Effects of Feral Goats on the Santa Catalina Island Ecosystem

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INTRODUCTION

The goat (*Capra hircus*) has had a long history of association with man. Remains identified as belonging to this species have been found at the archaeological sites of the ancient cities of Jarma and Jericho and have been radiocarbon dated to 6,500 B.C. (Reed 1959). The goat may well have been the first domestic ruminant.

In spite of this long association, little about the goat is known. The purpose of the goat in many areas seems to have been that of a "poor man's cow"—an animal that excelled at nothing except survival on poor quality forage on lands that were marginal or unsuitable for more rewarding agricultural endeavor. In addition, the goat was small enough to be supported on the small plots of land that might be owned by poorer people (Devendra and Burns 1970).

A direct consequence of the goat's extreme adaptability is that little is known of its forage preferences. Goats are generally kept where little else can be expected to do well, and must simply make a living on whatever is available to them. At present, there remains considerable disagreement as to the forage preferences of goats (reviewed in Coblentz 1977).

In addition to the lack of ecological knowledge of the goat, the ancestral species has never been precisely defined. Taxonomically, the domestic goat is conspecific with the wild goat or bezoar; most authorities (Reed 1959, Harris 1962, Epstein 1971) consider the bezoar to be the true ancestor. However, there is evidence to suggest that certain breeds derived from hybridization between the bezoar and markhor (*Capra falconeri*) (Epstein 1971).

Bates (1956) summed up the scientific community's interest in goats when he wrote:

> The goat . . . might well be called the ecological dominant over much of the Mediterranean region, the Venezuelan Andes, and many other parts of the world, including numerous oceanic islands. Yet, running through a series of ecology textbooks, I find no entry of "Goat" in the indexes.

I find it disheartening to report that my own examination of recent ecology textbooks revealed a similar lack of mention of goats.

HISTORY OF THE GOATS

The origin of the goats on Santa Catalina Island is uncertain. Until recently, goats were believed to have been liberated by either the early Spanish explorers or the English pirates that preyed upon the Spaniards (Coblentz 1976). It now appears (K. Johnson, pers. comm.) that goats were first brought to the island in the early 1800s by traders who avoided paying duties by leaving a portion of each cargo on Santa Catalina, and who then smuggled the contraband onto the mainland. At any rate, goats were well established by the mid-1800s (Curtis 1864).

It has never been clearly proven that goats caused the original defoliation of Santa Catalina, but it is clear that they have perpetuated it in all areas where they persist unchecked. Excessive grazing of sheep and cattle in the mid-1800s (22,000 sheep, Curtis 1864) and early 1900s (4,000 cattle, D. Propst, pers. comm.) certainly contributed to the deterioration of habitats on the island.

EFFECTS OF GOATS UPON VEGETATION

Unchecked populations of both tended and feral goats can have a severe impact upon the native flora of an area (reviewed by Coblentz 1977). There are several reasons, both physiological and behavioral, for the goat's ability to cause ecological damage.

The goat has a relatively large rumen, which facilitates greater efficiency in utilizing forage by allowing an increased passage time, resulting in more complete digestion of the forage. This means that the goat can survive and generally reproduce on amounts of forage that would not sustain many other large herbivores. Additionally, goats have a high threshold for bitter tastes (Bell 1959); this allows them to utilize bitter or oily shrubs that few other herbivores will eat.

The feeding activities of goats are considerably more destructive than most other herbivores. Because they can subsist on poor quality forage, they continue to eat what coarse vegetation remains in an area until there is little vegetative cover on the soil. In addition to direct destruction by foraging, goats also directly destroy vegetation by trampling and soil compaction due to their tendency to use regular trails. Trail formation by goats removes a considerable amount of land from production (1 to 2 per cent, Coblentz 1974) and can also initiate or contribute to gully erosion.

Goats exhibit remarkable behavioral plasticity, allowing them to utilize a greater proportion of the plant biomass in an area, which consequently results in increased environmental destruction. Goats not only feed within the zone of their easy reach but will often push over tall shrubs to get at the better quality forage, stripping most available leaves from the crown. Stems of brittle species, such as St. Catherine's lace (*Eriogonum giganteum*), a species endemic to Santa Catalina Island, are easily broken by this behavior.

Goats also assume the role of arboreal herbivores, climbing trees with low limbs or inclined trunks in order to browse on foliage and on various fruits and mast in certain seasons. The fruit and mast eating activities greatly reduce the number of new seedlings in goat-inhabited areas, and those few seedlings that do appear are soon eaten. Insular endemic plant species have been particularly sensitive to the foraging activities of goats.

The adaptability of the feral goat was exemplified, in part, by the seasonally changing food habits of Santa Catalina Island goats. During the period of study, they appeared to simply take the best forage available, regardless of the forage class (Table 1); grasses and forbs are consumed in May, when abundant, and browse is consumed during drier seasons, such as in December.

On Santa Catalina, the close proximity of areas with goat populations to areas from which goats had been extirpated some 15 years earlier made several comparisons meaningful. The vegetation in the two adjacent areas appeared different; several measurements were taken to ascertain if the apparent differences were real (see details in Coblentz 1977). Goat-inhabited areas on Santa Catalina Island had only about 60 per cent as much total vegetative cover as goat-free areas (Table 2). There was no sagebrush in the goat-inhabited area, compared with nearly 10 per cent in the goat-free zone. In addition, it was subjectively observed that the forage in the goat-free areas grew to greater height and was more vigorous. Annual grasses, which were nearly twice as abundant in the goat-free areas, were especially conspicuous by their larger size.

The impact of the goats on herbaceous vegetation was measured by establishing 0.0001-acre exclosures and matching plot pairs in both goat-free and goat-inhabited areas. These were clipped at the conclusion of the growing season and the forage weighed. Production was greater in the goat-free area in both years that samples were made, and the difference was greater in the drought year of the study (1971-72) than in the wet year (1972-73) (Table 3). In the goat area exclosures, production was about 2.5 times greater in the wet year than in the dry year, yet was only about 25 per cent higher in the exclosures in the goat-free area. Clearly, forage production

Table 1. Percentages of forage classes in the identified fraction of rumen contents samples from Santa Catalina Island goats.

	December 1974 (n = 29)	May 1975 (n = 28)
Grass	6	74
Forb	4	18
Browse	90	8

Table 2. Mean percentage of total vegetation cover, and associated 95 per cent confidence limits, in shrubland habitat of goat-inhabited (GI) and goat-free (GF) areas of Santa Catalina Island, California. Sampling by ten 100-point point transects in each area.

	November 1971	March 1972	November 1972	April 1973	All
GI	24 ±4	27 ±7	20 ±5	47 ±8	27 ±5
GF	42 ±7	37 ±7	31 ±7	57 ±7	42 ±5

Table 3. Estimates of herbaceous layer production in goat-inhabited (GI) and goat-free (GF) areas of Santa Catalina Island, California. Protected plots (p) and nonprotected plots (np) are presented to indicate utilization by goats. All figures are in kg/ha.

Growing season	GI-p	GI-np	GF-p	GF-np
1971-72	818	359	2202	1246
1972-73	2081	1540	2730	2612

was more stable in the goat-free area. Similarly, in the drought year, production was nearly three times greater in protected plots in the goat-free area than in the goat area, and only about 30 per cent greater in the wet year. Here again, these results illustrate the greater stability of the goat-free area and, in this instance, the high potential productivity of the goat-inhabited area.

DISCUSSION

The variability of production in the goat area was apparently due to the lack of any mulch layer on the soil surface, coupled with the lack of an organic layer in the upper horizons of the soil. The mulch layer is formed by dead herbaceous vegetation that remains after the grazing activities of herbivores and is especially important because it (1) retains soil moisture, (2) slows erosion, (3) prevents the soil surface from reaching excessive temperatures, and (4) provides nutrients. Wherever small amounts of mulch occur in the goat areas, primarily around the base of shrubs and in patches of *Opuntia*, greater herbaceous production occurs.

In addition to the quantitative measurements of vegetation taken from the goat-inhabited and goat-free areas, it was obvious that certain plant species had proliferated in the areas from which goats had been removed. It was also obvious that erosion had slowed considerably in the goat-free areas.

The great improvement of the vegetation observed in the goat-free areas occurred in spite of considerable grazing and browsing pressure from other animals. Bison (*Bison bison*), mule

deer (*Odocoileus hemionus*), and feral pigs (*Sus scrofa*), all of which were exotic to the island, were present in fairly high numbers during the study. The goat, then, is implicated as being the major ecological disturbance on Santa Catalina Island.

The future of goat-affected habitats on Santa Catalina is not yet secure, in spite of significant efforts by the owners of the major portion of the island, the Santa Catalina Island Conservancy. Stabilization and recovery of some areas is progressing well; control of goats in other areas, however, would be exceedingly dangerous and costly. Poisoning, which would be effective (D. Propst, pers. comm.), is out of the question due to possible effects on non-target endemic wildlife. Furthermore, the goat is a potentially prolific animal. For any given geographical area (*e.g.*, herd home range, entire island), complete control is mandatory. Rudge and Smit (1970) have calculated that a goat population reduced by 80 per cent will attain 90 per cent of its former abundance within four years. Clearly, goats present a potentially continuing problem.

Considering the long periods of time required for biotic succession to occur in semi-arid environments, such as Santa Catalina Island, goat control or removal should proceed rapidly in all areas where it can readily be accomplished.

SUMMARY

Range relationships of feral goats (*Capra hircus*) were studied from June 1971 through April 1973, and again in December 1974, May 1975, and December 1975. Endemic vegetation was severely impacted by goats. The percentage of cover of shrubland vegetation was greater in areas where goats had been eliminated, as was production of the herbaceous layer. Overutilization of the vegetation in goat areas resulted in extensive gully and sheet erosion. Marked recovery of some plants has occurred since the total removal of goats from the central portion of Santa Catalina Island about 15 years prior to this study.

REFERENCES

BATES, M. 1956. Man as an agent in the spread of organisms. *In* W. L. Thomas, Jr., ed., Man's role in changing the face of the earth. University of Chicago Press, Chicago, Ill.

BELL, F. R. 1959. Preference thresholds for taste discrimination in goats. J. Agric. Sci. 52:125-158.

COBLENTZ, B. E. 1974. Ecology, behavior, and range relationships of the feral goat. Ph.D. thesis, University of Michigan, Ann Arbor, Mich.

_____. 1976. Wild goats of Santa Catalina. Natural History 85:70-77.

_____. 1977. Some range relationships of feral goats on Santa Catalina Island, California. J. Range Mgmt. 30:415-419.

CURTIS, J. F. 1864. Report to headquarters district of southern California. *In* War of the Rebellion: compilation of official records, Union and Confederate Armies. Series I, Vol. L, 1897. U.S. Gov't. Printing Office, Washington, D.C.

DEVENDRA, C., and M. BURNS. 1970. Goat production in the tropics. Commonwealth Agr. Bureaux, Farnham Royal, Bucks, England.

EPSTEIN, H. 1971. The origin of the domestic mammals of Africa, II. Africana Publ. Co., New York, N.Y.

HARRIS, D. R. 1962. The distribution and ancestry of the domestic goat. Proc. Linn. Soc. London. 173:79-91.

REED, C. A. 1959. Animal domestication in the prehistoric Near East. Science 130:1629-1640.

RUDGE, M. R., and T. J. SMIT. 1970. Expected rate of increase of hunted populations of feral goats (*Capra hircus* L.) in New Zealand. New Zealand J. Sci. 13:256-259.