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Feral Asses on Public Lands: An Analysis of Biotic Impact, Legal Considerations and Management Alternatives

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The feral ass, or "wild burro," (*Equus asinus*), a native of northeastern Africa, was introduced into North America in the sixteenth century by Spanish explorers. Their value as "beasts of burden" had been recognized as early as 3400 B.C. in Egypt and Mesopotamia (Peake 1933 and Antonius 1937; fide McKnight 1958) and they are still used as such in many portions of the world. Although the feral ass has been in North America since the sixteenth century, it has been reasoned (McKnight 1958) that the species did not become feral in the southwestern United States until sometime during the nineteenth century. Prior to this, the animal was much too valuable to both Indians and Anglos as a work animal, and possibly food, to be allowed to become feral. It was only after the great impetus of mineral exploration had subsided and the settlement of the region ensued that some animals were released, or escaped, and feralization began. By the end of the nineteenth century, the feral ass had become established in many isolated areas of the Southwest. Since their feralization, they have been credited with a considerable amount of habitat destruction resulting in allegedly depriving native animals of essential food and water. In many areas where the feral ass has become established, it has done so at the expense of the native desert bighorn sheep (*Ovis canadensis*), an animal whose numbers have been severely reduced in the Southwest (Russo 1956; Dixon and Sumner 1939; Ferry 1955; Laycock 1974). Also, in a recent analysis of the problem in New Mexico, Koehler (1974) has found evidence that the feral ass directly competes with the native mule deer on certain ranges.

In a recently completed study on feral ass behavior and ecology in Death Valley, California, an area well known for very high population densities of feral asses, Moehlman (1972) denies noticeable habitat damage by the feral ass by stating . . . "Contrary to a widely held belief, the burros I observed did not strip the land, foul water holes or endanger other animals." She adds . . . "Although heavy browsing occurred within a mile of water, my first appraisal of vegetation data indicates [sic] that plants on which burros feed do not suffer severely." Our photographic evidence from Death Valley and the data presented in this paper from our investigations in other areas show that these conclusions are not valid. Blong and Pollard (1968) found that ewes, lambs, and yearling bighorn were concentrated within .75 miles (.46 km) of water during the summer of 1965. Denniston (1965) working in the River Mountains of southern Nevada found that desert bighorn concentrated within .5 miles (.30 km) of their only water source during the hot, dry months of summer. In a brief review of alleged vegetation destruction by the feral ass, Laycock (1974) writes . . . "The destruction of vegetation may cut sharply into rodent populations, reducing food for birds of prey, while habitat for such small birds as quail vanishes." Moehlman (1974) further attempted to evaluate the impact of feral asses on small rodents by counting the number of supposedly active rodent burrows along transects ranging from high to low ass densities. By using this method, no difference was found in the number of apparently active burrows along these transects. Thus, Moehlman concluded on the basis of this questionable sampling technique that the asses were having little or no effect on the rodent populations.

The objective of our study was to quantitatively and qualitatively evaluate the influence of feral asses on desert and riparian habitats in the Grand Canyon, Arizona. Absolute densities of small mammal populations and vegetative composition and structure were investigated. We selected two similar study plots, separated by the Colorado River, with feral asses present on one plot, but not on the other, thereby providing a "control plot" and an "impact plot."

History of the Feral Ass in Grand Canyon

The history of the feral ass' success in the Grand Canyon may be considered typical of the problem throughout the Southwest. By the early 1920's, many rangers in Grand Canyon National Park were reporting to the superintendent that for the sake of the native wildlife, drastic control measures were needed to restrict the destructive and rapidly expanding feral ass population. Burros were credited with much of the overgrazed range condition within the Inner Canyon. This is illustrated by the following quote found in an unpublished report written by Chief Ranger J. P. Brooks in 1932: "Overgrazed conditions existed on all areas ranged over by burros. In many places herbage growth was cropped to the roots and some species of shrubbery were totally destroyed. Soil erosion was greater in burro infested areas . . . "

From 1924 to 1931, a "burro hunt" was conducted in Grand Canyon National Park. The animals were shot with high powered rifles and left to decompose. During this 7 year period, 1,467 feral asses were killed. It was believed that the burro population in Grand Canyon National Park had been reduced to possibly 50 to 75 head, thus, Park Biologists were confident that no more "burro hunts" would be necessary. Yet, between 1932 and 1956, an additional 370 animals were removed. Between 1956 and 1968, 771 more were destroyed with an additional 252 having been captured and taken out of the park. This represents a total removal of 2,860 feral asses from the park in the 45 year period from 1924 to 1969. No control has been attempted since 1969. One of the main reasons for the lack of control efforts has been the negative public sentiment engendered by the "burro hunts" of the mid and late 1960's. This public sentiment, largely initiated by articles written by assinophiles (burro lovers), was quite effective in pushing through protective legislation for wild horses and burros. An example of the severity of public hysteria with which land managers must deal may be found in the text of an article by Weight and Weight (1953): "From time beyond memory, the humble, gentle burro has been man's uncomplaining servant and the playmate of his children. There is a legend that because he carried Mary to Bethlehem and Jesus along the desert trails of Palestine, he was given the mark of the Cross—which you can see upon his back and shoulders." An accompanying photo of a dead burro bears the caption, "Sportsmen, satisfied with the thrill of shooting a friendly burro at point-blank range, often do not even carry out the pretense of hunting for meat, but leave the body as it fell. This burro was shot and left in Great Falls Canyon, not far from where the little colts, above, were found."

In the past, little quantitative data have existed to be used by those who suspected or knew of the environmental havoc that would be wrought by these "starlings" of the mammalian world. Logic and other examples of great ecological damage caused by introduced species, such as rabbits in Australia and red deer in New Zealand, fell way to anthropomorphized sentiments for "man's faithful friend." The result was Public Law 92-195 in 1972, which made killing a feral ass on most lands a felony. Killing bighorn illegally is merely a misdemeanor. We wish here to present quantitative and qualitative data on the environmental hazards wrought by wild burros and other information which raise questions concerning the wisdom of this law if not indeed its legality. It may very likely be that Public Law 92-195 is in conflict with the National Environmental Protection Act of 1969 (Public Law 91-190) and the Endangered Species Act of 1973 (Public Law 93-205).

Procedures

The duration of our field studies was from 1 March 1974 through 31 January 1975. Both study plots received identical quantitative and qualitative vegetational and mammalian analyses. Vegetation was sampled by means of the line-intercept technique (Canfield 1941) and the point-quarter technique (Cottam and Curtis 1956; Morisita 1959). Approximately 2,624 feet (800 m) of line-intercept transects and 50 point-quarters stations were censused per study area. Percentage infestation of mistletoe (*Phoradendron californicus*) was measured by absolute counts of parasitized trees and shrubs on each study area. The vegetation data presented herein are a condensation of our field data collected during May, June, and August 1974.

For mammal censusing, each plot was sampled with a 10 by 12, 5.3 acres (2.2 ha.) grid of Sherman live traps placed at 50 feet (ca. 15 m) intervals. These traps were baited with a rolled oat/scratch grain mixture. Traps were set for four consecutive nights at 4:00 p.m. during March, May, June, November, 1974, and January 1975. They were checked once each day at 7:00 a.m. The following data were recorded: species and individual identification, trap number, sex, reproductive condition, weight (0.1 gram), and age class. Females were classed according to obvious signs of pregnancy, lactation, or vulvar condition. Age classes were determined on the basis of adult or immature pelage. All animals were toe clipped for individual identification. The density of each species was estimated separately by a modification of the Lincoln Index (Bailey 1952). The mammal and plant species diversities of each study area were determined by using the diversity index, H′ (MacArthur and MacArthur 1961).

Description of Study Areas

The sites selected for this investigation are located within the lower reaches of the Grand Canyon in the Mohave desert scrub vegetative community (Lowe and Brown 1973). The impact plot, 209 Mile Canyon, is on the west side (right) of the Colorado River and is inhabited by a small herd (8 to 15 individuals) of feral asses. The control plot, Granite Park, is directly opposite 209 Mile Canyon and shows no evidence of occupation by feral asses. Both study plots are 5.3 acres (2.2 ha.) in size and include both desert scrub and riparian habitats on the alluvial fans of the respective drainages.

The riparian zone of the Colorado River in this section of the Grand Canyon is typified by co-linearly arranged belts of mesic to xeric vegetation. In addition, both study plots are fronted by sand and gravel beaches of river deposit origin. Elevations range from approximately 1,503 feet (458 m) at the river's edge to 1,601 feet (488 m) on the upper terraces above the historic high water line (Dolan et al. 1974).

Both plots show more similarities in gross vegetational composition and structure than differences. An east-west orientation, equal proximity to water and the relatively flat topography of the sites, tends to equalize the abiotic factors of irradiation, moisture gradients and protection from local weather for both sites.

Results and Discussion

Vegetation

An analysis of the vegetation on the control plot and impact plot is presented in Table 1. The control plot supported greater vegetative diversity including an understory of sub-shrubs and a dense carpeting of grasses and forbs (especially plantain). The ground cover and sub-shrub components were virtually absent on the impact area. The control plot contained vegetation cover on approximately 80 percent of the total transect area surveyed compared to 20 percent vegetation cover on the impact plot. The number of species found on the control area was 30 percent higher than that on the impact area.

The mean area (m^2) occupied by each individual cat-claw or mesquite on the control plot was $27.9m^2$ per plant, while the same species on the opposite side of the river at the impact plot was not as large, occupying only $20.7m^2$ per plant. Also, there was a higher infestation of mistletoe (*Phoradendron californicus*) on the impact plot, with 16.5 percent of all cat-claw/ mesquite (*Acacia gregii/Prosopis juliflora*) being infested with this parasite as compared to only 5.4 percent of the same species parasitized on the control plot. Cat-claw and mesquite shrubs on the impact study area had been heavily browsed by asses. The mistletoe infestation may be correlated with over-browsing, but a definite conclusion cannot be drawn without further study.

There was no significant difference in total species diversity from one plot to the next, however, the control plot showed a richer sub-shrub and grass component ($H' = 1.60042$ and .821670) than the impact plot ($H' = 1.28478$ and .422710).

Small Mammals

The results of the small mammal population censuses are presented in Table 2. The most striking difference between the populations on the two study areas

Table 1. The line-intercept vegetation data summary for the control and impact study areas.

Species		Control				Impact			
		Relative Density	Relative Frequency	Relative Dominance	Importance Value	Relative Density	Relative Frequency	Relative Dominance	Importance Value
Shrubs									
Acacia	[1]a.	01.40	8.24	22.02	31.66	14.98	22.31	23.92	61.21
greggii	[2]b.	15.69	16.28	26.73	58.70	35.22	32.93	26.00	94.15
Baccharis	a.	...	...	...	...	00.96	01.65	03.00	05.61
sergilloides	b.	...	...	...	...	02.27	02.44	03.26	07.97
Brickellia	a.	...	...	...	...	02.90	04.96	01.68	09.54
longifolia	b.	...	...	...	...	06.81	07.32	01.83	15.97
Larrea	a.	01.40	09.41	13.14	23.95	03.89	03.30	02.47	09.66
tridentata	b.	15.69	18.61	15.94	50.24	04.54	04.87	02.68	12.09
Lycium	a.	...	...	...	...	00.48	00.83	00.24	01.55
pallidum	b.	...	...	...	...	01.14	01.22	00.26	02.62
Prosopis	a.	05.43	32.94	44.15	82.51	21.26	34.70	60.65	116.62
juliflora	b.	60.78	61.63	53.59	176.00	50.50	51.22	65.95	167.17
Sueda	a.	00.70	01.76	03.07	05.53	...	...	...	...
torreyana	b.	07.84	03.49	03.73	15.06	...	...	...	...
Sub-Shrubs									
Chaenactis	a.	00.52	02.35	00.18	03.05	...	...	...	...
fremontii	b.	26.09	26.65	08.28	61.02	...	...	...	...
Cryptantha	a.	00.79	02.35	00.18	03.32	...	...	...	...
spp.	b.	39.13	26.50	08.28	74.06	...	...	...	...
Dyssodia	a.	...	...	...	...	00.96	01.65	00.15	02.86
pentachaeta	b.	...	...	...	...	11.76	13.32	03.47	28.55
Encelia	a.	00.09	00.59	00.25	00.93	03.86	04.96	03.33	12.15
farinosa	b.	04.35	06.68	11.59	22.62	47.06	40.03	78.87	165.96
Ephedra	a.	...	...	...	...	00.96	01.65	00.12	02.73
spp.	b.	...	...	...	...	11.76	13.32	02.84	27.92
Lepidium	a.	00.44	02.35	00.48	03.27	...	...	...	...
montana	b.	21.74	26.65	21.85	70.24	...	...	...	...
Opuntia	a.	...	...	...	...	00.48	00.83	00.29	01.60
spp.	b.	...	...	...	...	05.88	06.69	06.94	19.51

[1]Data summary comparing density, frequency and dominance of all species in cat-claw/mesquite area.

[2]Data summary comparing density, frequency and dominance only between species of similar strata, i.e., shrubs, sub-shrubs and graminoids.

Table 1 (cont.)

Species		Control				Impact			
		Relative Density	Relative Frequency	Relative Dominance	Importance Value	Relative Density	Relative Frequency	Relative Dominance	Importance Value
Sub-Shrubs (cont.)									
Porphyllum gracile	a.	00.09	00.59	01.07	01.75	01.93	00.33	03.30	05.56
	b.	04.35	06.68	49.34	60.37	23.53	07.89	26.63	58.05
Sphaeralcea fendleri	a.	00.09	00.59	00.01	00.69	...	...	...	...
	b.	04.35	06.68	00.66	11.69	...	...	...	...
Grasses and Forbs									
Bromus[3] *rubens*	a.	43.13	28.24	07.85	79.22	45.41	20.35	00.85	66.61
	b.	48.22	72.73	52.89	173.84	95.92	85.00	90.14	271.06
Festuca spp.	a.	00.87	00.59	00.09	01.55	01.93	02.48	00.09	04.50
	b.	00.99	01.52	00.58	03.09	04.08	15.00	09.86	28.94
Plantago spp.	a.	20.56	04.71	04.01	29.28	...	...	...	...
	b.	23.18	12.12	22.95	58.25	...	...	...	...
Sporobolus contractus	a.	24.50	05.29	03.50	33.29	...	...	...	...
	b.	27.61	13.63	23.58	64.82	...	...	...	...

[3]Exotic weed species.

is dramatically demonstrated by comparing the average absolute mammal density of both plots for the entire sampling period. The control plot had an average density of 128 mammals/acre (51.8/ha.), whereas the impact plot contained only 32.6 mammals/acre (13.2/ha.). It is also important to note that the species composition was different between the two study areas. The mammalian species diversity indices (H′) on the control plot and the impact plot were .78652 and .69022 respectively. The greater species diversity on the control plot was also complemented by a greater evenness of species distribution (J′) (.56736) than that found on the impact plot (.42886).

The total absolute densities of the small mammal populations on both plots were higher at the onset of this study (March 1974) than they were at its termination (January 1975). The fluctuations found in these densities (a decline of 77.3/acre [31.3/ha] to 10.6/acre [4.3/ha] on the impact plot and 219.7/acre [98.9/ha] to 43.5/acre [17.6/ha] on the control plot) were consistent for both plots and may be reflecting "normal" population fluctuations. Nevertheless, in all trapping periods, the density and diversity of the small mammal populations on the control plot were substantially higher than those across the river at the impact plot.

In addition to the total population densities, another striking difference in the rodent communities of the two study areas is in the relative species composition (Table 2). On the impact area, the density of the cactus mouse (*Peromyscus eremicus*) accounted for an average of 80.8 percent of the entire rodent commu-

Table 2. Small mammal population densities on the two study areas.

Control

Species	Absolute density (per hectare)						Relative density (percent)						
	Mar	May	Jun	Aug	Nov	Jan	Mar	May	Jun	Aug	Nov	Jan	x̄
Peromyscus eremicus	53.5	35.3	43.2	27.7	11.4	11.4	60.0	65.0	64.0	45.0	56.0	65.0	59.2
Peromyscus boylii	00.3	00.0	00.3	00.3	00.0	00.0	00.3	00.0	00.3	00.0	00.0	00.0	00.1
Perognathus intermedius	34.3	18.7	23.5	31.3	08.6	06.0	39.0	34.0	35.0	51.0	42.0	34.0	39.2
Neotoma albigula	00.8	00.5	00.8	02.5	00.3	00.2	00.7	01.0	00.7	04.0	02.0	01.0	01.5
Total	88.9	54.5	67.8	61.8	20.3	17.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Average total Absolute Density, March 1974 to January 1975 = 51.8 mammals per hectare.

Impact

Species	Absolute density (per hectare)						Relative density (percent)						
	Mar	May	Jun	Aug	Nov	Jan	Mar	May	Jun	Aug	Nov	Jan	x̄
Peromyscus eremicus	30.4	09.4	08.2	09.1	07.7	02.9	97.0	94.0	76.0	66.0	85.0	67.0	80.0
Peromyscus crinitus	00.0	00.3	02.3	04.4	01.4	01.4	00.0	03.0	23.0	32.0	15.0	33.0	17.5
Peromyscus boyleii	00.3	00.0	00.0	00.0	00.0	00.0	01.0	00.0	00.0	00.0	00.0	00.0	00.2
Perognathus formosus	00.3	00.3	00.3	00.3	00.0	00.0	01.0	03.0	02.0	02.0	00.0	00.0	01.3
Neotoma lepida	00.3	00.0	00.0	00.0	00.0	00.0	01.0	00.0	00.0	00.0	00.0	00.0	00.2
Total	31.3	10.0	10.8	13.8	09.1	04.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Average total Absolute Density, March 1974 to January 1975 = 13.2 mammals per hectare.

nity, whereas on the control plot, this species accounted for an average of 59.2 percent of the population. The only other species which contributed significantly to the impact plot population was the canyon mouse (*Peromyscus crinitus*), averaging 17.5 percent of the total population. The canyon mouse was never encountered on the control plot. Reasons for this are a direct reflection of the habitat requirements of this species and the state of the habitat on each study area. The canyon mouse prefers rocky, near barren areas that are usually devoid of vegetation and may be found commonly throughout the Grand Canyon on upper talus slopes and rocky outcrops. Clearly, the alteration of the impact area by feral asses has permitted a population of canyon mice to become established in an area not normally inhabited by this species.

The distribution and abundance of heteromyid rodents on the two study areas also further demonstrates the detrimental effects of feral asses. On the impact plot, only a few heteromyids, the long-tailed pocket mouse (*Perognathus formosus*), were captured, while the control plot contained a relatively large and stable population of the rock pocket mouse (*Perognathus intermedius*) (Table 2). The rock pocket mouse made up an average of 39.2 percent of the rodent community on the control plot while the long-tailed pocket mouse constituted an average of only 1.3 percent of the population density on the impact plot. In the Grand Canyon, we have found that the long-tailed pocket mouse is exclusively restricted to the north and west banks of the Colorado River and the rock pocket mouse is restricted to the south and east banks. However, where suitable habitat exists, there is no measurable difference in the population densities of these two species. On the two study areas, differences in the population densities of these heteromyid rodents were directly related to their dietary requirements and the availability of food. The primary food of both species of *Perognathus* probably consists of seeds, especially the seeds of forbs (Reichman 1975). As mentioned above (see Table 1) the forb strata of the impacted area has been thoroughly decimated through grazing and trampling by feral asses, thus rendering the habitat of this study area inhospitable to a population of *Perognathus*.

Summary

The results of this investigation demonstrate conclusively that the feral ass has a negative effect on the natural ecosystem of the lower reaches of the Grand Canyon. The principal impact of the feral ass is habitat destruction through grazing and trampling.

On the study area where feral asses occurred the vegetation cover and rodent populations were significantly reduced when compared to the study area where feral asses were absent. On the control plot, 28 species of vascular plants were found compared to 19 on the impact plot. The total vegetation cover on the control plot was 80 percent, compared to 20 percent on the impact plot. The mean area (m^2) occupied by each individual cat-claw or mesquite shrub was $27.9m^2$ on the control plot and $20.7m^2$ on the impact plot.

The mammal species diversity (H′) was higher on the control plot (.78652) than it was on the impact plot (.69022). In addition, the average absolute density of small mammals from March 1974 to January 1975 on the control plot was 128 mammals/acre (51.8/ha.), approximately four times the 32.6/acre (13.2/ha.) found on the impact plot. Thus, differences between the two areas in mamma-

lian species composition and diversity were attributed to the depauperate flora, particularly the forbs and grasses, on the 209 Mile Canyon impact area.

Alternatives and Priorities

We previously questioned not only the wisdom but also the legality of the Wild Horse and Burro Act (Public Law 92-195). News releases during 1975 announced that a three judge federal panel in New Mexico had declared the Wild Horse and Burro Act unconstitutional, stating that, " . . . wild horses and burros do not become property of the United States simply by being physically present on the territory or land of the United States." Even though Public Law 92-195 may eventually be declared unconstitutional throughout the land, the legal ownership of these exotic and destructive animals should not be a central issue. Clearly, the primary consideration should be whether or not wild horses and burros are damaging public lands. Our land managing agencies have been given the responsibility to protect public lands and to control their use in a manner compatible with legislative mandates and sound managerial principles. Although there is certain justification for some measure of protection for small, limited reproducing herds of wild horses and burros, our investigations lead us to the conclusion that Public Law 92-195 is not compatible with proper management concerns on our public lands.

Although the Wild Horse and Burro Act does not specifically apply to National Park Service lands, the public sentiment and political pressures engendered by the issue resulted in a reluctance on the part of National Park Service administrators to initiate or continue feral equine control measures. Recently, with quantitative data on habitat destruction by wild horses and burros becoming available, immediate control measures are being considered on park lands. In Bandelier National Monument a program of direct reduction by shooting for 1975 and 1976 was recently announced by National Park Service officials. The reduction in the Bandelier burro herd seems justified under the congressional mandates for management of park land. The 1975 "Management Policies" for the National Park Service (Washington, D. C.) states, "Control or eradication of noxious or exotic plant and animal species will be undertaken when they are undesirable in terms of public health, recreational use and enjoyment, or when their presence threatens the faithful presentation of the historic scene or the perpetuation of significent scientific features, ecological communities, and native species, or where they are significantly harmful to the interests of adjacent landowners."

There are actually very few control alternatives available to the resource managers on wild horse and burro infested lands. To take no control actions, a course vociferously advocated by some elements of our society, is truly an unacceptable alternative, not only on National Park Service lands, but on all public lands. The wild equines have few, if any, natural predators in North America, and if allowed to go further unchecked, our public lands could suffer irreparable damage, not only to native ecosystems, but also to economically important rangelands. Another alternative, trapping and removal, has met with mixed success. In some areas, with rough terrain and limited access, such as in the Grand Canyon, trapping and removal is virtually impossible. Fencing off some lands to keep wild horses and burros out of sensitive areas has been suggested.

Not only would this measure fail to solve the problem of too many wild equines, but also it would be incredibly expensive and extremely disruptive to the normal dispersal of the large native herbivores. Sterilizing large numbers of wild horses and burros has also been seriously suggested. Although this method might serve to control small herds in certain regions, it too would be an impractical solution to the overall problem now facing land managers. Over most of the isolated ranges currently suffering wild equine impact, the only viable alternative we are left with is direct reduction by shooting. If done properly, this method is the most humane, most effective and least expensive.

Control of the rapidly expanding herds of wild equines is an undeniable necessity on our public lands. Effective management will not be achieved until the resource managers and scientists alike collect adequate data on habitat destruction and relate it in a convincing manner to the general public.

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Discussion

MR. DALE JOHNSON: I do not have a question, but I do have a comment. Yesterday the Supreme Court heard the constitutionality case that was born in New Mexico and I do not know what the Supreme Court is going to do with it; but I would say that Mr. Harris, the attorney in New Mexico, did a tremendous job of arguing the point of unconstitutionality.

FROM THE FLOOR: I was curious about one portion of your paper. Are you starting this experiment with burros on a part of the range that has no current capacity for burros at all in the Grand Canyon?

MR. CAROTHERS: Obviously the range in Grand Canyon has carrying capacity for a large herd of burros. We cannot have both burros and vegetation which is our mandate in the Park Service to maintain.