Feral Burro Impact on a Sonoran Desert Range

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Highlight: Impact of feral burros on native desert vegetation was studied in the Havasu Resource Area, Lower Colorado River Valley, California-Arizona. Browse utilization ranged from heavy to light with increasing distance from the Colorado River. Overgrazing occurred near the Colorado River but decreased to light or moderate use at distances greater than 2.5 km from water. Overgrazing decreased the canopy cover of *Ambrosia dumosa* from about 2.26 to 0.04%, and decreased total canopy cover for all species from 8.64 to 2.80%. No plant species appear to act as increasers or invaders under grazing pressure by burros on the study area.

The feral burro (*Equus asinus*) has become a common member of the fauna in many areas of the southwestern United States. McKnight (1958) first called attention to potential range problems related to this animal. Recent ecological investigations of feral burros have centered on animal behavior and population parameters (Moehlman 1974; Woodward 1976). Woodward and Ohmart (1976) have reported on habitat use and dietary preferences in the Havasu Resource Area, California. However, quantitative information concerning feral burro impact on native vegetation has not been available. Perennial vegetation communities were identified and related to patterns of browse utilization in the present study.

Study Area

The study area is located in the Havasu Resource Area, 27 km north of Parker, Ariz. The Colorado River has been impounded at Parker Dam, forming Lake Havasu, which borders the study area on the southeast. Arizona State Highway 95 borders the study area on the north. Soils are entisols and aridisols, ranging in texture from sand to sandy loam. The study area is bisected by the Aubrey Hills, volcanic extrusions rising 100 to 150 m above the gentle sloping alluvial plain, and extending from the Bill Williams River about 25 km northwest to Lake Havasu City, Ariz. A major wash, called Standard Wash, also runs approximately north to south through the study area. When referred to in this paper, the study area will be called the Standard Wash study area.

Vegetation of the washes is dominated by foothills paloverde (*Cercidium microphyllum*), white bursage (*Ambrosia dumosa*), cheesebush (*Hymenoclea salsola*), and creosotebush (*Larrea tridentata*). The interfluves are sparcely vegetated with creosotebush and scattered chollas (*Opuntia* spp.). Riparian vegetation, dominated by salt cedar (*Tomarix* spp.), mesquite (*Prosopis juliflora* and *P. pubescens*), and arrowweed (*Pluchea sericea*), fringes the lake shore at the mouths of the washes. Perennial grasses are absent from the flora. Herbaceous cover varies with precipitation, but is dominated by the winter annual, wooly Indianwheat (*Plantago insularis*).

Approximately 50 feral burros inhabit the Aubrey Hills (Woodward 1976). A few desert bighorn sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*) are also present. No livestock are grazed in the study area.

Elevation of the study area ranges from 140 to 330 m above sea level. Mean annual precipitation for Parker, Ariz., is 116 mm. Ambient air temperatures generally range from winter lows around 0°C to summer highs around 42°C. The Colorado River is the only permanent source of water for all large animals.

Vegetation communities, patterns of browse utilization, precipitation, and soil moisture relationships were investigated as part of a

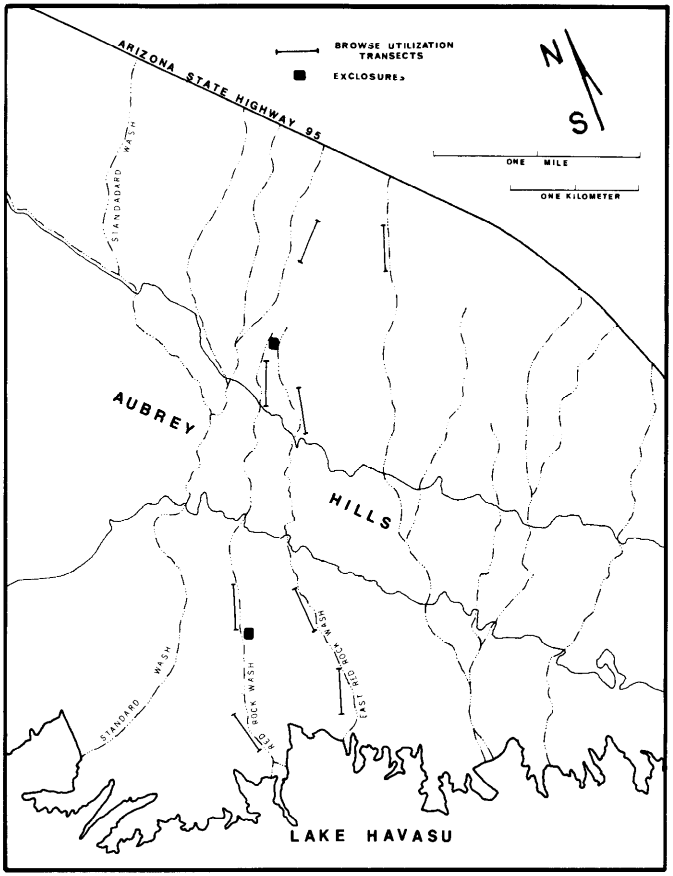

Fig. 1. *Location of exclosures and paired plots and utilization transects in the Standard Wash study area.*

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study of carrying capacity relationships conducted in1974 and 1975 (Hanley 1976).

Methods

Precipitation and soil moisture were monitored in two exclosures and two paired plots measuring 70 by 20 m, at distances of 1.25 and 3.25 km from the lake (Fig. 1). Both exclosures were located in secondary washes (i.e. washes in which flows of water were less frequent and intense than in major or primary washes). Precipitation was collected in a rain gauge located in each exclosure. Soil moisture was measured with gypsum electrical resistance blocks buried at depths of 20, 40, 60, and 80 cm at each of two sampling sites in each exclosure and paired plot. Precipitation and soil moisture data were collected biweekly in winter and spring, monthly in summer and fall, from September, 1974, through November, 1975. The millimeters of water in the 20 cm of soil surrounding each electrical resistance block were summed by site and depth over the sampling period. The summed value gave a representation of the total soil water environment surrounding each block over the year.

Browse utilization transects were evaluated four times per year: late February, May, August, and November. Four transects were located at distances of 0.5, 1.5, 3.0, and 5.0 km from the lake in each of two washes (Fig. 1). White bursage was selected for examination, since growth of the current growing season was easily recognizable, and it appeared to be a highly preferred and important browse species. Approximately 200 individual plants were examined in each transect. Degree of utilization was estimated by percentage of live stems that had been browsed. Estimates were tallied in utilization classes (0%, 1 to 5%, 6 to 25%, 26 to 50%, 51 to 75%, 76 to 95%, and 96 to 100%) to minimize error. Browse utilization data was evaluated from August, 1974, through November, 1975.

A tentative classification of perennial vegetation was developed following an intensive reconnaissance of the study area. Twenty-eight stands selected as representative of homogeneous community types were sampled by the point-center-quarter method. Eighty plants were sampled in each transect. Distance to nearest plant, species, average height, and average canopy diameter were recorded. Individual species canopy cover and density were calculated for each stand. The stands were classified using a diversity change index (Bonham and Brady 1973). In each community type thus classified, canopy cover and density were calculated for each species. Riparian communities were not sampled in this study.

Precipitation, soil moisture, and browse utilization data were analyzed by nonparametric statistical procedures (Zar 1974) to avoid the assumptions of parametric statistics (particularly those of normality and homoscedasticity). Precipitation at the two exclosures was compared by the Wilcoxon paired-sample test. Differences in soil texture (which could markedly influence soil moisture characteristics) were tested using Cochran's Q test for dichotomous nominal scale data in a randomized block analysis of variance. Blocks were soil depths; treatments were moisture block sites. Differences in total millimeters of water among the exclosures and paired plots were compared by the Kruskal-Wallis test, a single factor analysis of variance by ranks. Utilization differences between the two washes were compared by the Wilcoxon paired-sample test. Utilization differences at varying distances from the lake were teted using Friedman's two-way analysis of variance by ranks.

Results and Discussion

No significant differences ($\alpha = .20$) occurred in precipitation between the exclosures. The mean precipitation for the two exclosures over the 15-month period was 77.3 mm. The summer of 1975 was particularly dry. No significant differences ($\alpha = .10$) in soil texture occurred among sites. The sites could therefore be treated similarly in the analysis of their soil moisture regimes. Analysis of total water content of exclosures and the soils of the paired plots also indicated that no significant differences ($\alpha = .05$) occurred. Since soil moisture is the foremost limiting factor in desert ecosystems, this indicates that the site potential of the study plots is probably similar for each.

Table 1. Mean utilization (%) of live stems of white bursage in two washes (August 1974 to November 1975).

Distance from lake (km)	Red Rock Wash	East Red Rock Wash
5.0	1.1	2.8
3.0	7.7	6.1
1.5	64.2	56.6
0.5	69.0	63.5

Given the probable similarity in site potential, the secondary wash vegetation above and below Aubrey Hills would also be expected to be broadly similar in the absence of herbivory or other significant but unmeasured environmental parameters. The browse utilization transects were designed to provide objective data both on intensities of utilization and its spatial variation (Table 1). No significant differences ($\alpha = .20$) in utilization between the two washes occurred. Data from the two washes were therefore combined, and the mean values at each distance from the lake were tested with Friedman's two-way analysis of variance by ranks. Blocks were sampling dates, treatments were distance from the lake. Highly significant differences among distances from water ($\alpha = .001$) were found. Multiple comparisons of ranked data showed a highly significant difference ($\alpha = .01$) between 0.5 and 5.0 km from the lake and a significant difference ($\alpha = .05$) between 1.5 and 5.0 km from the lake. Transects 3.0 km from water were not significantly different from those at either greater or lesser distances. The

Table 2. Major vegetation community types of the Standard Wash study area.

Community type		Canopy cover (%)	Density (plants/ha)
Open Hills, *Larrea*	*Larrea tridentata*	1.03	165.5
	Opuntia echinocarpa	.09	19.2
	Ambrosia dumosa	.05	19.2
	Cercidium microphyllum	.04	1.1
	Opuntia basilaris and *O. ramosissima*	.01	8.0
	Total	1.22	204.0
Primary Wash, *Cercidium-Hymenoclea*	*Cercidium microphyllum*	3.01	34.7
	Larrea tridentata	2.52	53.7
	Hymenoclea salsola	1.59	179.0
	Lycium andersonii	.76	39.3
	Dalea spinosa	.16	10.7
	Acacia greggii	.15	3.1
	Opuntia echinocarpa	.06	6.4
	Bebbia juncea	.02	3.3
	Ambrosia dumosa	.02	14.6
	Encelia farinosa	.01	2.0
	Total	8.30	346.8
Secondary Wash, *Cercidium-Ambrosia*	*Cercidium microphyllum*	3.66	66.5
	Larrea tridentata	2.52	190.3
	Ambrosia dumosa	2.26	402.1
	Lycium andersonii	.12	11.9
	Krameria grayi	.05	12.9
	Opuntia spp.*	.03	37.0
	Total	8.64	720.7
Secondary Wash, *Cercidium-Larrea*	*Cercidium microphyllum*	1.25	29.7
	Larrea tridentata	1.20	95.6
	Lycium andersonii	.23	28.0
	Encelia farinosa	.07	27.7
	Ambrosia dumosa	.04	62.4
	Opuntia spp.*	.01	9.1
	Total	2.80	252.5

**Opuntia basilaris, O. echinocarpa, O. ramosissima.*

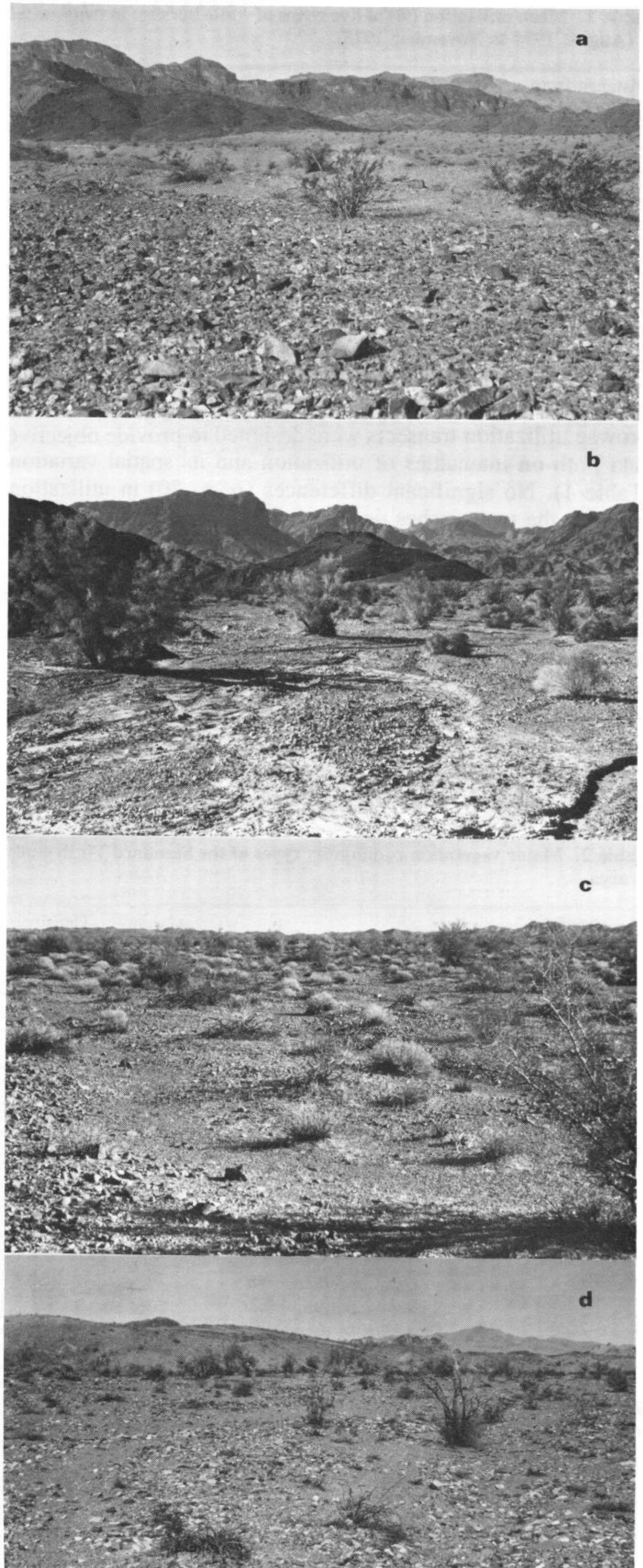

Fig. 2. *Major community types occurring in the Standard wash study area (a) Open Hills,* Larrea *community; (b) Primary Wash,* Cercidium-Hymenoclea *community; (c) Secondary Wash,* Cercidium-Ambrosia *community; (d) Secondary Wash,* Cercidium-Larrea *community.*

secondary wash areas below Aubrey Hills, in other words, were subjected to much higher levels of vegetation utilization than those areas above Aubrey Hills. Actual percent utilization (% of current year's growth removed by herbivory) quite likely exceeded 100% in several instances.

The results of this variation in utilization pressure was evident in terms of vegetation composition. Analysis of vegetative data resulted in the grouping of stands into four major vegetation community types (Table 2).

The "Open Hills, *Larrea*" community type (Fig. 2a) occurred on the dry interfluvial hills and was the most widespread community in the study area. It was composed almost entirely of creosotebush and had the lowest percent canopy cover and density of the community types.

The "Primary Wash, *Cercidium-Hymenoclea*" type (Fig. 2b) was restricted to the major drainage washes throughout the study area. The vegetation was dominated by relatively large foothills paloverde and creosotebush individuals and a great abundance of cheesebush. Smoke tree (*Dalea spinosa*) occurred only in this community type.

The "Secondary Wash, *Cercidium-Ambrosia*" type (Fig. 2c) was dominated by foothills paloverde, creosotebush, and white bursage. This community type was common in washes receiving lower utilization pressures and was restricted to the portion of the study area between Aubrey Hills and Arizona Highway 95. It had the greatest canopy cover and density of the four community types.

The "Secondary Wash, *Cercidium-Larrea*" type (Fig. 2d) occurred in topographic situations similar to the Secondary Wash, *Cercidium-Ambrosia* type, but was restricted to the portion of the study area between Lake Havasu and Aubrey Hills where utilization pressures were heaviest. The same species were dominant (with the exception of white bursage), but both canopy cover and density were only about one-third as great.

Burro impact on the study area was most pronounced in the secondary wash communities. The magnitude of impact can be evaluated by comparing cover and density values (Table 2) for the Secondary Wash, *Cercidium-Ambrosia* type (low utilization) and the Secondary Wash, *Cercidium-Larrea* type (heavy utilization). Over-utilization resulted in a great reduction in density and size of white bursage and a general reduction in density and canopy cover of nearly all species. There appeared to be no species acting as increasers or invaders under heavy burro utilization pressure.

That burros have had a substantial impact on the vegetation of this area is evident. However, assessment of the impact is complicated by the unavailability of data concerning the time required and the numbers of burros responsible for the differences observed in community structure. Information is also unavailable concerning the effects on other animal populations and the effects of interspecific competition for food resources. Browsing of white bursage, foothills paloverde, and creosotebush by hares was apparent (as evidenced by feces and stem gnawings) in both the exclosures and paired plots. Utilization by hares was greatest in the plots nearest Lake Havasu.

Woodward and Ohmart (1976) reported that burros grazed on interfluves mainly during the winter months, and washes were used primarily for travel to the Colorado River for water. Habitat use shifted to the washes with the greening of perennials in the spring. During the summer, burros were more restricted in their movements and primarily utilized the riparian habitat and washes within 3 km from the river. During the cooler months, utilization was more widespread and at greater distances from water.

Grazing on the interfluves (Open Hills, *Larrea* community type) is largely consumption of wooly Indianwheat. Availability of this forage resource depends on favorable precipitation patterns in the winter. The secondary wash communities, on the other hand, provide both perennial and annual forage species during years of favorable precipitation. During years of poor precipitation, however, the forage provided by annuals in any location may be insignificant and the major source of forage will be perennial vegetation in the secondary washes.

Management, therefore, should be concerned primarily with carrying capacity of the secondary wash communities. They are the greatest forage resource, and consequently suffer the greatest feral burro impact.

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