

Preface

Introduction to the special issue on the changing Mojave Desert

The Mojave Desert, which lies between the Great Basin Desert in the north and the Sonoran Desert in the south, covers an estimated 114 478–130 464 km² of the southwestern United States and includes parts of the states of Nevada, Utah, Arizona, and California, with the amount of land mass dependent on the definition (Fig. 1; Rowlands et al., 1982; McNab and Avers, 1994; Bailey, 1995; Groves et al., 2000). This desert is sufficiently diverse to be subdivided into five regions: northern, south-western, central, south-central, and eastern (Rowlands et al., 1982). It is a land of extremes both in topography and climate. Elevations range from below sea level at Death Valley National Park to 3633 m on Mt. Charleston in the Spring Range of Nevada. Temperatures exhibit similar extreme ranges with mean minimum January temperatures of -2.4°C in Beatty, Nevada and mean maximum July temperatures of 47°C in Death Valley. Mean annual precipitation varies throughout the regions (42–350 mm), is highest on mountain tops, but overall is low (Rowlands et al., 1982; Rowlands, 1995a). The distribution of precipitation varies from west to east and north to south, with $>85\%$ of rain falling in winter in the northern, south-western and south-central regions. In contrast, the central and eastern regions receive a substantial amount of precipitation in both winter and summer. The variability in topographic and climatic features contributes to regional differences in vegetation.

Numerous classification systems exist for Mojave and western Sonoran or Colorado Desert vegetation (for a summary see Rowlands et al., 1982; Rowlands, 1995b) and each system describes different numbers and types of plant communities. The numbers of plant communities vary from 7 to 29, depending on the author(s), and range from scrub typical of alkali sink (often with species of *Atriplex*, *Kochia*, *Suaeda*, and *Allenrolfea*) to high elevation forests with white fir (*Abies concolor*) and bristlecone pine (*Pinus longaeva*). The more common scrub communities support creosote bush (*Larrea tridentata*), which is the principal species seen throughout the Mojave Desert; other species such as the Joshua tree (*Yucca brevifolia*) are also characteristic at mid-level elevations.

Superimposed on the diverse physiographic and biotic resources are the anthropogenic uses of land and resources. The majority of land (79%) within the Mojave Desert is under the jurisdiction of the federal government of the United States of America, specifically the Department of the Interior's Bureau of Land Management (BLM), National Park Service (NPS), and Fish and Wildlife Service (Table 1). The Department of Defense (DOD) also

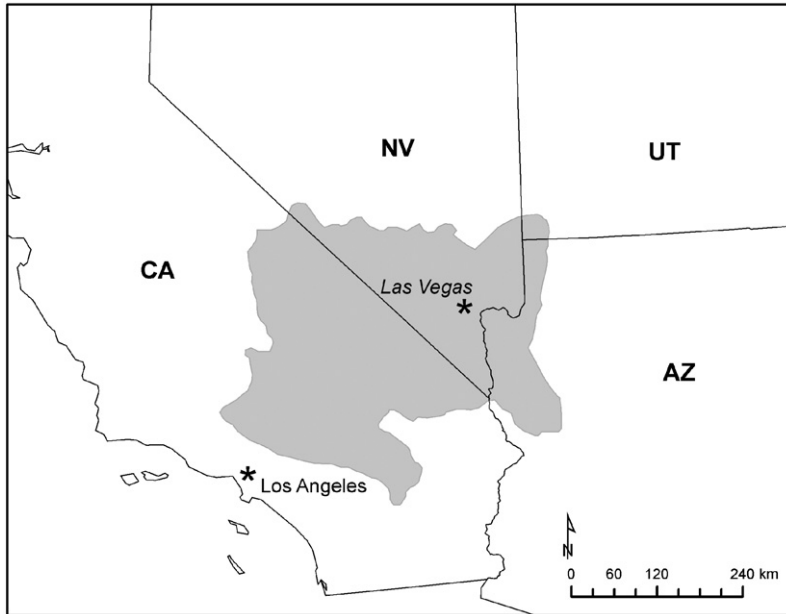


Fig. 1. The outline of the Mojave Desert which encompasses parts of the states of California (CA), Nevada (NV), Utah (UT), and Arizona (AZ) (Rowlands et al., 1982).

has substantial holdings. The holdings of the four state governments (California, Nevada, Arizona, Utah) are relatively minor (4.2%), whereas the 16.8% in private holdings have substantial influence on nearby and surrounding desert resources. Cities, towns, settlements, and rural areas are included in the figures of private land. In addition, the distribution pattern of private land has affected development, and thus the natural resources.

Land has continually moved from federal to private status in the vicinity of existing developments, thus supporting growth of settlements and cities in such areas as the southwestern Mojave Desert, along the Mojave and Colorado rivers, and in Las Vegas Valley (e.g., US Department of the Interior, BLM, 1980; Norris, 1982). In the 1990s and early 2000s, a significant block of private land in remote areas, primarily land belonging to the railroads, also was transferred into the federal sector and into wilderness. Substantial public land under the jurisdiction of the BLM was transferred into the wilderness system and to the NPS for the new Mojave National Preserve and Death Valley and Joshua Tree national parks (US Congress, 1994).

Whether under federal or private control, the desert landscape serves multiple functions. The federal agencies have a myriad of mandates in terms of managing the Mojave Desert land. The BLM, the largest land holder, manages land for multiple-use, including utility and transportation corridors, mining and energy development, livestock grazing, recreation, wilderness, wildlife, and archeological and Native American values (US Department of the Interior, BLM, 1980). In contrast, the NPS is required to protect landscapes and ecosystems for visitor use and recreation. The DOD has five major installations within the confines of the Mojave Desert and has multiple missions of training military personnel and testing new equipment.

Table 1

Land ownership, administration, and jurisdiction in the Mojave Desert, including a buffer area of 50 km that extends into the Great Basin and Sierra Nevada

Management type or ownership	Area (km ²)	% of total
Federal		
Bureau of Land Management	90 479	42.7
National Park Service	31 091	14.7
Forest Service	16 222	7.6
Department of Defense	15 457	7.3
Fish and Wildlife Service	6 727	3.2
Department of Energy	3 472	1.6
Native American Reservations	3 101 ^a	1.5
Bureau of Reclamation	837	0.4
State land (general)	8 446 ^a	3.9
Park and Refuge System	600 ^a	0.3
Private lands	35 553 ^a	16.8
Total	211 985	100.0

^aMojave Desert Ecosystem Program, 1998; updates from the National Atlas of the United States (2005).

Table 2

Examples of sizes of urban areas in 2000, a comparison of population sizes, and the percent change between years

Location	Urban area (km ²) in 2000	Populations		
		1980	2000	% change
California				
Bakersfield*	285.83	105 611	247 057	133.9
Los Angeles*	3 081.05	2 968 528	3 694 820	24.5
Victorville	322.09	14 220	64 029	350.3
Nevada				
Las Vegas	740.48	164 674	478 434	190.5
Utah				
St. George	87.13	11 350	49 663	337.6
Arizona				
Phoenix*	2 021.95	789 704	1 321 045	67.3
Prescott*	100.52	19 865	33 938	70.8

The cities are within or proximate* to the Mojave Desert. The population data and shape files were from the United States Bureau of the Census (2001). The US Bureau of the Census (2001) delineated urban area boundaries to encompass densely settled territories, which generally consisted of: (1) a cluster of one or more block groups or census blocks each of which had a population density of ≥ 386 people km⁻² at the time, (2) surrounding block groups and census blocks each of which had a population density of ≥ 193 km⁻² people at the time, and (3) less densely settled blocks that form enclaves or indentations, or are used to connect discontinuous areas with qualifying densities.

Human populations in the vicinity of and within the Mojave Desert have additional and profound effects on land and resources. For example, > 30 million people live within a few hours' drive of the desert, and many of them frequently visit for recreation. The Mojave Desert has several rapidly growing cities, some of which contain residents that commute to jobs within the Los Angeles Basin or Central Valley (Table 2, Fig. 2). In the California

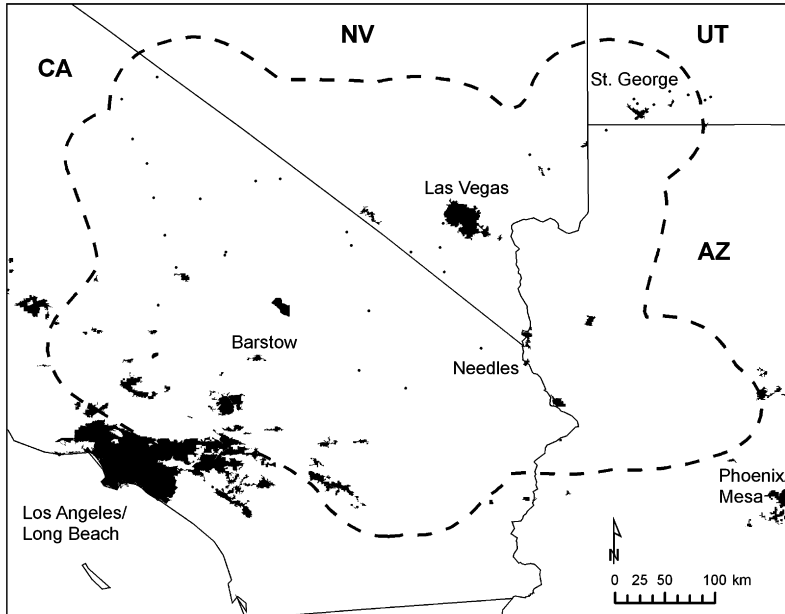


Fig. 2. The Mojave Desert with a 50 km buffer, as defined by the [Mojave Desert Ecosystem Program \(1998\)](#). The darkened areas are major cities and settlements adjacent to or within the desert. In California (CA), the cities near the desert edge include, but are not limited to the Los Angeles basin, Bakersfield and Tehachapi in the Central Valley, and cities along the Colorado River. The Colorado River forms a substantial part of the boundaries between CA, Nevada (NV) and Arizona (AZ). Within Nevada, the major area of growth is in the Las Vegas Valley. In Utah, St. George and the surrounding cities have rapidly expanding populations.

portion of the Mojave Desert, incorporated cities experienced population growth of $>350\%$ between 1970 and 1990; if the trend continues, “the population is projected to increase by nearly 900 000 people” between 1990 and 2020 ([Hunter et al., 2003](#)). Growth in the Las Vegas Valley of Nevada and the St. George area of Utah followed a similar pattern ([Table 2](#)). Population growth contributes to conflicts with natural resources, such as rare, threatened, and endangered plant and animal species.

This issue of the *Journal of Arid Environments* highlights several current and significant topics among a diverse array of the sciences. The papers include basic and applied science, as well as new techniques. Some papers cover multiple topics, such as threatened or endangered species, alien species, and anthropogenic impacts. The research findings contribute to our understanding of both natural and anthropogenic processes on the landscape and are directly applicable to management of ecosystems and species. The first paper on climate ([Hereford et al.](#)) retrospectively evaluates precipitation patterns in the Mojave Desert during the last century, particularly episodes of drought, and the effects on perennial plants and the Mojave ecosystem. Two papers are on new techniques: one is on methods of measuring cover of vegetation ([Frank and Tweddale](#)) and a second is on modeling habitat for lizards ([Heaton et al.](#)).

Three papers on vegetation by [Brooks and Berry](#), [Brooks et al.](#), and [Brooks and Matchett](#) are focused on alien plants, their direct and indirect effects on the native vegetation, and the relationships to historic and current anthropogenic activities. Alien

annual grasses, *Schismus* and *Bromus* in particular, have successfully invaded the Mojave Desert and are having profound effects on multiple ecosystems, as well as threatened and endangered species. Their success has been due in part to such anthropogenic influences as paved and dirt roads and livestock grazing. In addition, in the last 25 years, alien annual grasses have provided fuels for large numbers of fires, far beyond those historically observed, and the amount of land burned annually has been increasing. Land managers are faced with the difficult task of limiting the spread and negative effects of alien species.

Military use of land contributes to numerous changes in the soil surface, topography, and the ecosystem in general. Anthropogenic activities (e.g., cities, towns, settlements, roads, sewage ponds, and agricultural fields) also support and subsidize some native predators, such as the common raven (*Corvus corax*). In a paper on ravens at a military base in the central Mojave Desert (Boarman et al., this issue), the species was most abundant where human populations were high and where food and water were subsidized (the landfill and sewage ponds). Raven populations have increased several-fold since the 1960s and are having negative impacts on other vertebrate species, such as the desert tortoise (*Gopherus agassizii*), a federally threatened species and a flagship and indicator species for the Mojave Desert.

The desert tortoise was listed as threatened in 1990 under the Endangered Species Act because of rapid population declines and extensive loss and deterioration of habitat (US Fish and Wildlife Service, 1994) and has >26 087 km² of designated critical habitat. Critical and other protected habitats for the tortoise occupy about 20% of the Mojave Desert. Efforts to recover the tortoise have stimulated the development and revision of ten major land use plans throughout the Mojave region in the last 16 years (Berry, 1997). Three papers are focused on or indirectly include the desert tortoise. One paper presents research on a newly emerging infectious disease (*Mycoplasma*), which may be spread from captive to wild tortoise populations by releases, translocations, or escapes (Johnson et al.). This infectious disease affects other turtle species in other parts of the world. A second paper (Berry et al.) describes attributes of 21 tortoise populations on a military base in the central Mojave and correlates mortality with several anthropogenic activities. A third paper (Chaffee and Berry) provides basic data on distribution of selected and potentially toxic elements in soils, stream sediments, and forage plants from throughout the Mojave Desert, specifically in habitats of the desert tortoise. The data sets for soils, sediments, and plants are then used to evaluate potential impacts to the ecosystem and tortoise from elemental toxicants generated by mines, roads, and military use. The tortoise is just one of many rare, threatened, and endangered species in the Mojave Desert struggling to survive.

Genetic data are increasingly being used to examine relationships and diversity between and within species. Such data can be incorporated into land use plans to preserve biological diversity. The results of a study on genetics of the fringe-toed sand lizard (*Uma scoparia*), which was once a widespread species of aeolian dune systems in the Mojave and eastern Colorado deserts, provide evidence for distinct population segments in the northern part of the range in the Amargosa and Red Pass areas (Murphy et al.).

Managers of federal, state, and private lands in the Mojave Desert face major challenges because of the growing human populations, multiple requirements for consumptive use of resources, and the pressures of recreation. The research findings in this volume address several significant issues of concern and can be applied in solving some of the more pressing land-use problems.

Acknowledgements

We thank Dr. J. Yee for her statistical reviews of many of the papers in this volume and K. Keith for assistance with figures.

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