IMPACT OF FERAL BURROS ON THE DEATH VALLEY ECOSYSTEM

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Abstract. Man introduced non-native burros into a desert ecosystem in the late 19th century. Burros have successfully filled the vacant niche. Burro population size now numbers approximately 1,500 animals and is increasing. Field evidence indicates feral animals have seriously affected native flora and fauna of the region and threaten the viability of Death Valley National Monument as a natural area of the National Park System. Environmental damage includes soil damage and accelerated erosion, vegetation destruction, spring and waterhole disturbance, and competition with native wildlife for food, water and space. Habitats of rare or endemic plants and animals may be threatened. National Park Service management problems and efforts to control burro impact are discussed.

INTRODUCTION

Feral burros were introduced in the Death Valley region perhaps as early as the early 1870's. Later introductions occurred in the late 1800's and continued into the early 20th century. Most of the free-roaming burros were escapes or abandoned burden and pack animals owned by prospectors and miners during the heyday of mining activity in the desert (Hansen 1973).

Through the last century burros have successfully occupied their ecological niche. Their numbers grew and they expanded their range into much of the upland areas where suitable forage and sufficient water was available. By 1933 when Death Valley National Monument was established, burros were long established in all of the mountain ranges bordering Death Valley. In a number of areas damage caused by burros was already severe. Dixon and Sumner (1939) reported vegetation damage, competition with and displacement of native wildlife in the mid-1930's. Numerous later reports document further competition and damage (Sumner 1959; Welles and Welles 1961; McKnight 1958).

The Death Valley burro population now numbers about 1,500 animals and is increasing (Hansen 1973). Most of the burros range within Management Units 1 through 5 on the west side of Death Valley. The Monument, Figure 1, has

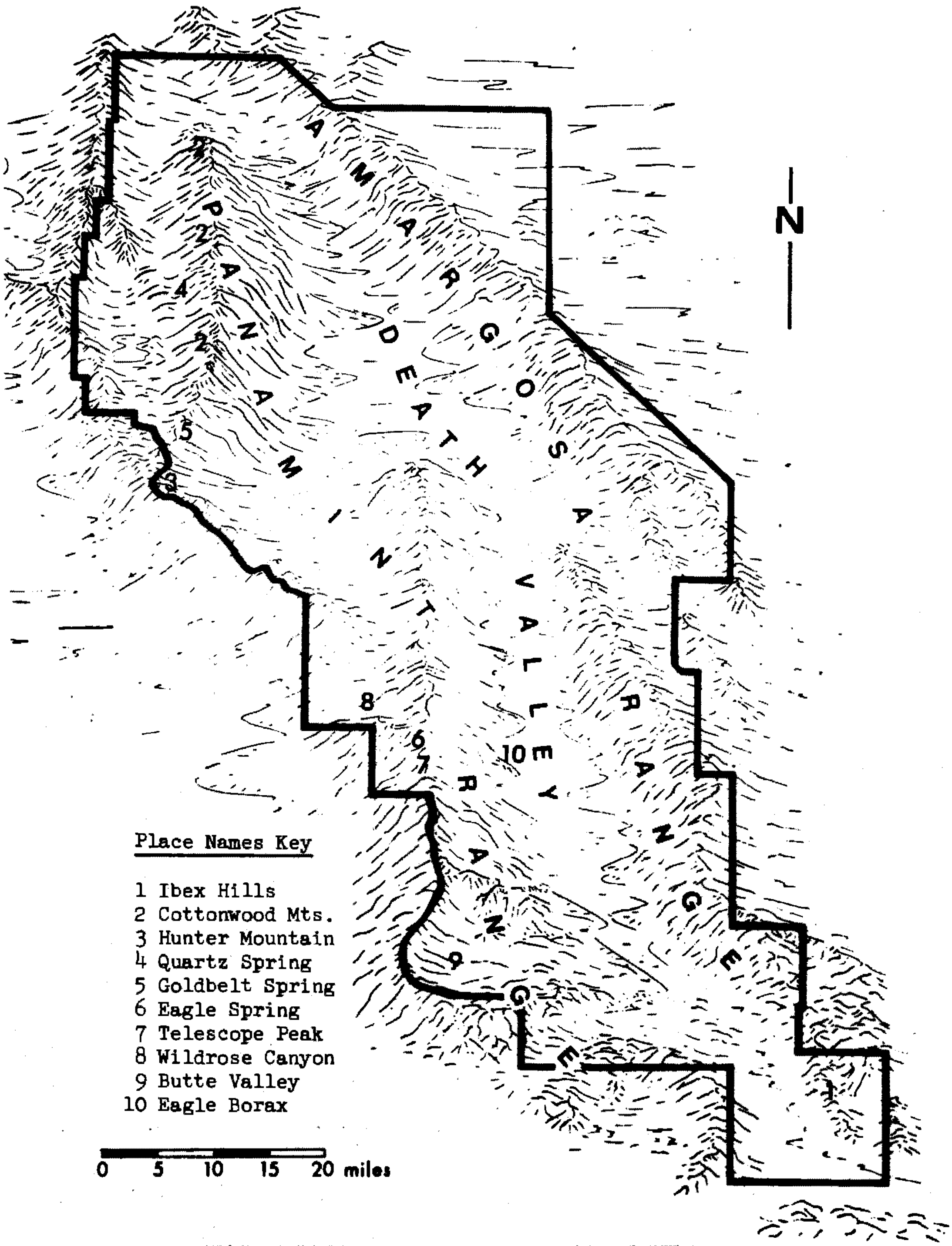

FIGURE 1.
DEATH VALLEY NATIONAL MONUMENT TOPOGRAPHIC FEATURES AND PLACE NAMES.

been divided into 11 management units, Figure 2.)

The largest concentration of free-roaming burros in California occurs in the Death Valley region, on and adjacent to Monument lands. More than 40% of the wild burros in California range within Death Valley National Monument (Weaver 1972). Burros ranging on public lands in Nevada also enter the Monument, but their numbers are smaller. The present distribution of burros is shown in Figure 3. Recent range extensions noted since the burro census of 1972 have been included. The broken line on the map shows potential range expansion and is based on the availability of suitable terrain, water and forage. Burros presently range on 777 square miles (497,000 acres) or 25.6% of Monument lands.

Topography and Vegetation

Elevations within the Monument range from more than 200 feet below sea level to over 11,000 feet. North-south trending mountain ranges border 154 mile long Death Valley on the east and west. The Amargosa Range rises steeply on the east side of the valley to average elevations of about 5,000 feet and a maximum of just over 8,700 feet in the northern section. To the west of Death Valley lies the higher Panamint Range having average elevations about 8,000 feet and an extreme of 11,049 feet. The terrain utilized by burros includes broad alluvial fans and bajadas, canyons, intermontane valleys, and rolling uplands.

Vegetative cover is diverse as may be expected in an area of great relief. The flat floor of Death Valley is barren of vegetation and encrusted with salts except in low to moderately saline areas where phreatophytes exist. Desert shrubs cover much of the land between sea level and 6,000 feet. The desert shrub community can be divided elevationally into several associations having discontinuous, gradational or overlapping boundaries.

Creosotebush-saltbush (*Larrea-Atriplex*) sparsely covers the lower elevations, mainly on the rocky alluvial fan deposits. Creosotebush-burrobush (*Larrea-Franseria*) covers middle elevations. Stands of hop-sage (*Grayia*), blackbrush (*Coleogyne*) and associated shrubs comprise the cover at the higher elevations. The latter associations appear to be favored by burros.

Pinyon-juniper woodland occurs between 6,000 and 9,000 feet. Limber pine and bristlecone pine woodland is found at elevations above 9,000 feet. Shrub cover in and between stands of coniferous woodland is principally big sagebrush (*Artemesia tridentata*).

Wildlife

A diversified fauna exists in the Death Valley region which lies near the indistinct boundary between the Mojave and Great Basin deserts. Fifty-one species of native mammals, 36 reptiles, 3 amphibians, and 6 fishes have been recorded from the Monument (DVNHA, 1973).

The desert bighorn sheep ranks high among animals requiring special management attention because their numbers and habitat are declining. A 1972 census indicated a bighorn population of 583 (Hansen 1972). In 1961 counts estimated 915 bighorn in the same area (Welles and Welles 1961). Range studies by Hansen (1972) have placed the pre-pioneer (pre-1850) bighorn population at as many as 4,800 animals. Table 2 shows the present and pre-1850 distribution of bighorn by management units.

Areas presently occupied by bighorn total 384 square miles and appear as non-contiguous enclaves (Figure 4). Former range totalled about 1,400 square miles and included nearly all mountainous areas of the present Monument. Only the Ibex Hills in the southeastern portion of Death Valley

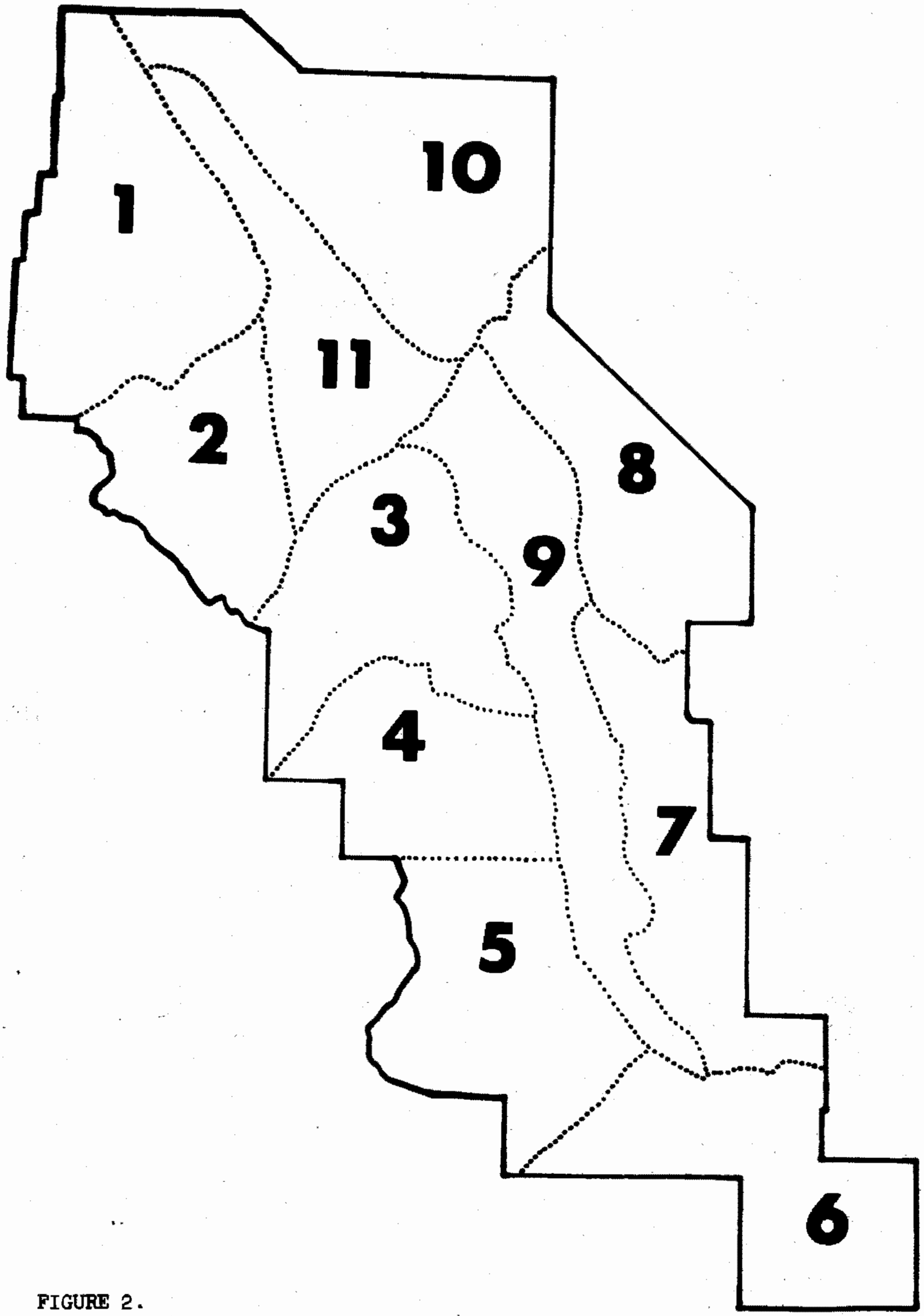

FIGURE 2.
MANAGEMENT UNITS, DEATH VALLEY NATIONAL MONUMENT.

received transient use as animals moved between the southern Amargosa Range and the Avawatz Mountains farther south (Hansen 1972).

The decline of bighorn has been attributed to many factors. Natural causes for decline include predation, respiratory diseases, parasites, natural accidents, and extended periods of drought. The decline has been hastened by man (Weaver 1972a). The proximity of man in large numbers, mining activities, usurpation or occupation of water sources, highway construction, fencing and other barriers, and poaching have adversely affected bighorn. In Death Valley mining activity and the modification of water sources have had the greatest impact. The impact of burros must be added to natural and man-induced causes for the decline of bighorn. It is the sum of all these factors which has depressed bighorn numbers and their range. The presence of burros, however, results in impacts which reach beyond those affecting bighorn.

Burro Impacts

The fundamental problem is that burros have been introduced into an ecosystem operating since the Pleistocene under nominally natural conditions characterized by normally marginal water supply, low annual forage production, severe climate (even for arid regions), and infrequent but sometimes devastating erosive forces, such as wind deflation and flash-flooding. The system is unable to absorb the addition of a new, large herbivore without large scale adjustments. A new equilibrium has not yet been reached.

The adjustment toward a new equilibrium has been observed for several decades. Four problem areas have been identified: competition with native animals, vegetational changes, damage to soils, and impacts at springs (Hansen 1973).

Competition with native animals

Surveys conducted since the 1930's have recorded the changes in bighorn distribution and have shown that competition exists between burros and bighorn for forage, water, and space (Sumner 1959; Hansen 1973; and others).

Bighorn regularly used three key springs in the Cottonwood Mountains in 1939. As burro numbers and use in the area increased, there has been no significant use of these springs by bighorn in the last 25 years (Sumner 1959). Bighorn and burros, however, share nearby Quartz Spring. A similar situation of reduced bighorn use exists in Cottonwood Canyon (in the same mountain range) and is worsened by the seasonal presence of trespass cattle. Bighorn were known to utilize Eagle Spring in the Panamint Mountains in 1935. Burros entered the area in 1938 and bighorn use terminated. Bighorn fed and watered in Butte Valley in the early 1930's; by 1935 bighorn were replaced by herds of burros (Sumner 1959).

Competition between burros and smaller mammals, especially rodents, has not been studied. However, field observations suggest that an adverse impact may exist (Hansen, pers. comm.). Further study is desirable to determine the effects of habitat disturbance, especially in such areas as trampling of animal burrows, and possible effects of reduced forage and seed production. Impacts upon herpetofauna, a major element of the desert ecosystem, is totally unknown.

Vegetation changes

Desert shrub-grassland associations support a greater number of burros than do other habitats. Both browse and grass species are utilized by burros, but where equally available, grasses are preferred (Browning 1971). It is significant that areas heavily grazed by burros are now shrubland instead

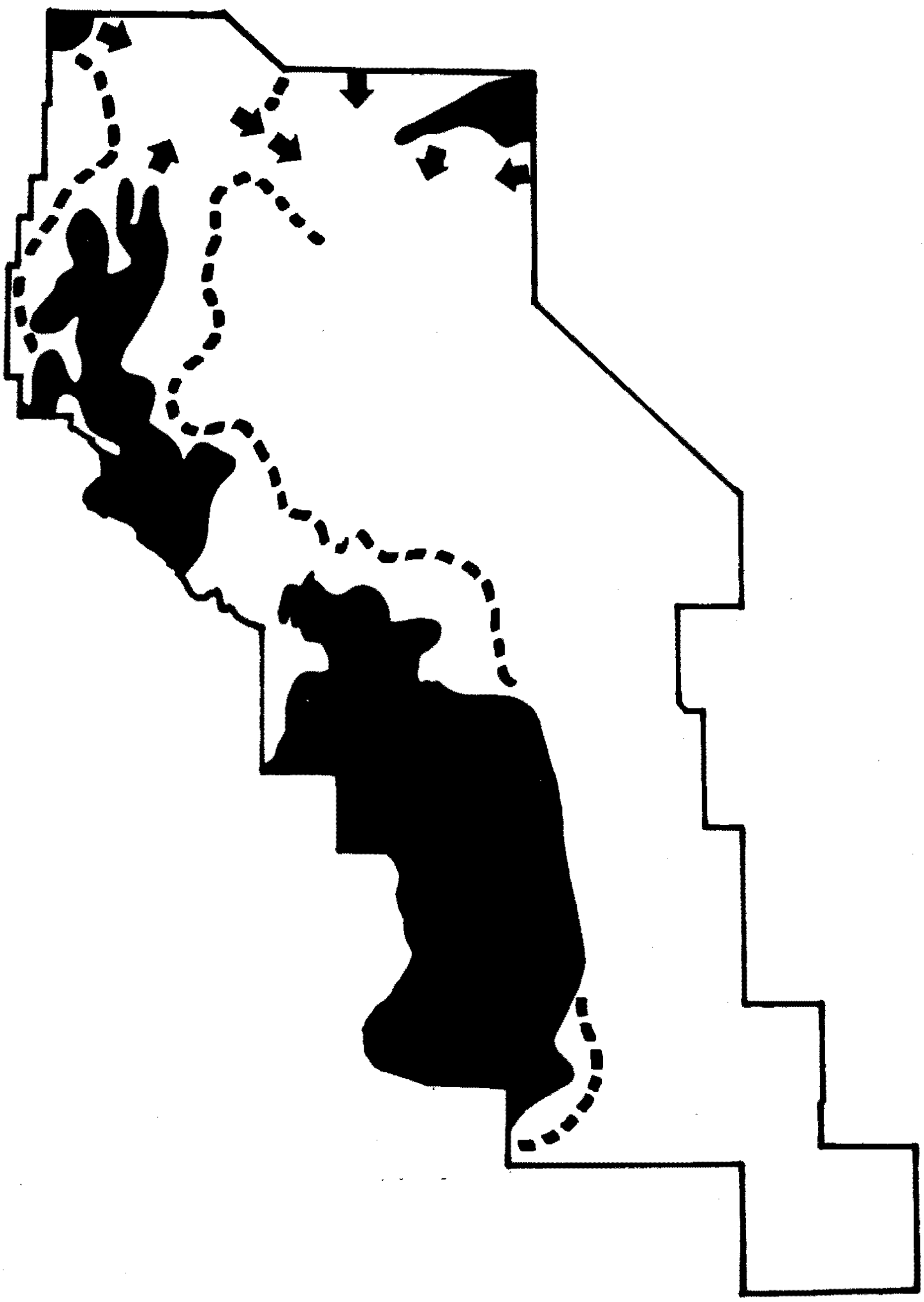

FIGURE 3.
BURRO DISTRIBUTION. BROKEN LINE SHOWS POTENTIAL BURRO RANGE EXPANSION. (AFTER HANSEN, 1973)

of shrub-grassland. Un-utilized portions of Unit 3 are shrub-grassland, believed to be remnants of the native (unmodified) vegetative cover (Hansen 1973).

Data from transects within and adjacent to a burro exclosure at Wildrose Canyon were gathered in September 1973, after the exclosure had been in operation for two seasons during which time rainfall was above normal. Within the exclosure there is a marked increase in the volume of shrubs favored by burros. Only blackbrush (Coleogyne), a species utilized lightly by burros, is more abundant outside the exclosure (Fisher 1974). Burrobush (Franseria dumosa), a species favored by burros (Browning 1960), is more abundant within the exclosure and individual plants within the exclosure are larger (Fisher 1974). Other species of woody perennials also show increased vigor within the exclosure. Shockley goldenhead (Acamptopappus), indigo bush (Dalea), Mormon tea (Ephedra), hop-sage (Grayia), Haplopappus, and box-thorn (Lycium) all appear in the diet of burros (Browning 1960; Hansen 1973). Perennial grasses are more abundant within the exclosure, but despite favorable growth conditions, remain depressed on burro range (Fisher 1974).

Annual grasses and forbs show a significant difference in abundance within the exclosure (Table 4). Some species, such as fiddleneck (Amsinckia) and ricegrass (Oryzopsis), not recorded in the outside transect, have become reestablished inside the exclosure (Fisher 1974). Amsinckia tessellata is known to receive moderate use by burros in the spring (Browning 1960). The density of annuals within the exclosure was 73.8 plants per square meter; density outside was 26.7 (Fisher 1974).

In areas of heavy burro occupation the density and sizes of plants, especially shrubs, are much reduced. Damage is greatest in the vicinity of water sources. Mis-shapen shrubs and abnormally numerous dead shrubs result from repeated cropping (Hansen, Weaver, others). The ratio of dead shrubs outside vs inside the Wildrose exclosure was 27:1 (Fisher 1974). Vegetation which is not eaten often is damaged by trampling or uprooting during feeding (McKnight 1958). Though not quantified it is obvious that flowering and seed production has been reduced at least locally. Three areas within the Monument are especially hard hit: Butte Valley, Wildrose basin, and the Hunter Mountain-Goldbelt-Cottonwood Canyon region. Creosote-bush (Larrea divaricata) has been browsed in these areas of heaviest burro use. This plant is rarely eaten by any animal (McKnight 1958).

Relict plant communities may be affected by burros. Recent studies suggest burro damage, principally by trampling, as probable cause for the low reproduction of bristlecone pine (Pinus longaeva) above 10,000 feet on Telescope Peak in the central Panamint Range (L. Johnson, written comm.).

At the opposite elevation extreme, formerly abundant alkali sacaton grass (Sporobolus airoides) at Eagle Borax, a site below sea level, has been grazed so heavily by burros that many plants are now dead. This has occurred since 1969. Mesquite, saltbush, and Death Valley goldeneye (Viguiera reticulata), a local endemic species growing on adjacent alluvial fans, is also heavily utilized (Hansen 1973).

The existence of introduced burros exerts added stress on a natural ecosystem unadjusted to the presence of burros or similar animals. One conservative estimate of plant utilization is as follows: using 318 lbs. as the mean weight of a burro and 9.7 lbs. daily forage consumption, the 1,500 burros in Death Valley consume 14,500 lbs. (7.27 tons) of food per day or about 5,310,000 lbs. (more than 2,650 tons) of food per year. Weight and daily consumption values believed comparable to Death Valley conditions were selected from Maloiy (1970).

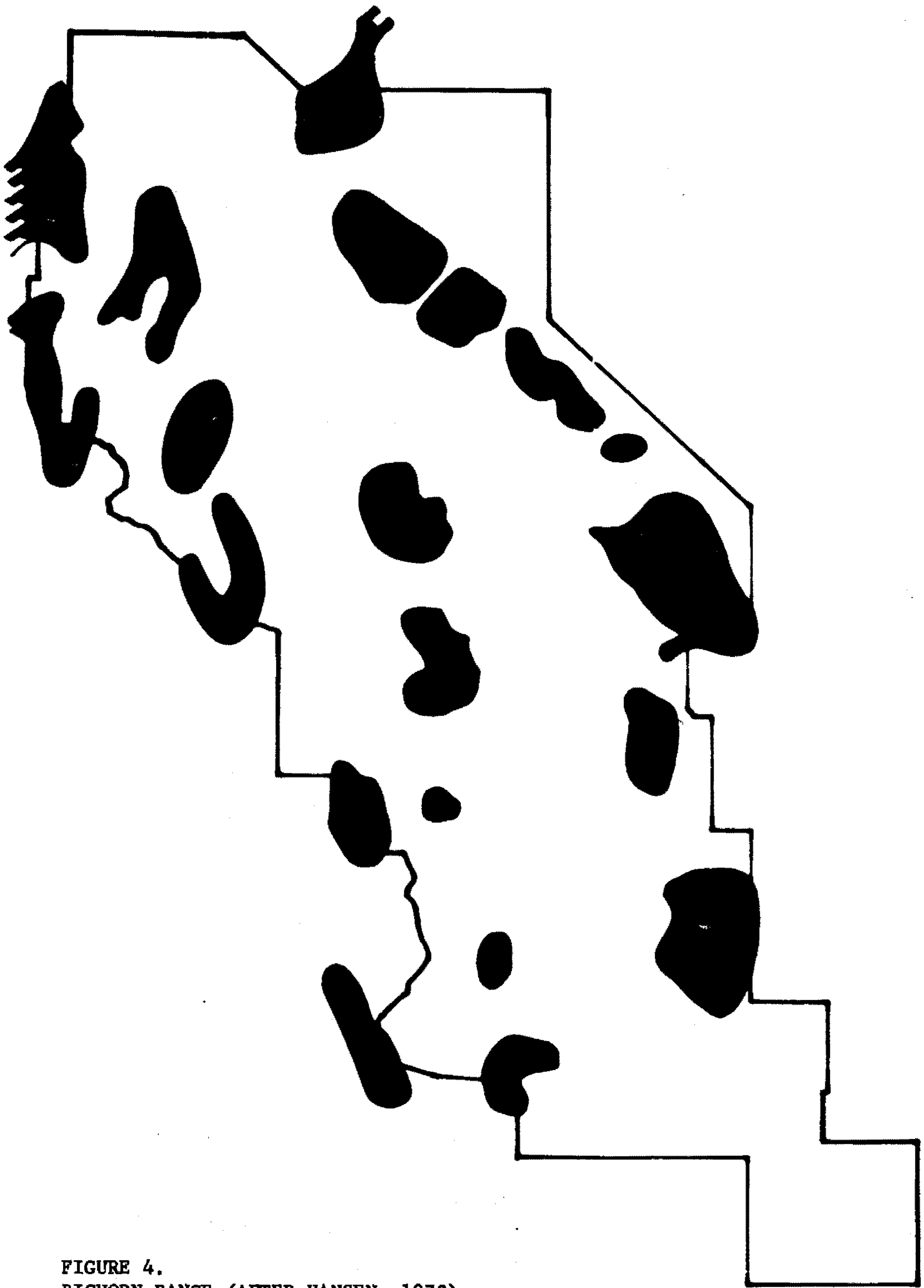

FIGURE 4.
BIGHORN RANGE (AFTER HANSEN, 1972).

Soils

Tracking and trampling diminishes vegetative cover and hastens erosion especially during infrequent and often severe storms. Bare soil between plants is normally protected from wind deflation and water erosion by the development of a gravel cover of desert pavement, often one pebble thick, which retards movement of underlying silt- and sand-sized fractions (Thornbury 1960). Tracking disturbs the pavement and exposes the finer soil particles. Where pavements are absent or poorly developed soil is retained by the development, following rains, of a thin, porous mineral crust (Hansen 1973). Fungal mycelia also serve as soil binders (F. Went, pers. comm.). Though both mineral and fungal structures are repaired after rains, tracking soon destroys them.

Tracking in the Wildrose area has disturbed 97-100% of the bare soil areas within one mile of the sampled water source (Hansen 1973). Up to 5 miles from the water, 20-25% of the bare soils are disturbed (Hansen 1973). In the Goldbelt Spring area of the Cottonwood Mountains, 80-100% of the bare soils are disturbed.

A pronounced effect of tracking is readily visible on hillsides where burro trails tend to be numerous. Soils removed from trail treads on steep hillsides are displaced outward and downward through repeated trail use (Weaver 1972a). During storms greater amounts of soil are removed by sheetflood and rillwash erosion. Locally (Rogers Peak, central Panamint Mountains, for example), thin soils have been removed to bedrock. Thicker soils are subject to gullying (Hunter Mountain).

Springs

Environmental alteration is severe at and near water sources because burros tend to congregate around waterholes and repeatedly move to and from them. Unless food is scarce burros generally do not travel more than 5 or 6 miles from water (McKnight 1958; Hansen 1973).

Ponded springs are polluted with urine and feces (Weaver 1972a). Though it was formerly thought that bighorn would abandon a spring used by burros, it is known that wildlife and burros regularly do use the same springs. Contamination of water by burros does not preclude use by large animals. Pollution, however, remains an issue. Pollution is unquestionably objectionable to humans and precludes hikers' and backpackers' use of affected springs (Weaver 1972a).

Burros can and do usurp available water at the expense of native wildlife. Many springs in the Monument do not have flow volumes large enough to supply the needs of both burros and native animals (Weaver 1972a; Hansen 1972). Flows of many springs are measured in gallons per day and have no flow during summer. Other water sources are small potholes (tinajas) capable of storing a few tens of gallons of water. Though adequate during winter months, wildlife water supply in summer is often tenuous. As summer temperatures climb to and above 120° F. in Death Valley, daily evaporation often exceeds 1 inch. Though the 90:1 evaporation/precipitation ratio (Hunt et al. 1966) is less at elevations above the valley floor, small springs go dry early in the summer. Tinajas then store water for only a short time after infrequent storms. Unlike other deserts there is no summer rainy season. The amount of available water is the most important factor acting to limit bighorn herd distribution. Man has aggravated the situation by usurping and altering many springs. Add the feral burro and bighorn survival in some locations has become critical (Hansen 1972; Weaver 1972a).

Table 1. Burro Distribution in Death Valley by Management Unit (Hansen 1973)

Unit	Burros
1	125
2	600
3	100
4	455
5	220
6	0
7	0
8	occasional
9	0
10	20
11	0

Table 2. Present and Past Bighorn Population by Management Units (Hansen 1972)

Unit	Bighorn Present	Population Pre-1850
1	90	1,000
2	125	800
3	80	300
4	33	900
5	20	500
6	0	Transient
7	110	250
8	65	150
9	0	0
10	60	900
11	0	0
Totals	583	4,800

Burros affect springs and aquatic habitats in other less direct ways. Destruction of vegetation around springs has reduced cover for birds and small mammals (Weaver 1972a). Less visible is the threat to invertebrates. Of the near 300 springs in Death Valley National Monument, less than 20 of the more accessible springs have been inventoried. To date 15 species of aquatic molluscs have been found. Most are new, endemic species. The area may contain twice the known number of molluscs (D. Taylor, pers. comm.). Water turbidity, changes in chemistry due to the presence of excreta, and repeated disturbance of pond substrates are factors affecting the survival of some invertebrates.

Burro Control Activities

A burro control program began in 1939. At that time the population was approximately 1,500 animals and the range included the mountainous areas on both sides of Death Valley. By 1942 all burros were successfully removed from the mountains on the east side of the valley. The complete removal from the Amargosa Range reduced the Monument population to about 700 burros (Hansen 1973). Control and removal activities continued but varied with fluctuations in available personnel and funding levels. Efforts in the Panamint Mountains were directed toward cropping population increments and did not attempt a systematic removal of burros from a given area. Removal activities centered mainly in the Wildrose and Butte Valley areas. Between 1939 and 1968 official records show that 3,578 burros were removed from Death Valley and may have been as high as 4,130 if unrecorded trapper reports are added. Burro control activities were curtailed in 1968 (Hansen 1973). The National Environmental Policy Act of 1969 required the preparation of an environmental impact statement (EIS) prior to initiation of a major or controversial federal project. Additionally several wild horse and burro protection bills were introduced in Congress. (The Wild Horse and Burro Act, Public Law 92-195, became law in December 1971.) The odds for successfully completing an EIS were low, especially because the outcome of pending legislation to control burros was uncertain.

By 1972 the burro population had again risen to 1,500 with the animals occurring in greater densities on a smaller range (Hansen 1973). Live trapping resumed in July 1973 as an interim control measure. To date 45 burros have been trapped by the National Park Service and removed by permit holders for pets.

Management Considerations

The National Park Service recognizes the burro as an exotic animal. The basis for planning and management actions is the National Park Service Resource Management Policy (1970) for natural areas, which states in part:

> "Management will minimize, give direction to, or control those changes in the native environment and scenic landscape resulting from human influences on natural processes of ecological succession. Missing life forms may be reestablished where practicable. Native environmental complexes will be restored, protected, and maintained, where practicable, at levels determined through historical and ecological research of plant-animal relationships. Non-native species may not be introduced into natural areas. Where they have become established or threaten invasion of a natural area, an appropriate management plan should be developed to control them, where feasible."

In compliance with this policy and the provisions of the National Environmental Policy Act of 1969, a management plan and draft environmental impact statement are being prepared.

Table 3. Shrub Volumes Inside and Outside of the Wildrose Burro Exclosure (from Fisher 1974)

Shrubs	Plant Volume (cm^3) INSIDE	OUTSIDE
Acamptopappus schockleyi	3,210,737	317,678
Coleogyne ramosissima	120,511	1,678,862
Dalea fremontii	230,476	230,938
Ephedra sp.	3,757,474	1,780,056
Franseria dumosa	50,307	14,155
Grayia spinosa	1,810,034	330,010
Haplopappus sp.	266,774	145,450
Lycium andersonii	10,741,674	601,203

Table 4. Annual Grasses and Forbs Recorded in Vegetative Transects Inside and Outside of the Wildrose Burro Exclosure (from Fisher 1974)

Annual Grasses and Forbs	No. Individuals INSIDE	OUTSIDE
Amsinckia tessellata	4	0
Grass spp.	74	0
Bromus rubens	1160	461
Chaenactis sp.	11	2
Chorizanthe brevicornu	3	0
Cryptantha sp.	7	0
Descurania pinnata	11	2
Eriastrum eremicum	24	19
Eriogonum sp.	0	1
Erodium texanum	4	0
Gilia cana	69	9
Ipomopsis polycladon	12	7
Lepidium dictyotum	12	5
Oxytheca sp.	9	1
Streptanthella longirostris	2	1

Table 5. Estimated Burro Populations, Death Valley National Monument (from Sumner, 1951; Hansen, 1973)

Year	Burros
1939	1,500
1942	700
1951	800
1967	1,000
1969	1,350
1972	1,500

The plan proposes exclusion of burros from Death Valley. The plan also provides for the exclusion of trespass livestock as well. Elements of the plan are as follows:

1. Continuing research adding to present knowledge of vegetative systems and the animals therein. Studies of new management and control techniques is also recommended.

2. Implementation of a public information program to inform the public of the environmental effects of feral animal problems and to apprise the public of the progress of the project.

3. Fencing permanently portions of the Monument boundary to preclude entry by animals ranging on lands adjacent to the Monument. Burros ranging on surrounding public lands are protected by federal law and populations there will be managed as a public resource.

4. Removal of burros within the Monument by live trapping and direct reduction as required.

5. Construction of temporary barrier or drift fences as required within the Monument to prevent repopulation of areas where animals have been removed, to protect springs and other water sources from damage by feral animals, and to reduce competition with native wildlife species.

6. Monitoring of vegetative recovery following exclusion of animals to determine the need for restorative projects and control of exotic plants.

Conclusions

Damage by feral burros is one of a number of man-caused problems affecting the integrity of a natural ecosystem in Death Valley. To be effective, other habitat management projects such as restoration of former wildlife habitat, rehabilitation of old mining scars, relief of human impact by recreational activities, and others, cannot be successful if destructive influences remain. For example, it is of no benefit to bighorn to rehabilitate a spring formerly used by them if burros will move in. It is impractical to revegetate an abandoned mining road if burro impact negates management's efforts. For restorative actions to be assured reasonable success, such actions must be delayed until a primary destructive force is rendered inoperative. If burro control is unacceptable, the public must accept the ecological fact of life that the Death Valley ecosystem will continue to alter until a new equilibrium is reached and native populations will continue to decline significantly. In the long term, the disappearance of some native species can be expected.

Acknowledgements

A paper on this subject should and probably would have been presented by Charles G. Hansen, National Park Service Research Biologist, had he not been killed in a plane crash in the line of duty on May 2, 1973. This paper is dedicated to Dr. Hansen in commemoration of his dedication to wildlife and related studies in Death Valley. Much of the information contained in this report was taken from his writings and the many lengthy discussions we had together. Special thanks are due Lewis Nelson, Jr. and Charles L. Douglas for particularly constructive reviews of the manuscript.

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