6 ANTHROPOGENIC LAND USES AND INFLUENCES

Anthropogenic lands uses and influences differ in different parts of the Plan Area. In the western Mojave Desert, human disturbances primarily include urban and rural development, as well as agriculture. In other parts of the Mojave Desert, grazing, mining, military training, and other land uses are the primary disturbance factors (Webb et al. 2009). In the Sonoran Desert, substantial land has been converted to urban and rural uses and agriculture in eastern Riverside County in the Coachella Valley just west of the Plan Area, along the Colorado River in the Blythe area, and in Imperial County between the Salton Sea and the United States–Mexico border near Mexicali. There are also military uses in the Sonoran Desert. This section discusses these human disturbances, as well as rural and urban development within the desert, water conveyance, utilities and infrastructure, mining, and recreational uses.

6.1 Rural and Urban Development

Development in the Mojave Desert began with mining settlements connected by railroads and dispersed cattle and sheep ranches. Over the last 100 years, the human population in the Mojave Desert has increased significantly. In 2000, an estimated 2.36 million people resided in the Mojave Desert, of which, approximately 1 million were in California (Webb et al. 2009; Randall et al. 2010). Along with expansion of suburban areas across the southwestern U.S., several cities in the Mojave Desert, including the Lancaster–Palmdale, Victorville–Apple Valley–Hesperia, and Ridgecrest areas experienced a substantial rise in population after 1980 (Webb et al. 2009). Since then, many of the cities in the western Mojave Desert have doubled in size as people relocate from Los Angeles and other nearby urban centers; however, in many areas, the recession that began in 2008 has slowed the population growth rate (Randall et al. 2010). In 2009, the population estimate for the main population centers in the western Mojave Desert was more than 500,000 people, including approximately 145,800 people in Lancaster, 144,000 in Palmdale, and 110,900 in Victorville (U.S. Census Bureau 2011). The only population center of size in the Eastern Mojave Desert is Needles, with about 5,300 people.

The Sonoran Desert portion of the Plan Area is much less urbanized and the main population areas are associated with large-scale agricultural activities in the Imperial Valley. Most urban development in the Sonoran Desert has occurred in the Coachella Valley just west of the Plan Area. Agricultural development in Imperial County began in the early 1900s when the Alamo Canal was completed in 1901. Several additional expansions of water diversions to agricultural areas in California occurred in 1909, 1913, 1927, 1948, and 1957 and provided for population expansion (LCRMSCP 2004). According to the U.S. Census Bureau, in 2009, the population of Imperial County was about 167,000 people, of which, about 122,780 (74%) live in the cities of El Centro, Brawley, Imperial, Calexico, and Holtville (U.S. Census Bureau 2011). These cities are all associated with the large-scale agricultural operations in Imperial County. Smaller population centers in the Sonoran Desert portion of the Plan Area include Blythe in Riverside County, with a population of about 21,300 people, and Borrego Springs in San Diego County, with a population of about 2,500 people.

Impacts of urban, rural, and agricultural development include direct habitat loss, degradation, and fragmentation (Randall et al. 2010). Degradation of surrounding natural desert landscapes can occur for several reasons. Public lands closer to urban areas are subject to greater anthropogenic impacts due to continued disturbance at the urban–desert interface and easy access by large numbers of people (Webb et al. 2009). Urban, rural, and agricultural development also can promote the spread of invasive non-native plants and other invasive species, as discussed in more detail in Section 6.9. The types of development, such as primarily rural or agricultural (e.g., horse properties, alfalfa fields, and other crops), versus more urbanized development, influence the type of non-native plants and other invasive species introduced into the desert (Webb et al. 2009).

The urban and suburban metropolitan areas in the western Mojave Desert and urban/agricultural areas of the Sonoran Desert are linked by highways, utility corridors, and railroads, which facilitate secondary roads and other vehicular routes to serve as these linkages. Urban, rural, and agricultural development also impact desert ecosystem processes by increasing the water and energy supply demands. The water and energy needs of desert urban areas are supported largely through imports via aqueducts, pipelines, transmission lines, and diesel-powered trucks and locomotives. These anthropogenic impacts are discussed in more detail below.

6.2 Transportation Corridors and Roadways

Major transportation corridors in the Mojave Desert include Interstate 15 (I-15) from Cajon Pass, through Barstow to Las Vegas; Interstate 40 (I-40) from Barstow to Needles; Highway 395 from Adelanto to the Owens Valley; Highway 58 from Mojave to Barstow; and Highway 14 from Palmdale to Highway 395 near Ridgecrest. Reflecting its less intense urban development, there are fewer major transportation corridors in the Sonoran Desert, but they include Interstate 10 (I-10) from the Coachella Valley to Blythe; Interstate 8 (I-8) from San Diego County to Yuma, Arizona; Highways 86 and 111 paralleling the Salton Sea south to the El Centro area; and Highway 78 from Brawley to Blythe.

Roads also directly impact wildlife through habitat loss and animal mortality and injury from vehicular collisions, especially to small rodents such as kangaroo rats and pocket mice, as well as jackrabbits and reptiles and amphibians, which readily cross rural or two-lane paved roads and dirt roads. Roads may also influence wildlife movement patterns by creating physical barriers or filters to movement and fragmenting habitat (Meese et al. 2007; Webb et al. 2009). Many small desert animals do not or seldom cross four-lane roads (Pavlik 2008). Existing paved and dirt roads also provide takeoff points for both legal and illegal off-road activities, trash dumping, shooting, and vandalism that can damage the desert ecosystem.

6.3 Water Conveyance

In the Mojave Desert, water conveyance and storage primarily serves to sustain urban development, agriculture, and mining activities (Randall et al. 2010). Most of the water used in the Mojave Desert comes from the Colorado River Basin and Northern California. Owens Valley water was originally brought through the western Mojave Desert to the San Fernando Valley in 1913 via the Los Angeles Aqueduct. The California Aqueduct East Branch was completed in 1971 through the State Water Project (SWP), enabling the conveyance of Feather River water from Northern California to cities in the Western and South-Central Mojave Desert. Most of the water used by the Southern Nevada Water Authority (SNWA) comes from the Colorado River at Lake Mead. Groundwater withdrawals are also an important source of water for the Mojave Desert (Webb et al. 2009).

While outside sources of water, from Northern California, northern Nevada, and the Colorado River, are commonly used, these outside resources are utilized only after regional resources have been depleted or are close to depletion. Depletion of the local or regional water supply impact highly valued riparian areas and wildlife populations reliant upon these water sources (Webb et al. 2009). All of the major riparian systems in the Mojave Desert are threatened to some degree by water diversion and groundwater pumping. Even non-riparian vegetation communities can be negatively impacted when the water table drops below a certain threshold. In the Mojave Desert, water diversion is one of the five most commonly cited causes of species endangerment. In addition, aquifer contamination is a potential threat related to water use in the desert (Randall et al. 2010). In the Sonoran Desert portion of the Plan Area, water conveyance is primarily conducted by the IID, which diverts and transports approximately 3.1 million AF of Colorado River water to nine cities and nearly 500,000 acres of agricultural land in Imperial Valley (IID 2011). Water is conveyed from the Colorado River along the 82-mile All-American Canal that runs east to west along the United States–Mexico border and which distributes water to about 230 miles of main canals and 1,438 miles of lateral canals.

Water diversions and groundwater pumping may facilitate alterations that encourage the invasion of non-native plants into riparian areas. These activities reduce the availability of moisture to native obligate phreatophytes (deep-rooted plants that obtain water from a permanent ground supply), which require almost constant contact with free water compared to the non-native tamarisk (*Tamarix* spp.), which can withstand periods of drought (see discussion on non-native species in Section 6.9). Water diversions and groundwater can also result in soil salinization, which can inhibit the growth of native plants. Water management practices that create more stable hydrology also promote tamarisk invasion since young plants are less tolerant of repeated flooding than native cottonwood (*Populus fremontii*) and willows (*Salix* spp.). Higher abundance of non-native riparian species, such as tamarisk, can lead to reductions in the diversity and abundance of riparian-dependent wildlife, increased soil salinity, exacerbation of over-bank flooding and channel incision and channel erosion, increased frequency and magnitude of wildfire, and reduced forage availability and water access for wildlife and livestock (Dudley 2009).

6.4 Utilities and Infrastructure

Industrial-scale electrical power plants generate electricity that is transmitted through transmission lines that extend across the Mojave and Sonoran deserts to urban centers. Substantial energy development has occurred in the western Mojave Desert. For example, The USFWS identified 22 energy power plants constructed within or near the range of the Mohave ground squirrel alone in the western Mojave Desert region (76 FR 62214–62258).

Increased development of utility-scale electrical generation plants in the desert requires additional transmission lines to distribute the electricity generated. The construction, operation, and maintenance of these transmission lines and associated access roads and other infrastructure impact desert ecological processes by causing habitat loss, degradation, and fragmentation (Randall et al. 2010).

Transmission lines and energy generation facilities require construction of access roads that disrupt soils, uproot plants, and fragment habitat. Soil disturbance also facilitates the invasion of non-native plants, as discussed in more detail in Section 6.9. However, the narrow strips of utility corridors may require less time to recover from disturbance compared to areas that are more broadly disturbed given the proximity of seed sources and dispersers (Webb et al. 2009). Transmission lines can be associated with increased fire risk under certain conditions (Randall et al. 2010).

A number of other known and potential adverse effects of energy generation facilities, including solar, wind, and geothermal facilities, have been identified, including dust and dust suppression (e.g., chemical suppressants); noise; light pollution; altered microclimates, topography, and drainage; pollution and hazardous materials; water consumption; and collisions with turbines and other facilities (e.g., towers) (BLM and DOE 2010; Cryan 2011; Hunt et al. 1998; Lovich and Ennen 2011).

Utilities have an impact on wildlife species in the desert as well. Transmission towers can serve as perching and nesting sites for common ravens, and provide ideal vantage points for hunting and resting sites to conserve energy. The towers facilitate their capacity to prey on newly hatched desert tortoises and other small animal species. Structures such as transmission lines, wind turbines, and power towers, also pose a direct threat to flying birds and bats from strikes and collisions. Routine maintenance and repair operations along transmission corridors can also result in collisions between wildlife and patrol and maintenance vehicles. Because many of these facilities are remote, utilities and infrastructure development can be accompanied by associated infrastructure and access roads that facilitate public access to otherwise remote and hard-to-reach areas.

6.5 Grazing

In the Mojave Desert, livestock grazing occurs both on privately owned land and on several large livestock allotments located on BLM and USFS lands. Grazing animals in the desert include cattle, sheep, horses, and feral burros (Randall et al. 2010). Grazing was introduced in the desert regions following the Gold Rush years in the mid-1800s and by the turn of the century, tens of thousands of cattle and sheep and smaller numbers of horses were grazing in the California deserts (Pavlik 2008). Livestock numbers peaked during World War II and then began declining. By 1968, public lands supported approximately 138,000 sheep and 25,000 cattle, and by 1980, these numbers had been reduced to about 60,000 sheep and 10,000 cattle (Pavlik 2008).

Direct impacts of grazing include removal and trampling of native vegetation and soil disturbances; heavy grazing can result in little or no vegetation (Randall et al. 2010; Webb et al. 2009). Unmanaged grazing can alter the plant cover, biomass, composition, structure, productivity, and succession of native vegetation communities, including introduction and facilitation of non-native species. Modification of native vegetation communities and soils in turn affects sensitive plants and terrestrial and aquatic wildlife species that depend on relatively undisturbed conditions.

Grazing can cause erosion and damage to sensitive soils or soil compaction, especially when concentrated near stock tanks or wells (Randall et al. 2010; Webb et al. 2009). Overgrazing can also destroy biological soil crusts, which undergo nitrogen fixation and act as important agents of nitrogen input into desert ecosystems. Therefore, destruction of biological soil crusts can negatively impact desert fertility and take hundreds of years to recover (Webb et al. 2009). In addition, soil disturbance promotes invasion by non-native plants, which increases the risk of fire (Randall et al. 2010).

6.6 Mining

Some of the first non-Indian settlers in California's desert regions were miners in the 1800s. Steamboat trade increased along the Colorado River during the Gold Rush years in the 1860s and the first large influx of miners into the Mojave Desert occurred in the 1850s. The Hardrock Mining Law of 1872 essentially provided miners free rein over the extraction of minerals (Webb et al. 2009). Resources that have been extracted from the Mojave Desert, for example, include borates, talc, copper, lead, zinc, coal, calcite, tungsten, strontium, uranium, precious metals (e.g., gold and silver), gem-quality non-metals, and building materials (e.g., sand, gypsum, cinders, decorative rock, and gravel) (Randall et al. 2010). There are still many active mining operations and many more abandoned mines in the Plan Area (Shumway et al. 1980; BLM and DOE 2010).

Mining can have several negative impacts on desert ecosystems. Primarily, mining causes surface disturbances and results in damage to desert soils and the destruction of fragile soil biological crusts, which can cause erosion and negatively affect water and air quality. Strip and open pit mining are the most visibly destructive to terrestrial habitat. Mining access roads destroy and fragment habitat in a manner similar to transmission line access roads. Mining facilitates invasion of non-native plants with open-pit mines and abandoned material sites providing ideal disturbance conditions for invasion, such as altered soil morphology (Randall et al. 2010).

Mining can also impact local water resources because many mining operations require large amounts of water for processing. Water use can range into the millions of gallons per day, potentially resulting in groundwater overdraft. Gravel and sand mining can severely alter natural hydrology since these types of mining occur in desert washes, mountain foothills, and alluvial fans and alter the infiltration of water into groundwater aquifers (Randall et al. 2010).

6.7 Military Uses

The California desert regions support several military installations and training areas, including from north in the Mojave Desert to south in the Sonoran Desert: Naval Air Weapons Station, China Lake; National Training Center, Fort Irwin; Edwards Air Force Base, Edwards; Marine Corps Logistics Base, Barstow; Marine Corps Air Ground Combat Center, Twentynine Palms; portions of Bob Stump Training Complex; Chocolate Mountain

Aerial Gunnery Range; and Naval Air Facility, El Centro (OPR 2006). Department of Defense (DOD) lands cover approximately 2,935,641 acres of the Plan Area.

Military training activities include ground troop activities, tracked vehicles, bombing strikes, and other explosives. The resultant military training, maneuvers, and bombing practice can have impacts on desert ecosystem processes. The effects of the original maneuvers conducted almost 70 years ago are still visible as soil erosion, surface scarring, and vegetation removal (Pavlik 2008). Relocation of desert tortoise during the expansion of Fort Irwin resulted in high desert tortoise mortality and the site has fewer tortoises than adjacent monitoring areas (Pavlik 2008; Randall et al. 2010). Despite the impacts of military uses on desert ecosystems, they can also benefit the desert ecosystem by restricting public access and buffering military installations against encroaching developments (Randall et al. 2010).

6.8 Off-Highway Vehicle Uses

In the desert southwest, off-highway vehicle (OHV) recreation became increasing popular in recent decades (Brooks and Lair 2009). Prior to 1980, almost all of the 12.1 million acres of BLM land in the desert was open to various intensities of OHV use (Pavlik 2008). Under the California Desert Conservation Area (CDCA) Plan, BLM lands have been classified by the types and intensity of motorized vehicle use authorized for the area. BLM lands in the Plan Area are designated as “open,” “limited,” or “closed” for vehicle use. The first sanctioned Barstow-to-Vegas off-road race occurred in 1967, and by 1975 attracted more than 3,000 riders, after which BLM no longer issued a permit for the race due to the potential for extensive environmental damage. In California, the number of OHV users increased by 108% between 1985 and 2002. There are more than 500,000 registered OHVs in Southern California within a few hours’ drive of the desert regions (Pavlik 2008). Current uses range from localized casual recreation to highly organized, well-funded, competitive off-road racing traversing hundreds of miles of public land (Randall et al. 2010). Motor-dependent backcountry recreation in the Plan Area is also important to OHV users and organized groups; this involves OHV travel to more remote destinations or trailheads for a variety of outdoor recreation activities, such as dispersed camping, rock-hounding, visiting historical sites, hunting, fishing, equestrian uses, and day-touring. These opportunities generally exist in areas and routes of travel designated under the CDCA Plan as “limited” for vehicle use. OHV trails are dirt roads generally less than 4 meters (13 feet) wide that are typically not bladed, filled, or otherwise improved (Brooks and Lair 2009). Along unmaintained roads such as jeep trails, topsoil may be in place and emergent perennial shrubs and grasses may grow up within the roadbed (Brooks and Lair 2009).

OHV use is an important recreational use that affects desert ecosystem processes when considered collectively, especially where trails are dense and occupy a large portion of the landscape (Webb et al. 2009). Although many individual OHV trails may have low travel frequency, even minimal vehicular passes can cause significant surface disruption, including soil compaction, alteration of soil composition, and destruction of biological crusts and natural desert pavement (Webb et al. 2009; Randall et al. 2010). Disturbed soils can lead to greater wind and water erosion as well as facilitate the invasion of non-native plant species, which increase fire risk, especially since OHVs can emit sparks (a potential source of fire ignition). OHV use also affects the desert ecosystem by altering hydrology and water runoff patterns, vegetation, and wildlife movement, and contributes to habitat loss and fragmentation (Brooks and Lair 2009; Randall et al. 2010).

OHV use can directly impact wildlife species through mortality from OHV collisions and indirectly impact wildlife through noise and dust generation. The low-frequency noise emitted by OHVs may affect the central auditory system of species such as kangaroo rats that have evolved sensitive hearing to detect predators, potentially resulting in direct injury or indirectly by increased predation. Studies have found reduced density and biomass of reptiles, small mammals, and plants in OHV use areas (Randall et al. 2010). Even playas, which are generally devoid of vegetation and wildlife use except when flooded, are subject to damage by OHVs and other vehicles. OHV use on playas damage the eggs of crustaceans such as fairy shrimp (*Branchinecta* spp.) and tadpole shrimp (*Triops* spp.).

6.9 Non-Native and Other Invasive Species

As noted previously, many of the land uses and anthropogenic impacts promote the invasion of the desert native communities by non-native species through various mechanisms. Non-native plants have been recorded in the California deserts as early as 1735 based on the presence of red-stemmed filaree (*Erodium cicutarium*) in woodrat middens near Death Valley, but trained botanist John Frémont made no notes of weeds or other nondesert plants during his travels in the desert regions in 1844, indicating that non-native species were yet not prevalent at the time (Pavlik 2008). There are currently about 232 taxa (10%) in the California deserts that are non-native (Baldwin et al. 2002), of which, about 27 are considered to be noxious weeds (Pavlik 2008). The early proliferation of non-native species was associated with agriculture and grazing, introducing non-native species such as tumbleweed (*Amaranthus albus*), Russian thistle (*Salsola tragus*), goosefoot (*Chenopodium murale*), and annual beard grass (*Polypogon monspeliensis*) (Pavlik 2008). Cheatgrass (*Bromus tectorum*), a contaminant of wheat, was widespread in arid western lands by the 1930s (Pavlik 2008).

As discussed previously, several types of modern human activities and land uses in the desert regions can promote invasions of non-native species, including paved and dirt roads and OHV activities that disturb soils and create trails; access roads and edges around utilities around mines; military activities; and grazing. Common weeds and non-native grasses associated with paved and dirt roads, trails, and other linear disturbances in desert regions include Russian thistle, tumbleweed, Sahara mustard (*Brassica tournefortii*), London rocket (*Sisymbrium ireo*), tansy mustard (*Descurainia* spp.), short-pod mustard (*Hirschfeldia incana*), fiddleneck (*Amsinckia tessellata*), red-stemmed filaree, Mediterranean grass (*Schismus barbatus* and *S. arabicus*), red brome, and cheatgrass (in the Great Basin Desert) (Brooks and Lair 2009; Pavlik 2008). Sahara mustard, in particular, has become one of the most invasive species in the desert landscape (Holt and Barrows 2013). Invasive plant species are common in desert wetland and riparian communities; approximately 20% of the plant species in the Mojave River are non-native (Dudley 2009, Table 6.1). Most of the invasive species in Mojave Desert wetlands and riparian areas are low-growing herbaceous species, and include sweet clovers (*Melilotus* spp.), pepperweed (*Lepidium* spp.), dock (*Rumex* spp.), annual beard grass, sow thistle (*Sonchus* spp.), and Bermuda grass (*Cynodon dactylon*) (Dudley 2009).

The most pernicious and widespread invasive species in desert riparian systems is tamarisk (also called salt cedar), which invades arroyos and streambeds (Dudley 2009; Pavlik 2008). It is common along the Mojave and Amargosa rivers in the Mojave Desert (Dudley 2009; Pavlik 2008) and along the lower Colorado River (Pavlik 2008), as well as other scattered areas throughout the Plan Area. Tamarisk is extremely drought tolerant and has explosive reproduction, providing it a competitive advantage over many native riparian species, such as cottonwoods and willows.

Desert regions also support several non-native wildlife species that can degrade native habitats, compete for resources with native species, and increase predation pressure on native species. These include American bullfrog, a voracious omnivore known to prey on Amargosa pupfish and many other native species, house sparrow, European starling, which compete with native birds for nest cavities, house mouse, burros (*Equus asinus*), and horses (*E. caballus*) (Pavlik 2008).

Other species that are native to North America that were formerly absent from or uncommon in desert areas have increased in abundance in association with human activities and land uses, and thus are considered to be “invasive” species. Common ravens have had a substantial impact on small desert tortoises (USFWS 2008). Common ravens take advantage of transmission structures for nesting, perching, resting, and foraging. Ravens are also attracted to other human subsidies, such as garbage from landfills and trash containers; water from sewage ponds and municipal areas; and nesting sites on billboards, bridges, and buildings (USFWS 2008). Coyotes, which prey on adult tortoises, also are attracted to landfill, where coyote populations can increase (USFWS 2008). Brown-headed cowbirds (*Molothrus ater*), which have increased in Southern California in association with grazing and other agricultural activities, parasitize the nests of endangered species nesting in the lower Colorado River and other riparian habitats in the Plan Area, including southwestern willow flycatcher and least Bell's vireo, as well as other neotropical migrants such as yellow warbler, although this species may be resistant to the demographic effects of brood parasitism (Heath 2008).