

DEMOGRAPHY OF FERAL BURROS IN THE MOHAVE DESERT

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Abstract: Age, sex, and body and reproductive condition of 631 burros (*Equus asinus*), and sex of 79 burro fetuses were determined from the Mohave Desert, California. The age distribution was skewed to young age classes in both sexes. Twelve individuals lived >10.5 years, and males lived longer than females. The postnatal sex ratio (61 M:100 F) was skewed, whereas the prenatal sex ratio (68.1:100) did not differ significantly ($P > 0.05$) from parity. Males had better body condition than females. Poor female body condition was associated with costs of pregnancy and/or lactation. Females of reproductive age (≥ 1.5 years) had a 61.9% pregnancy rate and a 35.2% lactation rate. Sixty percent of lactating females were also pregnant, which indicated that burros can give birth in consecutive years.

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Introduced burros (McKnight 1958, Carothers et al. 1976, Woodward and Ohmart 1976, Hanley and Brady 1977), goats (*Capra hircus*) (Spatz and Mueller-Dombois 1973), and European wild boars (*Sus scrofa*) (Bratton 1975) have become management problems because expanding populations have resulted in altered habitat. Federal protection for burros under the Wild Free-Roaming Horses and Burros Act of 1971 resulted in population increases throughout the western and southwestern United States, which made management actions necessary by the late 1970's. Lack of demographic data, however, has inhibited effective management of burro populations. Most of the available demographic information on burros was gathered ancillary to studies conducted for other reasons (Moehlman 1974, Woodward 1976, Norment and Douglas 1977) or from studies limited in scope (Morgart 1978, Walker 1978). The objective of our study was to quantify age distribution, sex ratio, body condition, and female reproductive condition of an undisturbed feral burro population in the Mohave Desert, California. The area is a secured military reservation, and California's 1952 moratorium on capturing or killing free-roaming burros was in effect for almost 30 years prior to the study.

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STUDY AREA

Burros were removed from a 302-km² area immediately north of Armitage Field on the Naval Weapons Center (NWC), China Lake, California. The area was selected because burros locally endangered the safety of personnel and Naval operations. The area included Indian Wells Valley, an internally draining basin with several playas, and the southern end of Coso Basin. Elevation ranged from 670 to 1,158 m; 70% of the area was <762 m. Vegetation was predominately a creosotebush (*Larrea tridentata*)-white bursage (*Ambrosia dumosa*) association (Turner 1982) that included white burrobush (*Hymenoclea salsola*), desert senna (*Cassia armata*), and saltbush (*Atriplex* spp.).

METHODS

Age, sex, body condition, and female reproductive condition of 631 burros, and sex of 79 fetuses, were determined following removal in March 1981.

Age, in years, was determined using general patterns of equid tooth eruption and wear (Joubert 1972). We assumed that burro dentition patterns resembled those of other equids because 2 species of zebras (*E. quagga boehmi* and *E. zebra hartmannae*) (Klingel and Klingel 1966, Joubert 1972) and domestic horses display similar timing of tooth development and replacement. Mean age for each age class was the midpoint of each 1-year interval.

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Table 1. Body condition of male and female burros, by age, Mohave Desert, California, 1981.

Age	Males				Females			
	N	Excellent	Fair	Poor	N	Excellent	Fair	Poor
0.5	46	2	4	40	77	1	16	60
1.5	26	6	11	9	29	3	11	15
2.5	26	13	9	4	58	6	21	31
3.5	21	9	7	5	56	3	24	29
4.5	22	10	8	4	32	4	7	21
5.5	33	18	12	3	35	4	15	16
6.5	20	12	6	2	28	6	8	14
7.5	18	9	8	1	24	2	6	16
8.5	7	3	2	2	18	3	4	11
9.5	6	2	2	2	12	0	3	9
10.5	4	3	1	0	21	2	4	15
≥11.5	10	1	3	6	2	1	0	1
Total	239	88	73	78	392	35	119	238
%		36.8	30.6	32.6		8.9	30.4	60.7

Pre- and postnatal sex ratios were compared separately to a theoretical 1:1 sex ratio with a Chi-square test and were compared to each other using a 2 × 2 contingency table (Snedecor and Cochran 1980:125).

Body condition ratings of excellent, fair, or poor corresponded to heavy (>1 cm), moderate (<1 cm), or no visible sternal and abdominal subcutaneous fat deposits, respectively (Pollock 1980:65, Berger 1986:110). Condition was compared between sexes by a 2 × 3 contingency table and within sexes by a Chi-square test.

Females were classified as barren, pregnant, pregnant-lactating, or lactating. The effect of female (≥1.5 years) reproductive condition on body condition was analyzed using a 3 × 4 contingency table. To determine which cells

contributed the most to the significant Chi-square value, the data were collapsed using an additional Chi-square test (Snedecor and Cochran 1980:209); only pregnant-lactating and lactating females could be combined ($\chi^2 = 0.6, P > 0.4$). The nature of the deviations was determined from the Chi-square values of each cell using a 3 × 3 contingency table. All statistical tests were considered significant at $P \leq 0.05$.

RESULTS

Population Density

Based on removal by shooting in the reduction area (N = 631) and by live-capture over the entire NWC in 1981-82 (N = 4,403), ≥5,034 burros inhabited the 4,436-km² area. The minimum population density was 1.1 burros/km².

Age Distribution

The age distribution was skewed to young age classes for both sexes with 19.5% of all individuals being foals (<1.5 years) (Table 1). Longevity was greater for males; 2 females (0.5%) and 10 males (4.2%) lived >10.5 years. Maximum estimated ages were 15.5 and 20.5 years for females and males, respectively.

Sex Ratio

The postnatal sex ratio (61M:100F, N = 631) was skewed toward females ($\chi^2 = 37.1, P < 0.001$), whereas the prenatal sex ratio (68.1:100, N = 79) was not significantly different from parity ($\chi^2 = 2.85, P < 0.10$). Pre- and postnatal sex ratios did not differ ($\chi^2 = 0.20, P > 0.50$).

Table 2. Reproductive status (%) of female burros, by age, Mohave Desert, California, 1981.

Age	N	Preg-nant	Preg-nant-lactat-ing	Lactat-ing	Barren
0.5	77	0.0	0.0	0.0	100.0
1.5	29	13.8	0.0	0.0	86.2
2.5	58	55.2	1.7	6.9	36.2
3.5	56	60.7	17.9	10.7	10.7
4.5	32	37.5	21.9	25.0	15.6
5.5	35	37.1	37.1	11.5	14.3
6.5	28	42.8	17.9	25.0	14.3
7.5	24	37.5	29.1	16.7	16.7
8.5	18	27.8	50.0	5.5	16.7
9.5	12	33.3	25.0	41.7	0.0
10.5	21	14.3	47.6	28.6	9.5
15.5	2	50.0	50.0	0.0	0.0
Total	392	129	66	45	152
%		32.9	16.8	11.5	38.8

Table 3. Reproductive condition of female burros ≥ 1.5 years of age (N) in each body condition, Mohave Desert, California, 1981.

	Excel- lent	Fair	Poor	Total
Barren	16	21	38	75
Pregnant	14	53	62	129
Pregnant-lactating	3	18	45	66
Lactating	1	11	33	45
Total	34	103	178	315

Body Condition

Body condition of females was significantly lower than that of males ($\chi^2 = 82.6$, $P < 0.001$) (Table 1). The number of males in each condition category was similar ($\chi^2 = 1.5$, $P > 0.25$) (Table 1). Males showed an age-related increase in condition; those in poor condition predominated age class 0.5 (87%) and comprised 51% of all males in poor condition. Males in fair condition predominated age class 1.5, as did males in excellent condition for succeeding age classes through 10.5 years. Body condition of males deteriorated after 10.5 years. The number of females in each condition category (all age classes (≤ 10.5 years)) decreased as condition varied from poor to excellent ($\chi^2 = 159.9$, $P < 0.001$) (Table 1). Female condition was poorest during the 1st year of life (Table 1).

Female Reproductive Condition

Evidence of female reproductive activity began in age class 1.5 with a 13.8% pregnancy rate. Pregnancy rate increased to 78.6% in age class 3.5 and varied from 58.3 to 77.8% for females through age class 10.5 (Table 2). Feral burros remained fertile into old age; both females in age class 15.5 were pregnant. The pregnancy rate for females ≥ 1.5 years was 61.9%, and females carried only 1 fetus.

Lactation was 1st observed in age class 2.5, which agreed temporally with our observation of 1st conception in age class 1.5. The lactation rate increased from 8.6% in age class 2.5 to 76.2% in age class 10.5 (Table 2). The average lactation rate for all females of reproductive age was 35.2%. Sixty percent of lactating females were also pregnant, which indicated that burros can give birth in consecutive years (Table 2).

Female body condition was related to reproductive state ($\chi^2 = 23.6$, 4 df, $P < 0.001$) (Table 3). Pregnancy, and especially lactation, were associated with poorer female body condition,

as indicated by a higher-than-expected number of barren females in excellent condition and lactating females in poor condition, and a lower-than-expected number of pregnant-lactating and lactating females in excellent condition.

DISCUSSION

Population Status

Population trend and survival rates of burros in the reduction area could not be determined from a single sample (Seber 1973:403). However, an increasing burro population in the previous decade was indicated from periodic aerial surveys of the NWC, severe range deterioration in areas frequented by burros, and vegetation recovery following burro removal (T. J. McGill, pers. commun.). Furthermore, an age distribution skewed to young age classes suggested a stable or expanding population.

We found subcutaneous body fat rapid and useful for assessing body condition. Using this technique, the average male ≥ 1.5 years was in fair to excellent condition, whereas most females ≥ 1.5 years (56.5%) and foals (81.3%) were in poor condition. Caughley (1970a,b) suggested that a high female fat index indicated an expanding population. Females from 2 burro populations in the Grand Canyon, Arizona, had kidney fat indices greater than or equal to that of males, and the population with the higher recruitment showed the higher fat index (Ruffner and Carothers 1982). Subcutaneous fat of burros in the reduction area suggested a slow rate of population growth.

Burro densities on the NWC were higher than on some areas of Death Valley National Monument (0.8/km², Moehlman 1974; 0.5/km², Norment and Douglas 1977) and lower than on others (3.8–4.9/km², White 1980). Norment and Douglas (1977) estimated an 18% annual rate of increase at low densities in Death Valley, whereas little or no growth occurred at higher densities (White 1980).

Life History Data

Both age of 1st reproduction and of 1st lactation indicated that female burros reached sexual maturity late in their 1st year (Woodward 1976). No other age-specific fecundity or lactation rate data exists for burros. Age-specific pregnancy rates of burros (Table 2) are generally lower than those of feral horses, especially in age class 1.5, where the latter were nearly

3× as fecund as burros (Seal and Plotka 1983, Berger 1986:79). Older burros and horses both exhibit high pregnancy rates. Age-specific lactation rates of burros were lower than horses through age class 8.5 (Seal and Plotka 1983). In comparison, percent pregnant and/or lactating females of reproductive age (76.2%) was similar to 2 burro populations in the Grand Canyon (Ruffner and Carothers 1982).

Poor female body condition, compared to that of males in other ungulate species (Verme 1967, Bear 1971, Anderson et al. 1972), has been attributed to costs of pregnancy and lactation. In our study a higher-than-expected number of barren females in excellent condition and lactating females in poor condition, and a lower-than-expected number of pregnant-lactating and lactating females in excellent condition, indicate that pregnancy, and especially lactation, are a significant energetic cost in burros. Additionally, females remained in poor condition throughout life, whereas males showed age-related increases in body condition. The high proportion of foals in poor condition was likely due to a correlation between condition of mother and offspring (Verme 1963, Clutton-Brock et al. 1982:88, 90) and the mother's inability to provide sufficient nourishment (Verme 1962, Murphy and Coates 1966). This may be especially true during extreme ambient temperatures or drought (Berger 1986:95), such as occurs on the NWC. Additionally, forage in the reduction area was of poor to fair quality (T. J. McGill, pers. commun.).

Stress induced by malnourishment and poor body condition of the mother may increase foal mortality (Verme 1962, Murphy and Coates 1966) and decrease female survival (Murphy and Coates 1966). Although such rates have not been estimated for burros, lower female survival was evidenced by greater male longevity in this study and in the Chemehuevi Mountains, California (Woodward 1976).

Sex ratios of burros vary among populations. Burros in Death Valley (Moehlman 1974), the Chemehuevi Mountains (Woodward 1976), the Bandelier National Monument, New Mexico (Morgart 1978), the Bill Williams Mountains, Arizona (Seegmiller and Ohmart 1981), and the Grand Canyon (Ruffner and Carothers 1982) exhibited a similar sex ratio, whereas those in the Black Mountains, Arizona (Walker 1978) were skewed toward males. Burros in the reduction area were skewed toward females. Dif-

ferences among populations may be related to previous harvesting. Burros on NWC had not been harvested in 30 years. The trend toward a female-predominated prenatal sex ratio only explains some of the postnatal sex ratio skewness. This suggests that factors regulating sex ratios in other equids and ungulates, such as costs associated with male reproductive competition (Berger 1983), greater nutritional stress in males (Clutton-Brock et al. 1982:279), and greater male emigration (Berger 1986:99-100), are related to this bias.

MANAGEMENT IMPLICATIONS

Effective management of feral burros requires more life history data, especially on rates of increase, age-specific survival, causes of variation in sex ratio, and variation in demographic characteristics among populations. Several years of census data and range evaluation prior to and following management reductions would allow integrating estimates of population growth and survival with demography. For example, an association of amount of subcutaneous body fat with population stability and age-specific pregnancy and survival rates would make body fat, especially of females and foals, useful for assessing the need for management. If partial reduction had occurred at the NWC, 1 option would have been selective removal of young females in obviously poor condition combined with continued monitoring to assess for density-dependent changes in population demography.

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