

Invasive Burro Removal in the Grand Canyon National Park: An intersection of cultural values and ungulate management practices within the National Park system.

Origins of feral burros (*Equus africanus asinus*) in the Grand Canyon

The burro, *Equus africanus asinus*, is believed to have been domesticated ~5,000 years ago in northeast Africa. Molecular evidence derived from ancient mitochondrial DNA, indicate that this domestication event may have occurred more than once and possibly from two different species, the Nubian wild ass (*Equus africanus africanus*), and the Somalian wild ass (*Equus africanus somaliensis*). Additional archaeological evidence indicates the timing of the domestication event likely coincided with the desertification of the Sahara and corresponding shifts in pastoral societies (Beja-Pereira, 2007). Though it is unclear when the domestic burro was brought to Spain, it became closely associated with the Spanish culture, and was used as a working animal throughout the Iberian Peninsula during Roman times (Harlow, 2017).

Burros were brought to North America by the Spanish conquistadors in the sixteenth century; and in 1598 Juan de Oñate set out from Mexico to conquer New Mexico, bringing the first burros into the modern day United States (Brookshier, 1974). Burros were later utilized by miners who traveled west seeking gold within the Grand Canyon and surrounding areas. When the rush ended, these burros were left behind, and by the early 1900s, they had formed a feral population, estimated to be over 2,000 individuals (Zarn, 1977). Three primary herds occupied three distinct areas of the Grand Canyon, the Tonto Plateau herd, the Shimuno herd, and the Lower Canyon herd (Fig. 1).

In 1919 the Grand Canyon entered the National Park system under the direction of Stephen Mather. One of his first orders of business was to address the burros within the park, setting the stage for a century of conflict by declaring that, “These animals living down in the canyon have increased to such an extent that they form a veritable pest, denuding the plateaus of grass and other forage so that native wild game such as antelope has been forced out; it is even necessary for working and exploring parties to pack feed for their working animals. Furthermore, they destroy the trails. The time is not far distant when radical steps will have to be taken to eliminate the burro evil.” (NPS 1920:27)

A history of ungulate management in the Grand Canyon National Park

Within the entirety of the Grand Canyon, there are four different agencies that are involved in resource management and regulation, The United States National Park

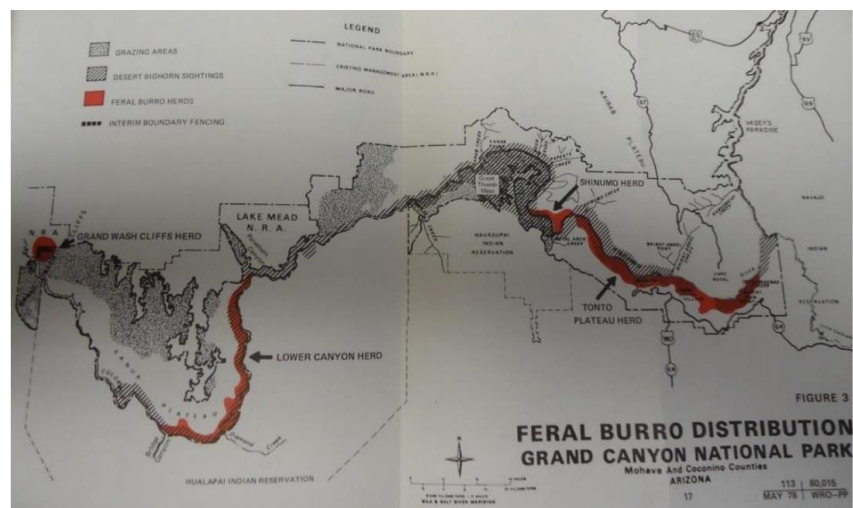
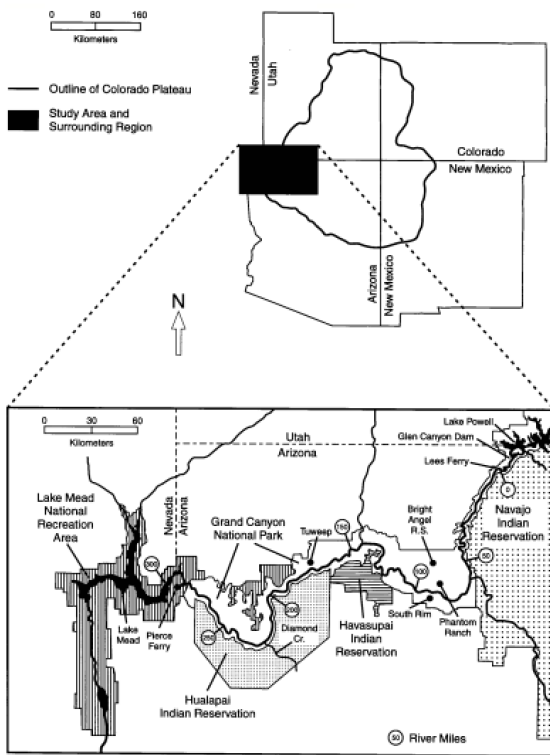


Figure 1. Map taken from Harlow (2017) - used with permission from the Grand Canyon Archives - GRCA 57685, Removal plan 1979, p. 17.

Service, the Bureau of Reclamation, the Hualapai nation and the Navajo nation (Fig. 2, Bowers et al. 1995). Historically however, ungulates have been managed primarily by the Park Service, and various strategies have been proposed over the years to control populations of both native and nonnative ungulates in the park. Throughout these efforts, the park has maintained constant awareness and concern for the public's response to various management actions (Wright et al. 1998). Ungulate management within the national park system as a whole has gone through marked stages, each seemingly reflective of that era's societal priorities. The following timeline highlights these unique periods within the Grand Canyon National Park. It summarizes the history of burro management in the canyon and is framed within the greater

context of the relationship between visitors and ungulates in the national park system as a whole.



1900-1924: Increasing ungulate abundance.

The Park Service was formed after conservation lobbyists advocated for a government agency to manage the nation's parks. There was pushback, however, from other management agencies – primarily those that supported the Forest Service – so Stephen Mather and the NPS attempted to secure the future of the agency by generating a strong public support system. One of the ways in which they achieved this was by increasing numbers of ungulates and enhancing viewing opportunities for the public (Wright, 1998). In 1906, Theodore Roosevelt declared the Kaibab Plateau a federal game reserve; and shortly after the Grand Canyon implemented rigorous

predator-control programs as well as supplemental feeding efforts to enhance ungulate populations (Sellars, 1997). Even Roosevelt, the beloved wilderness warrior, believed in rigorous predator control, and felt that it was extremely important “to keep down the larger beasts and birds of prey, the arch-enemies of the deer, mountain sheep, and grouse and the most formidable among these foes of the harmless wildlife are the cougars” (quote from Roosevelt taken from Harlow, 2017). Though these control programs were not well documented, it is estimated that between 1906-1923, 781 mountain lions, 30 timber wolves, 4,849 coyotes, and 554 bobcats had been destroyed (Dunlap, 1988).

Figure 2. Map of the Grand Canyon National Park and the various agencies involved in resource management and regulation (Bowers et al. 1995).

1924-1940: Ungulate overabundance. Unfortunately, predators serve an important role within the ecological community, and soon ungulate populations were growing unchecked throughout the Grand Canyon, as well as in National Parks across the United States (Trefethen, 1975). Many

scientists began expressing concerns over the inability of the landscape to support the rapid growth of these populations and feared massive population collapses and die-off events. In the winter of 1924-1925 that is precisely what occurred in the infamous Kaibab deer herd.

The 1906 deer population on the Kaibab Plateau was estimated to be around 4,000 individuals. Though the estimated growth varies across the literature (Fig. 3), it is believed that by the early 1920s deer populations were anywhere from 50,000-100,000 individuals (Binkley et al. 2006; Rasmussen et al. 1941; Leopold, 1943), and shortly after crashed due to the overconsumption of resources and inability of the landscape to regenerate. Though additional hypotheses have since been proposed to explain the rapid increase and sudden decline of the Kaibab herd (i.e. shifts in grazing patterns and fire regimes), there was a marked shift both in how managers identified a healthy ungulate population and in how they viewed predators. Aldo Leopold beautifully summed up this cognitive shift when he described the “fierce green fire” dying in the eyes of a wolf he had shot, and the sudden realization that predators are an integral part of the ecosystem (Leopold, 1949). In 1924, the National Park Service also created their first burro removal plan and instructed that the nonnative ungulate species be eliminated by “shooting, herding, or by any means possible” in the hopes that this would also promote the health of native ungulates. The Kaibab deer incident did not deter the Park service from these removal efforts and they continued steadily removing burros for many decades.

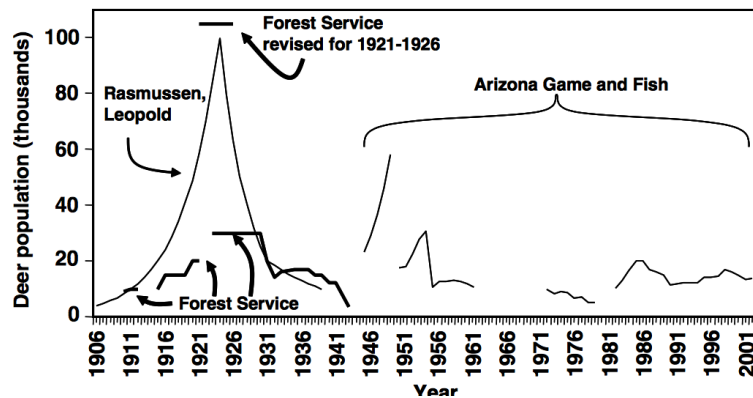


Figure 3. Taken from Binkley et al. (2006) summarizing the population fluctuations of the Kaibab deer herd before, during and after the infamous crash of 1924.

1941-1971: Ungulate control. In the 1940s the Park Service began to remove and relocate ungulates from specific populations as necessary to prevent winter habitat degradation and a repeat of the Kaibab incident. The burro [lethal] removal plan was also implemented consistently during this time, and while population levels were always controlled, the Park Service was never able to fully remove the burros from the Grand Canyon. These removal efforts were typically carried out quickly and quietly, without the public’s awareness. However numerous external events occurred during this time period that created yet another major shift in ungulate management within the National Parks. As described by Schectman et al. (1978) the emergence and solidification of activist citizen groups resulted in increased levels of public involvement in environmental decision making. The following events specifically altered the course of feral burro management in the Grand Canyon:

1953: Brighty of the Grand Canyon. Bright Angel was a feral burro that lived and worked in the canyon from 1892-1922. He was beloved by all the staff and visitors and in 1953 was

immortalized by the famous children's book author, Marguerite Henry through her publication titled *Brightly of the Grand Canyon*. This book brought burros into the hearts and minds of the American people, solidifying a cultural connection between burros and the romantic history of the Grand Canyon.

1959 & 1971: Implementation of Legislation. After the publishing of Henry's children's book, increased attention was drawn to the Park Service's lethal burro removal efforts. The *Hunting Wild Horses and Burros on Public Lands Act* was implemented in 1959, which prohibited the use of aircraft or motor vehicles to capture or kill any wild unbranded horse, mare, colt, or burro running at large on any public lands (Public Law 86-234). In 1971, the *Wild Free-Roaming Horse and Burro Act* was passed (Public Law 92-195). This piece of legislation was more comprehensive than the 1959 law, and mandated the protection, management and control of wild and free-roaming horses and burros on public lands. Though the National Park Service was not subject to these laws, the public outrage provoked letters, petitions, and negative media attention that forced them to act.

1976: NPS issues a burro management plan

In light of the negative press, the NPS felt the need to release an official document to justify their efforts, and in 1976 they put forth a burro management plan, stating that the burros were significantly altering the native vegetation in the lower reaches of the Grand Canyon, and formally recommending they be removed by shooting (Grand Canyon NPS, 1976). The public jumped on the fact that the NPS had seemingly put forth little effort in their report and had limited scientific facts to back up their claims. The public responded with arguments that the NPS's calls for lethal removal were cruel and unnecessary and that the burro was not harming the environment, but in fact was filling some sort of ecological niche left behind by a Pleistocene era relative. The Secretary of the Interior at the time agreed that in order to implement such a controversial management strategy, a full environmental impacts statement would be needed and the feasibility of alternatives to lethal removal would also need to be explored.

1980: NPS issues the Feral Burro Management and Ecosystem Restoration Plan and Final Environmental Statement:

Ecological impacts of burros and other ungulate grazers in the Grand Canyon

The documented effects of burros on the plant life and desert ecosystem in the Grand Canyon were extremely complex and studies often highlighted adverse impacts. One of the primary concerns was

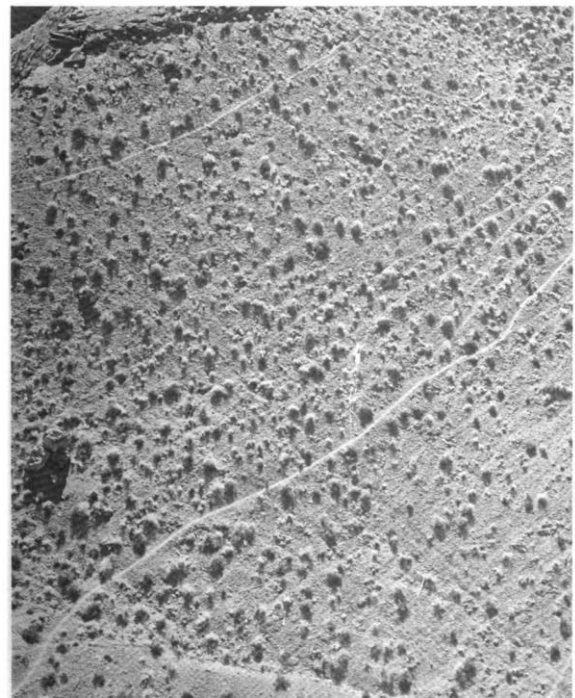


Plate 2 Trailing on the Tonto Plateau: Note two backcountry hiking trails

Figure 4 The trailing created by burros on the landscape

the impact of burros creating erosive trails and compacting delicate top soils (Fig. 4). The introduction of cattle and burros also resulted in heavy grazing, which negatively impacted the longevity and recruitment of desert vegetation. Numerous studies have indicated that, while burros are capable of foraging on a wide variety of plant species, they preferentially consume perennial grasses and forage selectively when given the opportunity (Jordan et al. 1979). They consume numerous shrub species including *Ephedra nevadensis*, *Ambrosia dumosa*, *Hymenoclea salsola*, and *Larrea tridentate*. *Ambrosia dumosa*, commonly known as burro-weed or white bursage, is a native dicot that serves as a nurse plant for cactus regeneration. Nurse plants provide canopy cover in extreme environmental conditions, increasing germination and survival in sensitive seedling by providing shade, soil moisture and nutrients (Ren et al. 2008). The grazing of *Ambrosia dumosa* by feral burros is believed to have resulted in the reduced recruitment of the barrel cactus (*Ferocactus cylindraceus*) (Bowers, 1977).

In contrast, the negative impacts of native herbivores such as bighorn sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*) on desert-scrub vegetation have been relatively minimal (Webb & Bowers, 1993). Additionally, there have been numerous studies addressing the competition between native (i.e. bighorn sheep and deer) and nonnative ungulates (i.e. burros and cattle). Most address the competition between bighorn sheep and burros for food, water, and shade (Carothers et al. 1976). An early study conducted in the Black Mountains of Mohave County reported that 50%-58% of the plants in the diets of bighorns and burros are shared (McMichael, 1964). Hansen and Martin (1973) looked at the relative density of plant fragments in burro, cattle, and bighorn dung within the Grand Canyon and found that

Table 1. Percent relative density of plant fragments discerned in burro, cattle, and bighorn dung from near Lake Mead, Grand Canyon, Arizona, 1972.

Names of plants	Cattle annual diet	Burro annual diet	Burro March diet	Bighorn annual diet
<i>Tridens</i> sp.	26.8	13.8	4.9	10.5
<i>Ephedra nevadensis</i>	15.3	0.1	0.2	9.4
<i>Muhlenbergia porteri</i>	15.0	24.9	15.3	11.9
<i>Sphaeralcea</i> sp.	5.1	4.1	3.1	52.2
<i>Bromus rubens</i>	3.4	7.3	43.8	1.1
<i>Tidestromia oblongifolia</i>	0.1	1.1	0.1	2.6
<i>Phragmites communis</i>	0.1	7.6	0.8	
<i>Acacia constricta</i>	21.1	4.1		3.0
<i>Hilaria rigida</i>	2.5	0.1		
<i>Opuntia</i> sp.	0.6	4.7		0.1
<i>Prosopis juliflora</i>	5.4			0.1
Seed	0.1			0.1
<i>Stipa speciosa</i>	1.5		0.3	
<i>Agave palmeri</i>	0.6		0.4	
<i>Krameria parvifolia</i>	1.5			
<i>Yucca newberryi</i>	0.5			
<i>Astragalus-Oxytropis</i>	0.1			
Lichen	0.1			
<i>Aristida wrightii</i>		14.7	4.1	7.2
<i>Tamarisk pentandra</i>		9.1	3.3	
Forb (<i>Nolina</i> ?)		4.7	1.6	
<i>Peucephyllum schottii</i>		0.1	0.9	
<i>Eriogonum</i> sp.		2.7		1.2
<i>Phoradendron californicum</i>		0.2		0.1
<i>Artemisia</i> sp.		0.4		
<i>Carex</i> sp.		0.2		
<i>Lycium</i> sp.		0.1		
<i>Crossosoma bigelovii</i>		0.1		
<i>Agropyron</i> sp.			10.7	
<i>Plantago insularis</i>			5.3	
Forb (<i>Oenothera</i> ?)			4.0	
<i>Franseria dumosa</i>			1.8	
<i>Lappula</i> sp.			0.8	
<i>Fraxinus anomala</i>				0.6
<i>Aster biglovii</i>				0.1

maintained a herd of feral burros. Results

bighorn were more selective grazers than either cattle or burros, with five major species (*Sphaeralcea*, *Muhlenbergia*, *Tridens*, *Ephedra*, and *Aristida*) making up >90% of their diet compared to seven major species in cattle and 8-9% (this varied seasonally) in burros (Table 1). They concluded that there was enough overlap in the diets of bighorns and burros to warrant concern for intense food competition in areas where their ranges overlap.

One study, conducted in the Grand Canyon between 1974-1975 compared two different plots that contained both desert scrub, and riparian habitat. The control plot contained no burros, while the 'impact' plot

Table 1. Taken from Hansen and Martin (1973) depicting the diet breakdown of burros, cattle, and bighorn sheep by plant species.

showed that the control plot maintained more vegetative structure (80% vs 20%) and housed a richer diversity of species and a greater density of small mammal communities (Carothers et al. 1976). Laycock et al. (1974) also observed the effects of burros on small mammal populations and his data supported the scenario that the destruction of vegetative resources by burros negatively impacted small burrowing mammals.

Is the domestic burro a functional replacement of the Pleistocene era equid?

Aside from the emotional argument against the 1976 proposal by the NPS to lethally remove burros from the Grand Canyon, many people felt there was an ecological basis for the preservation of burros within the region. Fossil evidence suggests that two major equus-like species existed throughout North America during the Pleistocene era. These were grouped into stout-legged horses and stilt-legged (slender-legged) horses, and both went extinct towards the end of the Pleistocene. The New World stilt-legged (NWSL) equids had slender distal limb bones that closely resembled those of the Onager, or Asiatic wild ass (*Equus hemionus*) (Eisenman et al. 2008). Recent molecular evidence from ancient DNA samples indicates that the common ancestor of all equus-like species, including the Pleistocene era species and the domestic burro actually evolved in North America (Heintzman et al. 2017). Despite the public's attempts to argue that the domestic burros in the Grand Canyon were simply a functional replacement of a naturally occurring extinct species, predictive models show that the climate and habitat types within the Grand Canyon during the Pleistocene and those within Northeast Africa were very different and there was therefore little basis for this argument.

Potential alternatives to lethal removal

The NPS reviewed potential alternatives to lethal removal, but concluded that the cost associated with live capture, removal and relocation of the burros was not feasible. They determined it would cost ~\$360,000 to remove the burros after which they would attempt to find permanent homes for them. Any burros that were not placed within 30 days (they anticipated large numbers would not find permanent homes) would be lethally removed anyways. Instead the Park Service opened this effort up to any outside agency or entity willing to conduct live removal of the burros at their own cost. They concluded that as long as burro populations were continually in decline, these removal efforts could continue and they would not pursue lethal measures.

1981: Burros are removed from the Grand Canyon National Park

The Fund for Animals offered to conduct a live removal and airlifted the majority of the burros out of the canyon. 577 animals were removed and the cost associated with this effort was estimated to be >\$1000/burro (Allen et al. 1981), all of which was raised between 1980-1982 by *The Fund for Animals*. Additionally, fencing was implemented in certain regions to prevent the re-introduction of burros to the park. Some lethal measures were taken to remove the last of the burros, but the non-lethal removal efforts were largely declared a success. Overall estimates of removal cost were ~\$500,000 much of which was not spent by the National Park Service.

Conclusion

In conclusion, the history of burro management within the Grand Canyon National Park is a complicated saga with many teachable moments. Today many invasive species removal efforts still happen quietly and with little public knowledge or awareness of their occurrence. The original disregard for public opinion and for the cultural value placed on these burros greatly complicated the removal effort and likely increased the fiscal and emotional cost. Recognizing that the public can be extremely powerful and can exert strong influence over policy is an important takeaway from this process. In the end, it took compromise between government agencies, the public and a non-profit organization to come up with a solution that satisfied all involved parties.

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