in the area (Houston *et al.* 1986a).

In addition to being a national park, Olympic is classified as a UNESCO Biosphere Reserve and World Heritage Site. These designations mandate that natural resources of the park be protected from negative influences. Mountain goats are a negative influence in the high country. They are changing the structure of endemic plant communities by grazing and trampling (Pfitsch 1981, Reid 1983), and increasing erosion around trails and wallows.

Olympic National Park has considered many techniques to control mountain goats including live-trapping, shooting, and fertility control. Other potential techniques were dismissed as impractical in the rugged terrain of the Olympic Mountains because of the danger posed to other animals or park personnel (Olympic National Park 1987).

Fertility control has been recognized as a wildlife management tool since the 1960s, but the technique has received relatively little attention. Sterilization is the only nonlethal population control alternative to transplantation. Sterilization techniques have been tested on a variety of animals including horses (*Equus caballus*) (Perkins *et al.* 1982, Wolfe 1982), asses (*E. assinus*) Carothers *et al.* 1976), white-tailed deer (*Odocoileus virginianus*) (Bell and Peterle 1975, Matschke 1977, 1980; Roughton 1979), cats (*Felis domesticus*) (McDonald 1980), coyotes (*Canis latrans*) (Stellflug *et al.* 1978), fox (*Vulpes vulpes*) (Linhart and Enders 1964, Allen 1982), skunks (*Mephitis mephitis*) (Storm and Sanderson 1969), other predators (Balser 1964), and black-tailed prairie dogs (*Cynomys ludovicianus*) (Garrett and Franklin 1983). Results, although mixed, show a potential that warrants further investigation. Research on sterilization has been hampered by high costs associated with the development and licensing of drugs and the difficulty of treatment application in wild populations.

[1]Present Address: Olympic National Park, 600 E. Park Ave., Port Angeles, Washington 98362

Female hormone implants appear to be the most effective and efficient technique tested (Matschke 1980). Two widely tested compounds for female implants are diethylstilbestrol (DES) and megestrol acetate (MGA). DES is a synthetic estrogen that interferes with implantation or causes early embryonic death. DES has been used successfully to control reproduction in coyotes (Balser 1964, Stellflug *et al.* 1978). MGA is widely used in cattle and sheep; it is safe for either sex and all ages, and it has no undesirable side effects.

One potentially useful technique for male sterilization is chemical vasectomy or epididymectomy. Injection of sclerosing agents (acetic acid, zinc tannate, lactic acid, formaldehyde, etc.) into the testis (Fahim *et al.* 1982) epididymis (Pineda and Hepler 1981, Pineda and Dooley 1984, Barnett 1985) or vas deferens (Pineda 1978) results in permanent sterility of the male. Barnett (1985) reported azoospermia in nine of nine treated dogs within 35 days of treatment; similar results were achieved by others using this technique on various species. This technique does not affect behavior of the male. It is also safe; hemorrhage is unlikely and infection is less likely than with surgical techniques, especially under field conditions. No surgical equipment is needed and little training is necessary to carry out the procedure.

This study tested two fertility control techniques on mountain goats. It was designed to test whether these techniques could be employed in an operational program to reduce mountain goat numbers in the park. These techniques are new and their use in free-ranging wildlife species has been limited.

Study Area

The study covered mountain goat populations inhabiting mountainous portions of Olympic National Park, located at the center of the 10,400 km^2 Olympic Peninsula in northwest Washington. The Olympic Mountains are dominated by Mount Olympus at 2,428 m. Glaciation and stream erosion have produced 10-11 major drainages radiating in a spiral towards the lowlands and the coasts of the Pacific Ocean and Strait of Juan de Fuca. The climate is maritime. Winters are mild and wet; summers are cool and dry. The mountains form an abrupt barrier to moist, westerly winds off the Pacific Ocean, causing a steep west to east gradient in precipitation. Average annual rainfall ranges from 400-500 cm along western windward slopes to 46 cm along northeastern leeward slopes. Mixed coniferous forests dominated by Douglas-fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*) or western hemlock (*Tsuga heterophylla*) are found throughout the low and middle elevations. Forests above 550 m are dominated by Pacific silver fir (*Abies amabilis*), mountain hemlock (*Tsuga mertensiana*), and subalpine fir (*Abies lasiocarpa*). Herbaceous plant communities at high elevations are diverse. They range from moist subalpine meadows dominated by red mountain-heather (*Phyllodoce empetriformis*) and black alpine sedge (*Carex nigricans*) to scattered plants on drier scree slopes.

Methods

Capture and Treatment of Females

Five females were captured by darting from a Hughes 500D helicopter using Palmer cap-chur darts (3 cc) fitted with plastic tails (Simmons) and 3.1 cm barbed needles. Needle barbs were trimmed to reduce injury to the animals. A Gerwig® variable-range capture rifle was used to deliver 3 cc of carfentanil citrate (an experimental tranquilizer), M99 (etorphine hydrochloride), or a mixture of the two into animals. After capture, the animal was given an intravenous (where possible) 3-4.5 cc dose of 2 mg/cc diprenorphine hydrochloride (M50-50) as an antagonist to the tranquilizer.

Four female goats were captured with foot snares and three females were drive-netted. The foot-snare technique was used extensively in previous studies of mountain goats in the Olympics (Stevens 1983) and required a salt-source as bait and simple rope snares that were operated manually. Drive-netting used 2.4 m high nets 25 m in length and a helicopter to chase mountain goats into the netting.

Initially, an attempt was made to select female goats from widely separated populations for these treatments. After animals from four widely separated areas were treated, however, it became apparent that logistical difficulties in monitoring these animals were too great. The remainder of treated females were captured from a smaller area to simplify monitoring.

Cylindrical silastic implants 13 mm in diameter and 40-50 mm in length containing from 4.53 g to 6.46 g of MGA were surgically placed subdermally in the neck region of captured females. Treated goats were fitted with radio collars to facilitate relocation.

Capture and Treatment of Males

Male mountain goats selected for treatment inhabited an area approximately 3 km from the area inhabited by most treated females. Although there was some risk that animals from one area might disperse into the other, economic and logistical advantages outweighed these concerns. Population data also were available on mountain goats in this area (Houston *et al.* 1986a).

We tried to choose the largest males to ensure social dominance and therefore, reproductive potential. Five male mountain goats were captured by aerial darting. These captures and treatments were accomplished more than three months prior to rut to allow enough time for complete sterility to occur. These animals were sterilized by injecting 0.75 cc Chemcast® (Bio-Ceutic Laboratories, Inc. Div. of Philips Roxan, Inc., St. Joseph, Missouri 64502) into the caudal epididymis of each testis. Chem-cast is a sclerosing agent consisting of 88 percent lactic acid and 12 percent inert ingredients. This substance, and those of similar pharmacology, have rendered males of many different species permanently sterile when injected into the testis (Fahim *et al.* 1982, Barnett 1985) or the vas deferens (Freeman and Coffey 1973). By sclerosing the caudal epididymis, the passage of sperm from the testis should be blocked without affecting hormonal levels and associated behavior patterns.

The caudal epididymis was chosen for the ease with which it could be isolated in the field. This facilitated injection of the solution without penetrating the testis or the nerves and blood vessels associated with the caput area of the epididymis. Treatment of each testicle was done with multiple injections from a single insertion of the needle, accomplished by changing the depth and angle of the needle for each injection. This procedure ensured that many areas of the epididymis were treated so as to completely block sperm. To determine the success of the treatment, reproductive organs of four treated males were collected two years after treatment and compared with those of four untreated males.

Censuses of Males and Females

The Appleton Pass and Mt. Carrie subpopulations were censused by helicopter both in 1985 and 1986 to evaluate the effects of the treatments. The methods used are as described by Houston *et al.* (1986a). In addition to the census, an index of sightability was determined using techniques refined by Samuel (1984). The study areas were first censused using only visual cues to locate mountain goats. When a mountain goat wearing a radio-collar was located, its identity was established either through visual inspection of ear tag numbers or by using a radio telemetry receiver. After the census was completed, the receiver was again turned on and the remaining radio-collared goats in the area were located. Thus, the efficiency of the census could be evaluated by comparing the number of radio-collared goats detected during the census with the number actually known to be in the area. This efficiency was used to 'adjust' counts of detected animals to estimates of total numbers in the censused area. Treatment effectiveness of females was tested with a *Z*-test (Zar 1984:395-397) comparing the proportion of females seen with young in treatment and control groups.

Results

Females

Each of the 11 female mountain goats given MGA implants in 1982, 1983, and 1984 was relocated annually through 1987 to determine its reproductive status (Table 1). At present, the effective life of the MGA implants is still uncertain; preliminary results suggest that the life expectancy of the implants is at least four years and could exceed five years.

In 40 goat-years of observations on treated females, four kids were produced yielding a 10 percent rate of kidding. The rate observed in non-treated females was 68 percent (47/69) over 69 goat-years (Table 2). The reproductive rate of treated females was significantly lower ($P < 0.005$) than that for untreated females during each year of the study.

Males

One of the five males treated was killed in an avalanche. Two of the remaining four males stayed with the censused sub-population of

TABLE 1. Number of young produced by MGA treated female mountain goats in Olympic National Park, Washington 1983-1987.

Tag No	1983	1984	Year 1985	1986	1987
11[a]	0	0	0	0	0
12[a]	0	0	0	0	0
2[b,d]		0	0	0	0
3[b]		0	1	0	0
4[b,d]		0	0	0	0
5[b]		0	0	0	1
6[b,d]		0	0	0	0
7[c,d]			0	0	0
8[c,d]			0	1	0
9[c]			1	0	0
10[c]			0	(dead)	—
Reproductive Success	0/2	0/7	2/11	1/10	1/10

a) treated in 1982 b) treated in 1983 c) treated in 1984 d) females known to have bred successfully prior to treatment. (Reproductive history of the other females was unknown.)

TABLE 2. Comparison of reproductive rates for treatment and control groups of female mountain goats in Olympic National Park, 1983-1986.

Year	Treatment Group	Control Group	Z[a]	Z*[b]	P(Z*)
1983	0/2	3/4	1.732	2.598	0.0047
1984	0/7	7/13	2.408	2.900	0.0019
1985	2/11	20/26	3.326	3.718	0.0001
1986	1/10	17/26	2.977	3.349	0.0004
1987	1/10	—	—	—	—

a) one-tailed test b) correction for continuity

females during the rut, whereas the two remaining treated males dispersed upwards of 11 km to other areas of the park. All four treated males apparently participated in the rut, as evidenced by their close association with females and dark stains on their flanks. Staining is associated with the digging of rutting pits (Geist 1964, Chadwick 1973, Hoffman pers. obs.). Comparative examination of the reproductive organs from the four treated males indicated that the caudal epididymis of each was blocked and thus the males were effectively sterilized. As shown in Table 3, aerial censuses in the area occupied by the males indicated no change in population size or reproductive rates between 1985-1986.

TABLE 3. Comparison of population size and reproductive rates for Mt. Carrie during 1985 and 1986. Data are from helicopter censuses.

Year	Date	Estimated Population[1]	Kid/Nanny	Kid/Adult
1985	6 Aug	29	0.50	0.25
1986	23 July	28	0.80	0.27

[1]Corrected for sightability (71%)

Discussion

Females

The MGA implants were effective in reducing reproductive performance of female mountain goats. The data suggest an effective period of at least four years with 90 percent effectiveness. The maximum length of the effective period is undetermined. Predicted life-expectancy of cylindrical MGA implants was three years; however, recent findings from other species suggest this might be a conservative estimate (U.S. Seal, V. A. Medical Center, Minneapolis, MN., pers. commun.). Changes in the geometry of the implant may allow this period to be extended. These changes are based upon the relationship between surface area of an implant and diffusion rate of steroids through the silicone rubber. Implants with relatively small surface areas have lower rates of diffusion and can be expected to have a long effective life (Dziuk and Cook 1966).

Over the course of the study, 90 percent of the treated females were without offspring in early spring. This may not be a true indicator of the effectiveness of hormone implants because neonatal mortality cannot be ruled out. Using techniques described by Sasser *et al.* (1986), blood samples from ruminant females can be assayed for pregnancy/specific protein B (PSPB). Presence of PSPB suggests current or recent pregnancy. This technique has been tested in mountain goats, mule deer and white-tailed deer and found to be a reliable test of pregnancy (Houston *et al.* 1986b, Wood *et al.* 1986). Blood samples obtained prior to or shortly after the normal parturition period would provide a better test of the efficacy of MGA implants but would require recapture of females each year.

Males

Although the four males were effectively sterile and participated in the rut, they apparently had

no effect on reproduction or population size in the study area. The fact that less than 50 percent of the males in the subpopulation were treated may have influenced this outcome. The extended movement of two of the treated males out of the study area and the possible movement of untreated males into the area may also have contributed to the inability to show treatment effects. Likewise, interpretation of mountain goat breeding behavior could also be incorrect, multiple inseminations may occur more frequently than believed. Despite these problems, this technique may have potential in managing the mountain goat population if a larger number of animals can be treated and if the selected large goats do dominate breeding.

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