and Bleich et al. (1996) suggested that populations less than 15 kilometers (9.3 miles) apart were likely to be connected by dispersal, unless they were fragmented by anthropogenic barriers. These dispersal distances may be greater when favorable escape terrain is available (Epps et al. 2007). In the Mojave Desert, barriers to bighorn dispersal primarily consist of highways (including I-40 and I-15), but also include aqueducts, mining operations, and urban development (Epps et al. 2005) (see Figure 9). Desert bighorn sheep rarely cross these continuously fenced barriers, which likely has reduced connectivity among bighorn populations as well as those of other species (Epps et al. 2005). In their study of genetic diversity of bighorn populations relative to human-made barriers, Epps et al. (2005) found that the genetic diversity in populations that were completely isolated by barriers had declined as much as 15 percent over a period of 40 years. However, population translocations may be effective in restoring populations. Other opportunities to mitigate the effects of barriers include the use of bridges over major roads for bighorn to cross, as on I-95 in Arizona (Epps et al. 2007).

Wildlife species such as desert bighorn sheep that persist in small, isolated populations are vulnerable to loss of habitat and genetic diversity (Epps et al. 2006). Isolated populations may serve as indicators for the effects of climate change since the effects may be more quickly detectable. A review of the status of bighorn sheep indicated that this is already occurring: the range of bighorn sheep in California has contracted, and at least 26 populations have become extinct (Epps et al. 2003). Over the past century, this has been concurrent with a 20 percent decrease in precipitation and an increase in temperatures in the region (Epps et al. 2004). After investigating the correlation between habitat elevation and genetic diversity, Epps et al. (2006) concluded that both genetic diversity and population extirpation rates were consistent with increasing temperature and aridity, and that further temperature increases and reductions in precipitation will result in even more loss of genetic diversity and the eventual extirpation of more populations in low-elevation habitat. Epps et al. (2006) also observed that populations had the greatest genetic diversity when suitable habitat persisted and connectivity with other populations was in place, which underscores the importance of maintaining connectivity between populations with more favorable habitats. These higher-quality habitat areas (which are less vulnerable to the effects of climate change) could serve as refugia for genetic diversity during drought and source populations for recolonization in periods of more favorable climate. Conversely, isolated bighorn populations in the Mojave Desert typically support too few sheep to persist for more than a few decades, as genetic drift and inbreeding eventually result in extinction (Schwartz et al. 1986).

Remote camera image of bighorn drinking from a guzzler (NPS photo)

In recent years, more arid climatic conditions have been documented in the southwestern United States, including less precipitation (Seager et al. 2007) and shifts in timing of precipitation (Weltzin et al. 2003) (see the climate discussion in the "Environmental Setting" section of this chapter). These changes may lower the reproductive success of bighorn sheep (Douglas and Leslie 1986; Wehausen et al. 1987) and may increase the probability of population extirpation (Epps et al. 2004). The predicted transition to a more arid climate and resultant impacts on desert bighorn sheep populations indicate that the use of water developments may be an important conservation tool to maintain available habitat, particularly in instances where loss of available water has been exacerbated by anthropogenic activities (Longshore et al. 2009).

Disease

Disease has also been a major limiting factor for bighorn populations, especially those in the Mojave Desert. Gross et al. (2000) found that disease, even of mild severity, has a profound influence on bighorn sheep population dynamics. Disease, more than habitat loss and fragmentation, may be the factor that ultimately results in extirpation of a population (Gross et al. 2000).

In recent years, pneumonia epidemics have spread through bighorn populations in many western states. The disease typically enters a population that has no resistance, and, as a result, animals can become infected and die at a high rate. The few animals that survive become carriers, infecting newborn lambs that often die within a few months of birth. This typically causes a long-term decline in a population that can last for more than a decade. Gross et al. (2000) found that even a single disease event depressed population growth for periods that exceeded two decades.

In 2013, *Mycoplasma ovipneumoniae* (pneumonia) caused a bighorn die-off in the Preserve and surrounding region. The outbreak was first detected in the Old Dad/Kelso area of the Preserve and was first reported in mid-May. By the end of 2013, impacted herds included all mountain ranges in the Preserve, South Bristol, Marble, and Clipper Mountains south of I-40, and the Spring Mountains in Nevada.

In 1995, a considerable number (at least 45) of bighorn sheep died as a result of toxic contamination from *Clostridium botulinum* (botulism) in water tanks at the Old Dad Peak guzzler in Mojave National Preserve (Swift et al. 2000). It is speculated that, due to a malfunction, the drinker basin had gone dry while there was still water in the tank. Seeking water from the tank, it is believed, several bighorn sheep dislodged the hatch to access water. As the water level receded, several lambs fell into the tank and drowned. The decaying lamb carcasses provided a substrate for the growth of botulism. The adult sheep were subsequently exposed to the toxin as they attempted to drink from the contaminated tank. Swift et al. (2000) note that this event demonstrates the importance of guzzler placement and maintenance to prevent bighorns from accessing or breaking through the top of the tank.

Hunting

The Preserve includes two bighorn sheep hunt zones established by CDFW:

- Zone 2, which includes the Kelso Peak/Old Dad Mountains area
- Zone 3, which includes the Clark Mountains and a large area north of I-15

A very limited number of bighorn sheep licenses are issued throughout the state through a lottery and auction system. The CDFW determines the number of tags to be issued based on population estimates. The season extends from early December to February 1. The numbers of tags issued in recent years are as follows (CDFW 2013-17):

- 2013 – Three in Zone 2; two in Zone 3
- 2014 – Zero in Zone 2; one in Zone 3

- 2015 – Zero in Zone 2; one in Zone 3
- 2016 – One in Zone 2; two in Zone 3
- 2017 – Zero in Zone 2; two in Zone 3

Use of Water Sources

The importance of perennial water as a limiting factor for desert bighorn sheep populations is an area of ongoing research. Some authors have found that populations exist year-round in mountain ranges without perennial water (Krausman et al. 1985), and some historical observations pointed out that desert bighorn sheep did not use artificial water when naturally occurring water was available, and that plant succulence played an important role as a water source (Wilson 1971). Many desert ecologists consider the availability of perennial water to be one of the primary factors influencing the distribution of bighorn sheep (Monson and Sumner 1980; Gunn 2000; Turner et al. 2003; Cain 2006; Bleich et al. 2009). During summer months, water sources are considered an essential component of suitable habitat for nearly all desert bighorn sheep populations (Bleich et al. 1997; Andrew et al. 1999; Turner et al. 2004; Oehler et al. 2005; Sappington et al. 2007). Turner (1973) found that bighorn sheep must have access to sources of free-standing water to maintain water balance, and Mahon (1971) noted that water availability may be a limiting factor in the reproduction of desert bighorns since ewes require sufficient water to lactate properly. While Krausman et al. (1985) observed two adult female bighorn sheep that did not drink during a 10-day summer study, Welles and Welles (1961) noted that bighorn sheep visited water every 3 to 5 days, on average, during the summer.

The availability of water influences the distribution of bighorn sheep (Jaeger 1994; Bleich et al. 2009) and plays an important role in population persistence (Epps et al. 2004; Bleich et al. 2009). Bleich et al. (2009) found that the availability of high-quality habitat for bighorn sheep increased with the availability of water sources, while Epps et al. (2004) found that populations at lower elevations (below about 1,500 meters/4,900 feet) and in areas with the lowest annual precipitation (less than 8 inches/200 millimeters) were much more likely to become extinct and, therefore, are much more vulnerable to the decreased precipitation anticipated to occur with climate change (Epps et al. 2004).

Dry Season Habitat

"Dry season habitat" is defined as suitable habitat close to reliable water sources that is used by desert bighorn sheep during the hot summer months (July through September).

Dry season habitat is the quantitative basis for comparing changes between the plan alternatives (see *Chapter 4: Environmental Consequences*).

Artificial water sources, such as guzzlers, have been used for decades to enhance and restore habitat for desert bighorn sheep (Halloran and Deming 1958; Weaver et al. 1958; Werner 1984). Most researchers agree that artificial water sources support or increase some, but not all, desert bighorn populations (Rosenstock et al. 1999). In some mountain ranges, bighorn sheep have been shown to be restricted to areas with available water sources during the hot season (Blong and Pollard 1968; Leslie and Douglas 1979; Cunningham and Ohmart 1986). Jaeger (1994) found that female bighorn sheep moved to areas with more water sources, both natural and artificial, at the start of the dry season and dispersed from these areas at the end of the hot season. Studies in Joshua Tree National Park predicted that without artificial water development, up to 47 percent of summer habitat for bighorn sheep in the park would be lost (Longshore et al. 2009). Gunn (2000) observed that it often takes three to seven years for bighorn sheep to habituate to the use of newly established water sources.

Research in Cabeza Prieta National Wildlife Refuge in the Sonoran Desert (southern Arizona) found that during years with above-normal precipitation, perennial sources of free-standing water did not result in significant changes in diet, foraging area characteristics, movement rates, home range size, productivity, or juvenile recruitment for desert bighorn sheep (Cain 2006). However, during periods of drought, forage quality and quantity was a more important limiting factor than water availability, since the presence of artificial water sources was not sufficient to prevent drought-related mortalities of bighorn sheep (Cain 2006). In another study, Cain et al. (2007) reported that higher mortality rates were observed during drought conditions in habitats that had water compared with those where water was removed, suggesting it was unlikely that the presence of water structures was adequate to prevent mortality during droughts and that forage plays a dominant role in determining home range sizes, areas used, and movement rates.

Bighorn Habitat in the Preserve

Desert bighorn sheep show preference for rugged topography with sparse vegetation and seasonal access to water. Key factors in determining favorable habitat include proximity to a perennial water source, rugged topography with steep slopes (more than 25 percent and sometimes greater than 60 percent), and accessible escape terrain (with slopes greater than 80 percent) (Darby 2015; Bristow et al. 1996; Turner et al. 2004). Areas with dense or tall shrub and forest vegetation communities (such as pinyon juniper, Joshua tree, chaparral, and creosote) are less preferred by bighorn. The importance of water is seasonal, as it is most important during the months of June, July, and August (dry season) or during droughts (Darby 2015).

To support this planning process, NPS staff developed an index to quantitatively compare the dry season habitat value across the Preserve. Using environmental variables and data collected from GPS-collared bighorn ewes in the Old Dad/Kelso area, a linear model was developed relating habitat variables (e.g. elevation, distance to water) to bighorn utilization (Hughson 2018—Appendix B). The Old Dad, Kerr, and Vermin guzzlers are located in the Old Dad/Kelso area. Ninety-three percent of the collared ewes remained within 2.5 kilometers of these guzzlers during dry season; therefore, a radius of 2.5 kilometers (1.55 miles) around water sources was the dry season habitat area that was analyzed. Figure 18 shows the distribution of collared ewes in the Old Dad/Kelso Peak area (Hughson 2018).

From the model, it can be inferred that ewes using the Old Dad/Kelso area during the dry season prefer to be near water and at relatively high elevations. Distance to water and elevation showed the strongest correlation with habitat utilization by bighorn ewes; slope and terrain ruggedness showed weaker correlations. Although alluvial soils and creosote-Mojave yucca communities appeared to correlate with utilization, they could not be used in prediction given the restricted area of the data used for model training.

A dry season habitat value index was developed based on the model results. The contribution of each existing big game guzzler to dry season habitat is expressed as a percentage of the Preserve's overall dry season habitat quality (Figure 19). A more detailed summary of the index and habitat model is in Appendix B (Hughson 2018).

Relationship of Desert Bighorn Sheep Populations to Water Sources

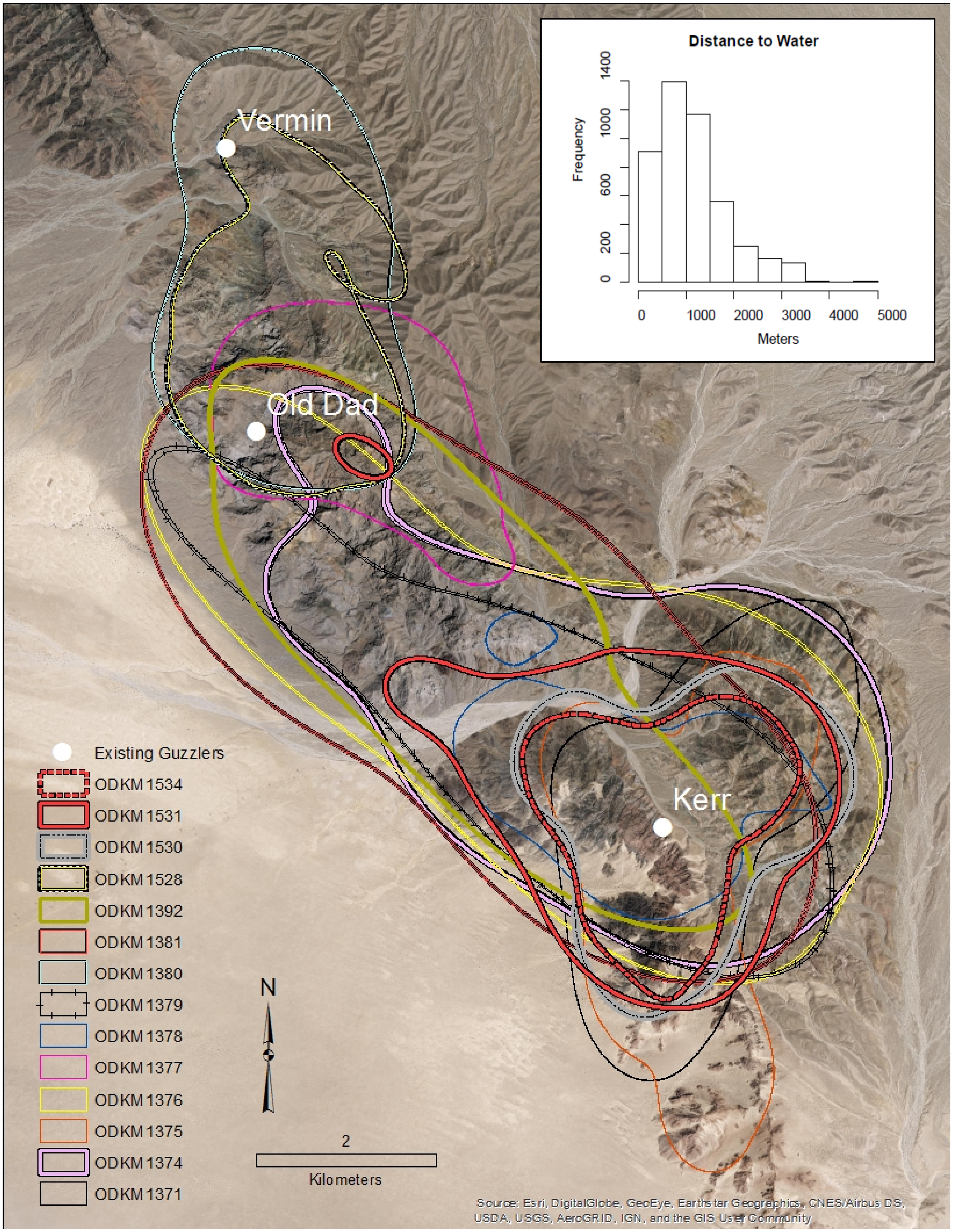
As discussed above, access to a reliable water source during the dry season is an important component of bighorn habitat and survival. This need for surface water to support lamb and ewe survival and bighorn populations in general is the intended purpose of most big game guzzlers that have been constructed in the Preserve. However, many natural or developed springs are also known to be used by bighorn and are considered part of the habitat context. The known water sources for bighorn—including guzzlers and springs—are listed in Table 15, by habitat patch.

For inventory and analysis purposes, it is understood that desert bighorn sheep will congregate in habitat areas that are close to reliable water sources during the dry season. Based on the GPS collar data from the Old Dad/Kelso area, a radius of 2.5 kilometers around waters sources is considered to be the range of suitable dry season habitat (Figure 18).

Table 15. Desert Bighorn Sheep Habitat Patches and Population Estimates

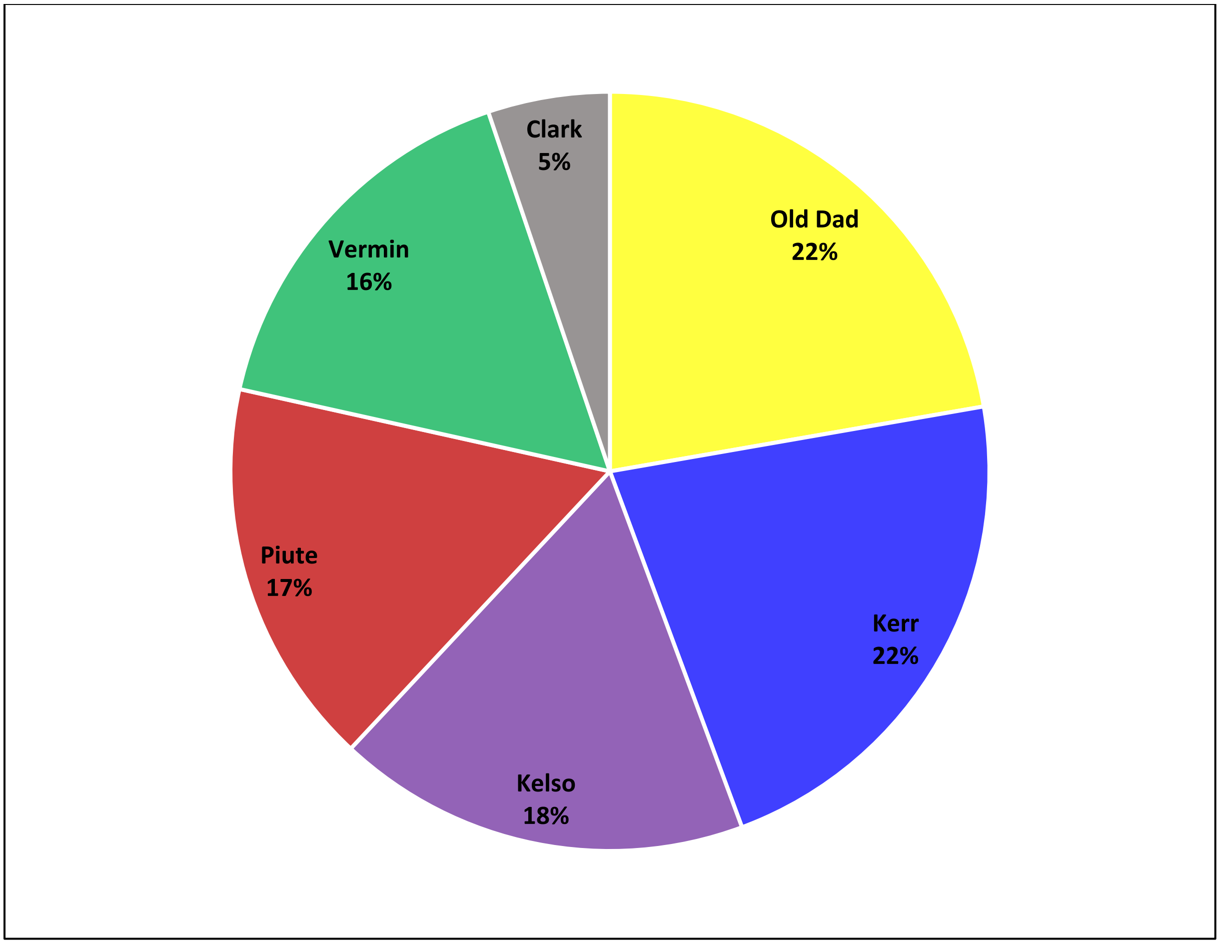
Habitat Patch	Total Habitat (acres)	Estimated Bighorn Population	Water Sources
Clark Mountains	74,134	100–150	Clark guzzler (not used) Black Bird Mine Spring; Pachalka Springs; Colosseum Mine Pit Lake
Old Dad/Kelso	106,987	200–300	Vermin, Old Dad, Kerr, and Kelso guzzlers; Cane, Marl, and Sheep Springs
Granite Mountains	42,262	<25	Budweiser Spring; Bull Canyon Creek; Barnes Spring
Providence Mountains	45,975	25–50	Cornfield, Foshay, and Warm Springs; Vulcan Mine Pit Lake
Mescal/Ivanpah Range	32,357	None	Few known sources, including Morningstar Mine Lake, Ginn Mine, and Mineral Spring on BLM land
Woods/Hackberry Mountains	27,490	50–100	Woods Mountain, Hackberry, Hackberry-South, Lance, and Twin Buttes Springs
Piute/Castle Mountains	75,631	25–50	Piute guzzler; Piute Spring; one additional guzzler and other sources on BLM land

Figure 18. Dispersal of Collared Bighorn Ewe Occurrences in the Old Dad/Kelso Mountain Area (ODKM)



Source: Hughson 2018 (see Appendix B)

Figure 19. Dry Season Habitat Value of Existing Guzzlers



Note: Total habitat value for all guzzlers combined is equal to 100%

The availability and types of water sources vary among the desert bighorn sheep populations and habitat patches in the Preserve. Four guzzlers support the Old Dad/Kelso population, while Cane, Marl, and Sheep Springs also provide limited water sources. One guzzler is present in the Clark Mountain area but is not known to be used by desert bighorn sheep and therefore is not considered to provide dry season habitat for bighorn. Woods Mountain Spring and Hackberry-South Spring are used by bighorn sheep and are within the range of the Woods/Hackberry population. The Piute Guzzler and Piute spring and creek in the Piute/Castle Mountain Range are used by bighorn sheep. In the Mescal/Ivanpah Range, no bighorn sheep have recently been documented despite at least three water sources - Ginn Mine, Morningstar Mine pit lake, and Mineral Spring on adjacent BLM land.

Other Wildlife Species

At least 300 bird species have been confirmed to occur in the Preserve, including 64 species that use the Preserve for breeding, 42 species identified as residents, and 108 species identified as migrants (Johnson and Stuart 2005). Common bird species in desert habitats in the Preserve include raven (*Corvus corax*), cactus wren (*Campylorhynchus brunneicapillus*), and roadrunner (*Geococcyx californianus*). Other notable bird species include prairie falcon (*Falco mexicanus*), Bendire's thrasher (*Toxostoma bendirei*), California thrasher (*Toxostoma redivivum*), gray vireo (*Vireo vicinior*), golden eagle (*Aquila chrysaetos*), Lucy's warbler (*Oreothlypis luciae*), mourning dove, and Gambel's quail. Riparian areas in the Preserve are especially important bird habitat.

In a bird survey focused on Piute Spring, biologists detected 60 total species (PRBO Conservation Science [PRBO] 2005).

Up to 49 mammal species have been documented in the Preserve including desert bighorn sheep (as described above). Other mammal species in the Preserve include coyote, mountain lion (*Puma concolor*), mule deer, and black-tailed jackrabbit. Common small mammals in the Preserve include desert woodrat (*Neotoma lepida*), cactus mouse (*Peromyscus eremicus*), brush mouse (*Peromyscus boylii*), canyon mouse (*Peromyscus crinitus*), and Merriam's kangaroo rat (*Dipodomys merriami*) (Drost and Hart 2008). Seven bat species have been documented in the Preserve including western pipistrelle (*Pipistrellus hesperus*) and California myotis (*Myotis californicus*).

The Preserve is home to at least 38 species of reptiles and amphibians, including 19 species of snakes, 16 species of lizards, 1 species of tortoise, and 2 species of frogs and toads (Persons and Nowak 2007). The sidewinder (Crotalus cerastes) is the most abundant snake in the Preserve, and many other species are common including gopher snake (*Pituophis catenifer*), speckled rattlesnake (*Crotalus mitchellii*), and Mojave rattlesnake (*Crotalus scutulatus*). The most abundant lizards in the Preserve include zebra-tailed lizard (*Callisaurus draconoides*), desert spiny lizard (*Sceloporus magiste*r), side-blotched lizard (*Uta stansburiana*), desert night lizard (*Phrynosoma platyrhinos*), and western whiptail (*Cnemidophorus tigris*). The desert tortoise (*Gopherus agassizii*) is common in the Preserve and is described in greater detail under "Special Status Species" below. The only naturally occurring amphibians in the Preserve are the red-spotted toad (*Bufo punctatu*s), which is found throughout the Preserve, and the Pacific tree frog (*Pseudacris regilla*), which is restricted to Soda Springs in the Preserve.

Water features are known to support nonnative invasive wildlife species that have detrimental impacts on invasive species—most notably the nonnative burro and native raven. Feral burros are a persistent nuisance species that damage native habitat and compete with desert bighorn, desert tortoise, and other native species for limited forage (NPS 2002). Common ravens have expanded along with human developments in the desert and can pose a threat to juvenile desert tortoise populations due to predation (McIntyre 2004).

The Mohave[1] tui chub (*Siphateles bicolor mohavensis*) is the only fish native to the Mojave River basin and the Preserve. The Mohave tui chub is described in detail below under "Special Status Species."

Common Wildlife Use of Water Sources, by Species Group

Photo monitoring of wildlife in the Preserve has documented 65 different species using water features (big game guzzlers, small game guzzlers, and springs). Wildlife observed include bats, insects, many different bird species, reptiles, rodents, carnivores, and ungulates. These observations include both native and nonnative wildlife species (NPS 2016). The following discussion summarizes the use of surface water sources, and potential impacts resulting from the loss of or changes to those water sources, by species group.

Herpetofauna, Small Mammals, and Carnivores

Most literature shows that native desert-adapted terrestrial wildlife species do not rely on artificial water sources. While some individuals and groups may use water sources on an opportunistic basis, sites with developed water sources have not been found to have increased

[1] There are two spellings. Mojave is the Spanish form, but Mohave is the American form used when referring to the Mohave tui chub.

species richness or contribute to population viability (Cutler and Morrison 1998; Burkett and Thompson 1994). In general, the benefits of desert water sources (artificial or natural) are likely to be associated with increased vegetation and cover that is supported by the water or is provided by the water collection and distribution infrastructure itself (Rosenstock et al. 1999).

Herpetofauna are not believed to require free-standing water, though some reptiles have been observed drinking (Mayhew 1968; Rosenstock et al. 1999). They may benefit more from development-related materials and structures (such as tanks) (Burkett and Thompson 1994). Only two amphibians are known in the Preserve, and they have not been observed in guzzlers or developed springs (e.g., troughs and tanks), only at naturally occurring springs and seeps.

It is largely believed that small mammals do not depend on water sources (Mares 1983; Rosenstock et al. 1999). As with herpetofauna, development-related materials and structures may play a more important role in increased abundance around water developments (Burkett and Thompson 1994).

Carnivores are not considered to require free-standing water, though many have been observed drinking from water developments. It is believed carnivores can obtain the water they need through their prey. Thermoregulation balance may be a carnivore’s most pressing need for free-standing water (Schmidt-Nielsen 1964 as cited in Rosenstock et al. 1999). It is possible carnivores are attracted to water developments primarily because of use by prey species (Rosenstock et al. 1999).

Bats

Bats are strongly attracted to water developments with open water, using them for both drinking and foraging (Rosenstock et al. 1999). As a result, bat distribution has likely expanded with water developments. Guzzlers have limited benefits to bats due to most of the water being inside storage tanks and to the small surface area of accessible water (Darby, pers. comm. 2016).

Migratory and Resident Birds

In several studies, migratory bird species have been observed using developed springs as stopover points during migration (Cutler and Morrison 1998; Rosenstock et al. 1999; Burkett and Thompson 1994), though the net population-level effects of water sources on bird species are not well understood (Rosenstock et al. 1999; Bush 2015). Springs with significant ground overflow may be more important if they support sufficient riparian vegetation. Resident birds, such as some passerines like house finches and white-crowned sparrows, are seen to heavily use water developments—primarily developed springs. Guzzlers do not likely benefit most birds because of the lack of open water and riparian vegetation. Raptors seem to benefit most, as they are frequently photographed bathing and drinking, primarily in developed springs with troughs or tanks (Darby, pers. comm. 2016).

Game Birds

Game birds include the native Gambel’s quail, mourning dove, and white-winged dove and the nonnative chukar and Eurasian collared dove. Gambel’s quail, mourning dove, and chukar are the most frequently seen birds at water sources. In a study of chukar, an introduced game bird species, Larsen et al. (2007) found that water developments located in areas with a sufficient threshold of shrub canopy cover received the most use. Mourning and white-winged doves have been shown to require surface water (Mirarchi 1993; Lewis 1993; Rosenstock et al. 1999), so any reduction in surface water could have negative consequences for those birds.

According to the *Western Quail Conservation Plan* (Zornes and Bishop 2009), Gambel's quail and chukar do not require free-standing water if succulent vegetation is available; however, in areas with frequent droughts, free-standing water becomes important. During hot and dry weather in the summer and fall, California quail typically come to water each day. Gambel's quail abundance is linked to winter precipitation and the green vegetation produced during wet years; and mortality and survival rates are primarily driven by annual variations in precipitation (Zornes and Bishop 2009).

Ungulates

Besides desert bighorn sheep (which are discussed separately), ungulates in the Preserve include mule deer and the nonnative burro. Based on literature and professional experience of wildlife managers, it is well understood that larger desert ungulate populations depend on surface water sources for survival (Bladh 2004; Bush 2015; McKee et al. 2015). Like bighorn sheep, mule deer appear to depend on free-standing water (Hervert and Krausman 1986), but this varies temporally with the hot, dry months being most important. There is also good evidence that mule deer have benefited from water developments in Arizona (Rosenstock et al. 1999), and reductions in water developments to below an unknown threshold could have negative consequences. Mule deer cannot use small game guzzlers and are not found where the big game guzzlers are located, except for Clark Mountain (which is used by mule deer) (Darby, pers. comm. 2016).

Overall Findings

Based on the above understanding of the reliance of general wildlife species on artificial water sources, the following assumptions were used in this analysis:

- All wildlife species groups are known to use springs for supplemental water or habitat. Migratory and resident birds, bats, and ungulates are not known to use small game guzzlers due to their inaccessibility or lack of open water.
- The presence of artificial water sources, such as guzzlers and developed springs, may support stopover habitat for migratory birds and localized habitat for small mammals, herpetofauna, and mule deer.
- Changes to or loss of individual water sources could negatively affect individual animals or groups in localized areas, but are less likely to affect regional population stability or species diversity; this is for both terrestrial wildlife and migratory birds.
- Changes to or loss of individual guzzlers or water sources could negatively affect individual and localized groups of introduced game birds (e.g., quail), while others would be less affected.
- Changes to or loss of small groups of water sources in the Preserve are expected to have limited effects on regional wildlife populations, considering the above points and the presence of about 450 known water sources.
- Maintenance or improvement of developed springs would benefit local wildlife, but those benefits would be proportionally small and localized and would not affect regional population stability or species diversity.

Special Status Wildlife Species

Special status species include species listed as threatened, endangered, or candidate under the Endangered Species Act (ESA); and species listed as threatened or endangered by the State of

California. Special status species known to occur or potentially occurring in the Preserve are listed in Table 16.

Table 16. Special Status Wildlife Species Potentially Occurring in the Preserve

Common Name	Scientific Name	Status	Occurrence
Arizona Bell's vireo	Vireo bellii arizonae	SE	Two nesting territories were identified at Piute Spring in 2004; current status is unknown
Bald eagle	Haliaeetus leucocephalus	SE	Have been documented near the Preserve, but presence in Preserve is not confirmed
California condor	Gymnogyps californianus	FE, SE	Historic; not present in the Preserve
Desert tortoise	Gopherus agassizii	FT, ST	Confirmed in the Preserve
Mohave tui chub	Gila bicolor mohavensis	FE, SE	Confirmed in the Preserve; occurs in MC Spring and Morningstar Mine Pit Lake
Southwestern willow flycatcher	Empidonax traillii extimus	FE, SE	Occasionally documented in riparian areas, but breeding behavior in the Preserve has not been verified*
Western yellow-billed cuckoo	Coccyzus americanus occidentalis	FT, SE	Occasionally documented in riparian areas, but breeding behavior in the Preserve has not been verified*
Willow flycatcher	Empidonax traillii	SE	Occasionally documented in riparian areas, but breeding behavior in the Preserve has not been verified*

*The limited riparian habitat in the Preserve may provide important stopover habitat during migration.
Note: FE = federally endangered, FT = federally threatened, SE = state endangered, ST = state threatened.
Sources: Johnson and Stuart 2005; PRBO 2005; Drost and Hart 2008; Persons and Nowak 2007.

The desert tortoise and Mohave tui chub are the only federally or state-listed species confirmed to reside in the Preserve year-round. These two species are discussed in detail below.

Desert Tortoise

Desert tortoises occur in the United States in the Mojave and Sonoran Deserts in Southern California, Arizona, and southern Nevada and in southwestern Utah; and in Mexico in Sonora and northern Sinaloa. Desert tortoises occur in a wide range of desert habitats from flats and slopes dominated by creosote bush to rocky slopes dominated by blackbrush and juniper woodlands and at elevations from below sea level to 7,300 feet (2,225 meters) (USFWS 2011a). In the Mojave Desert, tortoises generally occur on gently sloping sites with sparse cover of low-growing shrubs. Soils in desert tortoise habitat are predominantly sand and gravel that is soft enough for the tortoises to dig burrows, but firm enough so that burrows do not collapse (USFWS 2011a).

Desert tortoises have several adaptations for surviving in an arid environment. They spend much of their time hibernating in underground burrows where they are protected from extreme temperatures and lack of moisture (Nagy and Medica 1986). They emerge from burrows in late winter or early spring and remain active through fall. Desert tortoises are less active during summer months but may emerge after summer rain storms. During periods when they are less active, desert tortoises reduce their metabolism, reduce their water loss, and consume less food. Duda et al. (1999) found that home range size, number of different burrows used, average distance traveled per day, and levels of surface activity were significantly reduced during drought years. Tortoises reduce their surface activity and remain mostly dormant underground during drought, reducing their water loss and energy requirements (Nagy and Medica 1986; Duda et al. 1999).

Threats to desert tortoises include habitat destruction, degradation, and fragmentation from human activities such as urbanization, agriculture, livestock grazing, mining, roads, military operations, off-road vehicles, and predation by ravens and other subsidized predators (Boarman 2002). Predation by common ravens on juvenile tortoises is believed to be one of the most important threats to the desert tortoise (McIntyre 2004). Desert tortoise populations have also been adversely affected by humans collecting them as pets, for use as food, or for use in folk medicine (USFWS 1994). Desert tortoises in the western Mojave Desert also have been affected by a respiratory disease (mycoplasma), which has caused mortality and population decline (USFWS 1994).

Desert Tortoise Listing, Recovery, and Critical Habitat **–** The designated Mojave population of the desert tortoise includes those living north and west of the Colorado River (USFWS 1994). The Mojave population of the desert tortoise was listed as threatened by the USFWS and the State of California in 1990. The Recovery Plan for the Mojave Population of the Desert Tortoise was released by the USFWS in 1994 and revised in 2011 (USFWS 1994, 2011a). The 1994 Recovery Plan described a strategy for recovering the desert tortoise, which included the identification of six recovery units, recommendations for a system of Desert Wildlife Management Areas in the recovery units, and development and implementation of specific recovery actions.

Critical habitat is a term defined by the ESA that refers to areas designated by the USFWS that are essential for the conservation of threatened or endangered species and may require special management and protection. Critical habitat for the Mojave population of the desert tortoise was designated in 1994 (USFWS 1994). Two areas of designated critical habitat are present in the Preserve (see Figure 19). The first area of critical habitat includes 769 square miles in the Ivanpah Valley south of Nipton Road, including areas north, west, and south of Cima Dome in the Eastern Mojave Recovery Unit. The second area of critical habitat in the Preserve includes 438 square miles in the Fenner/Clipper Valley in the Colorado Desert Recovery Unit. Combined, the two critical habitat areas cover about 772,463 acres or 48 percent of the Preserve. Additional critical habitat occurs adjacent to the Preserve to the north on BLM land and to the south and east of the Fenner/Clipper Valley area in California and Nevada. Annual desert tortoise monitoring in 2011 estimated that about 11,000 tortoises occur in the Ivanpah Valley and about 12,000 are in the Fenner Valley (USFWS 2012).

Relationship to Water Resources **–** Adult desert tortoises can survive a year or more without access to water and can tolerate large imbalances in their water and energy budgets (Nagy and Medica 1986; Peterson 1996a, 1996b; Henen et al. 1998—all cited in USFWS 2011a). However, desert tortoises depend on the availability of free-standing water for survival (Nagy and Medica 1986; Henen 1994, 1997; Peterson 1996a, 1996b; Henen et al. 1998). Desert tortoises are reported to drink large amounts of free-standing water during and after rains (Medica et al. 1980; Nagy and Medica 1986; Peterson 1996a, 1996b; Henen et al. 1998), have been found to construct water catchments for drinking (Medica et al. 1980), and have been known to remember locations of natural water sources (Berry 1986). In drought years, access to surface water for drinking may be crucial for desert tortoise survival (Nagy and Medica 1986).

The potential for desert tortoises to drown in guzzlers has been a concern in the California desert. Hoover (1995) examined 89 small game guzzlers and found the remains of 26 desert tortoises and 1 live tortoise. It was not possible to determine whether the tortoises had died when they fell into the tanks or whether the tortoises died elsewhere and remains were washed or blown into the tanks. Most of the tortoise remains were found in tanks constructed from fiberglass rather than concrete (Hoover 1995). Hoover concluded that at least some of the tortoises had drowned in the tanks because he thought it unlikely that a desert tortoise could climb out of the fiberglass tanks. Hoover recommended installation of a roughened matt or abraded surface for tortoises to be able to have traction to escape the tank.

However, additional studies have not found that drowning in water developments or guzzlers is a substantial source of mortality for desert tortoises (Andrew et al. 2001; Rosenstock et al. 2004). Andrew et al. (2001) examined 13 wildlife guzzlers in the Sonoran Desert for signs of drowned tortoises and found no tortoise remains, but did find the remains of at least 30 individual vertebrates consisting of mammals, birds, and reptiles. Most skeletal remains found showed a high degree of breakage, consistent with predation by mammals or birds (Andrew et al. 2001), leading to speculation that many of the remains found were from pellets cast by owls or raptors or from scats deposited near guzzlers by mammalian predators and subsequently blown into the water by the wind.

Rosenstock et al. (2004) conducted more than 600 visits to wildlife water developments in southwestern Arizona from 1999 to 2003 and found 19 individual birds, mammals, and lizards dead in water tanks, presumably from drowning. They did not locate any remains of desert tortoises. They concluded that previous studies counting animal remains in water developments may have overestimated drowning events because many animals visiting guzzlers bring prey or scavenged food with them to the water source (Rosenstock et al. 2004).

Although entrapment in guzzlers may not be a substantial source of mortality for desert tortoises, most guzzlers have a ramp that allows wildlife entering the water to escape (Bleich et al. 2005). It is now standard practice to install a durable roughened (for traction) ramp in small game guzzlers to prevent desert tortoise mortality.

Mohave Tui Chub

The Mohave tui chub is the only fish native to the Mojave River basin in California. Mohave tui chub formerly inhabited deep pools and slough-like areas of the Mojave River and are well adapted to the Mojave River’s alkaline and hard water qualities. The arroyo chub was introduced into the Mojave River headwaters in the San Bernardino Mountains and first appeared in the Mojave River in the 1930s. Mohave tui chubs steadily declined following the introduction of the arroyo chub, and genetically pure Mohave tui chubs were eliminated from the Mojave River by 1970. In addition to hybridization with the arroyo chub, factors leading to the decline of the Mohave tui chub included habitat modifications resulting from dam construction, introduction of nonnative fish that prey on Mohave tui chub, and overdrafting groundwater in the Mojave River basin, which reduced the extent of aquatic habitat.

A small population of genetically pure Mohave tui chub persisted in the isolated MC Spring, located at Soda Springs on the west bank of dry Soda Lake in the Preserve. Since its rediscovery, the Mohave tui chub has been reintroduced to constructed ponds at several additional locations. Currently, five genetically pure Mohave tui chub populations exist at Soda Springs, Morningstar Mine, China Lake Naval Air Weapons Station, Camp Cady, and Lewis Center for Educational Research in Apple Valley (USFWS 2011b). All five of these sites are isolated populations in human-made habitats in the Mojave Desert.

Cultural Resources

Introduction

Since the Mojave Desert was first settled by Native Americans 8,000 to 10,000 years ago, water was the primary requirement for the establishment of long-term habitation and industry in the region. Little is known of how water was managed in the Mojave Desert by Native Americans before contact with the Spanish and Euroamericans. Water management requires systems to capture, store, and transport water. In a desert environment where water is critical, those systems have become pervasive and significant elements of the landscape and the historical record.

Legal and Policy Guidance

Cultural resources are protected under broad federal environmental regulations such as NEPA, cultural resource regulations such as the NHPA, and NPS directives and policies. Section 106 of the NHPA (1966, as amended), and its implementing regulations under 36 CFR 800, requires federal agencies to consider the potential effects on historic properties that could occur from the issuance of a permit, funding, or ground-disturbing action or undertaking. Section 106 also requires that the agency provide the Advisory Council on Historic Preservation and the SHPO an opportunity to comment on the potential effects of the undertaking on historic properties (36 CFR 800). Under this plan, historical water systems may be managed in such a way that could alter the character-defining aspects of historic properties. Therefore, the potential effects of water resource management on historic properties must be disclosed under NEPA and further evaluated for effects under Section 106 of the NHPA.

Section 110 of the NHPA requires federal agencies to inventory and evaluate all cultural resources that meet the NPS-defined 50-year age criteria for a potential historic property. Historic properties are those cultural resources that are listed or eligible for listing on the NRHP. NPS guidelines for the management of cultural resources are set forth under DO-28 (NPS 1998), which provides for the protection of cultural resources through research, planning, and stewardship.

Two other pertinent federal regulations govern the protection of cultural resources and are relevant for the current undertaking. The Archaeological Resources Protection Act (1979, as amended) prohibits unlawful excavation or disturbance of archaeological sites and permits authorized excavation. The Native American Graves Protection and Repatriation Act (NAGPRA, 1990, as amended) prohibits the disturbance of Native American unmarked graves and associated funerary items and requires the repatriation of human remains and associated funerary items to descendant groups.

Some of the general policy guidance directs the NPS to provide for the long-term preservation of, public access to, and appreciation of the features, materials, and qualities contributing to the significance of cultural resources. General approaches include:

1. preservation in their existing states;
2. rehabilitation to serve contemporary uses, consistent with their integrity and character; and
3. restoration to earlier appearances by the removal of later additions and replacement of missing elements.

The preservation of cultural resources in their existing states will always receive first consideration (NPS 2006).

Historical Context

Native American Context

The Preserve is in the Mojave Desert where numerous large-scale inventory projects have been conducted, although very little is known specifically about the prehistory of the Preserve itself. In part, these projects have defined a broad cultural chronology for the Mojave Desert that spans the last 12,000 years (Sutton et al. 2007). Between these earliest and latest Native American periods is a rich cultural history.

The many natural water sources in the Preserve are directly related to prehistoric settlement and land use patterns through time, as water was a primary component in settlement and subsistence strategies. Unlike many of their more sedentary agricultural neighbors to the east, such as the Anasazi, people in the Mojave Desert do not appear to have substantially modified their water sources or built water control features (Sutton et al. 2007).

At the time of European contact by the Spanish in 1776, California had the highest Native American population in North America, speaking more than 300 dialects. The Chemehuevi were the primary inhabitants of the eastern Mojave Desert around and in what is now the Preserve. The Chemehuevi practiced a hunter-gatherer economy centered on or tethered to the larger springs in the region. With the bow and arrow, the Chemehuevi hunted large game such as desert bighorn sheep and deer and hunted rabbits with nets (Kroeber 1925). They also gathered plants including agave, mesquite, and prickly pear. The Chemehuevi may have practiced limited horticulture or small-patch farming around springs and may have adopted flood farming along the Colorado River (Stewart 1968). Based on the limited food and water resources in the Preserve during prehistoric times, the area of the Preserve most likely did not sustain more than about 150 people (Nystrom 2003).

The Preserve is named after the Mohave people, agriculturists who farmed in the floodplain of the Colorado River and were able to produce food surpluses, which resulted in a population that numbered in the thousands. They were prolific traders and had an extensive network of trails across the desert from water source to water source. An excellent illustration of the importance of water sources to the Mohave people and other prehistoric peoples in the Mojave Desert is the Mojave Road. This network of trails, portions of which are in the Preserve, was developed by the Mohave people for trade purposes. The trails extended from water source to water source all the way to the Pacific Ocean and were the main communication and travel corridor between the Pacific Coast and the desert. The Mojave Road was eventually adapted by Euroamericans for use as a trail and wagon road, the water sources being critical for human and livestock survival in such a climatically hostile environment (Nystrom 2003).

Based on recent evaluations of springs and water features in the Preserve, 47 documented springs are believed to have prehistoric significance. These include Soda Springs, Piute Spring, Mail Spring, Eagle Well, Deer Spring, Rock Spring, Arrowweed Spring, and Vontrigger Spring.

Exploration

The first Euroamerican incursion into what is now the general area of the Preserve occurred in 1776 when Padre Francisco Garces entered the Mojave Desert. While traveling west through the desert, Garces encountered Chemehuevi people at a spring that he called Ojitos de Santa Angel somewhere around the Whipple or Monument Mountains. On his return trip through the desert, Garces encountered Chemehuevi rancherias near the Mohave Sink and the Providence Mountains (Stewart 1968). He also encountered the Mohave people on his travels. The Mohave were friendly and guided Garces through the desert on their trails. They also guided trapper Jedediah Smith in 1826 on one of his many trips through the area.

As more explorers and settlers began moving through the area, conflict erupted as early as 1827, and the Mohave were branded hostile and were avoided by Euroamerican explorers. The trail system the Mohave had shown to explorers became known as the Mojave Road. It was the basis for routes used by later explorers, settlers, and the military before construction of railroads (Nystrom 2003). The 1854 American expedition led by Lt. A. W. Whipple crossed the Preserve through the Lanfair Valley. Evidence suggests the 1776 Garces Expedition may have traversed the Preserve as well, but it is not known exactly where.

Each expedition noted the abundance of grass and the potential for livestock grazing. By 1864, military drovers were routinely crossing the Mojave Desert with livestock to supply Fort Mojave and other points further west, making routine stops at Marl and Rock Springs for water and pasture. The first motivation to settle and graze livestock over the vast expanse of the eastern Mojave Desert was to supply meat and hides to prospectors, miners, and the military. With the arrival of the Southern Pacific Railroad in 1883, the scale of cattle ranching in the region expanded with a reliable transportation network. The acquisition of water rights and construction of water management and distribution systems developed concurrently to meet the needs of the cattle ranching industry.

Historic Water Use

Historic habitation and land use depended on the same water sources that Native Americans had been using for thousands of years. Many of the natural water sources (springs and seeps) were modified, and new water sources were established to accommodate expanding human habitation and industries such as ranching and mining. Modifications of these seeps and springs include tunneling, hand-dug wells, drilled wells, dams in drainage channels, excavated earthen catchments and reservoirs, and pipelines (NPS 2005b). Development of these features is directly responsible for the proliferation and long-term success of ranching in the Preserve. The relative importance of these ranching operations has been demonstrated by their inclusion in or eligibility for listing on the NRHP as part of various historic districts. Water resources are important contributing components to the ongoing existence of these districts.

Mining. The first successful mining in what would be the Preserve began in the 1860s, after a few earlier attempts by Mexicans in the area and soldiers at Fort Mojave. Perhaps the most well-known mine in the area before the turn of the century was the Bonanza King Mine, established in 1880.

From the turn of the century to World War I, mining developed in the Vanderbilt area, New York Mountains, and Ivanpah Valley. Some of the mines developed in the Preserve during this period include the Copper World, the Von Trigger (later the California) Mine, and the Paymaster Mine. After a lull in mining following World War I, the Great Depression sparked an increase in gold mining, especially in the Mojave Desert. The Colosseum Mine and Telegraph Mine were two of the mines in the Preserve that were actively mined during the Great Depression.

World War II facilitated a shift in mining throughout the country, including in the Mojave Desert. Industrial metals, rather than precious metals, became sought after. The need for wartime materials again sparked an uptick in Mojave Desert mining. Copper, tin, and tungsten were among the materials important to the war effort found within the area that would become the Preserve. The Evening Star Mine produced tin and tungsten. The Vulcan Mine, which operated until 1948, produced iron ore for the Kaiser steel plant in Fontana, California (Life Magazine 1943).

In the decades between World War II and 1994 (when the Preserve was created), mining activities continued in some form. The Aiken and Cima Cinder Mines focused on salable materials and operated from 1948 through the 1990s. Due to advances in gold recovery, the

Colosseum Mine and Morningstar Mine were both reopened, using cyanide leach treatments to recover microscopic amounts of gold from discarded tailings. Other nearby mines continued operating or reopened and were purposefully excluded from the Preserve because of their active status.

The legacy of this mining history with respect to water resources was the creation or development of numerous water features in the Preserve. The development of adits and tunnels for underground mining activities often resulted in the development of water features. Examples of springs associated with mining activities include Adam Anna Ore Mine Spring, Big Hunch Mine Spring, Black Bird Mine Spring, Bronze Mine Spring, Columbia Mine Spring, Howe Spring Mine Shaft, Negro Mine Spring, and Sagamore Mine Spring. Mine pits resulting from the surface excavation of minerals at the Colosseum Mine (located on private land) and Morningstar Mine have since created pit lakes, which are the largest surface water bodies in the Preserve and surrounding area.

Ranching. Ranching in an environment such as the Mojave Desert is especially dependent on and integrally tied to water. Many of the water sources in the Preserve have been used by wildlife, humans, and livestock. Much of the ranching history is associated with these water sources. The significance of water development by ranches such as the Rock Springs Land and Cattle Company, Kessler Springs Ranch, OX Ranch, and Valley View Ranch was acknowledged in the 2007 NPS Rock Springs Land and Cattle Company Cultural Landscape Study (NPS 2007a). The labor-intensive enterprise of ranching required harnessing water resources from every available source using wells, springs, pipelines, and storage tanks and distributing it across a vast area in an efficient manner (NPS 2007b).

Before formal ranching activities around what would later become the Preserve, grazing livestock was common by many who traversed the area (Nystrom 2003). Following the population growth brought by the California and Nevada mining boom of the 1870s–1880s, the first ranches within the boundaries of the Preserve (Blackburn and Briggs) were established about 1875 at Marl Springs and at Government Holes. In the 1880s, additional ranches were established near the Bonanza King Mine near what is now Kessler Springs.

In 1894, Blackburn and Briggs merged their holdings and formed the Rock Springs Land and Cattle Company, which was headquartered at Barnwell, the northern terminus of the Nevada Southern Railway. Grazing occurred on unfenced federally owned public land, and cattle were transported from the railroad terminal at Barnwell to market. Control of water rights was a major component of the ranch’s overall strategy to control the area. They made aggressive and strategic moves to trade or buy water rights throughout the entire area, which allowed them to graze as many as 10,000 cattle on their 50-square-mile range. In fact, these ranches used surrounding federal land as their own land and only held genuine title to land around water sources, indicating the relative value of the watering holes (Nystrom 2003). By 1916, water pipelines from sources at Barnwell, Kessler Springs, and Hackberry Springs transported water to tanks and troughs spread across the range. The company built several distinctive permanent circular concrete troughs or placed moveable galvanized metal troughs at dozens of locations. More than 40 springs and 12 wells provided water for the expanding herds (NPS 2007b).

The monopoly on water held by the ranch caused conflict with surrounding homesteaders who were able to stake claims in prime grazing land in places like Lanfair Valley, but did not have access to water except for a few public sources, making it hard to grow crops. Most homesteaders eventually left due to economic and environmental circumstances. Others were driven from the Rock Spring area of influence after a bloody shootout at Government Holes in 1925.

Substantial changes to ranching in the Preserve came in the 1900s. The first change was a massive drought that struck in 1928, resulting in the death of thousands of cattle. Eventually, the Rock Springs Land and Cattle Company buckled under the hardship caused by drought and was sold piecemeal. Much of the former million-acre ranch was absorbed by other surrounding and new ranching interests. Three major ranches resulted from the dissolution, including the OX Ranch (400,000 acres), Kessler Springs Ranch (300,000 acres), and Valley View Ranch (300,000 acres) (BLM 2010). These ranches successfully navigated the second substantial change during this period—the Taylor Grazing Act of 1934, which required clear delineation and fencing of federally owned rangelands, thus enforcing the payment of fees for ranchers to graze livestock on federally owned public lands.

One major consequence of the Taylor Grazing Act was the development of numerous new water sources within the area that is now the Preserve. As ranches downsized, established water sources may have been isolated by new property lines and fences. As a result, individual ranchers had to develop new water sources on federally owned and private lands to support their livestock and minimize stress on the already established sources. Between the 1940s and creation of the Preserve in 1994, the various ranches continued to make improvements including constructing corrals, fences, and pipelines. Many of the ranches changed ownership or passed on operational control to family members or friends as years went by. By 1986, much of the land in the area that would become the Preserve would come under ownership or operational control of the Overson Family.

Maintenance and development of water sources and the accompanying infrastructure has allowed successful long-term ranching, which is important to the history of the Preserve and region. Developed water features and distribution methods allowed historic ranching to succeed and be sustained through modern times. Without such features, ranching operations would have been much more limited and overgrazing around a small number of springs and seeps more severe. An exhaustive list of small-scale water features can be found in the Rock Springs Land and Cattle Company Cultural Landscape Study (NPS 2007a). Many of the water development features are listed as significant contributing features to the NRHP-eligible cultural landscape district.

Documented Cultural Resources

The Preserve has a rich cultural heritage spanning both prehistoric and historic eras. This heritage is reflected in the many listed and potential NRHP sites, districts, and cultural landscapes that make up the cultural fabric of the Preserve. The Preserve's GMP (NPS 2002), the NRHP Focus database, and the NPS's Cultural Landscapes website have identified both individual properties and potential districts that have been listed or are eligible for listing on the NRHP.

Sites and districts in the Preserve that are currently listed on or found eligible for listing on the NRHP include:

- Aikens Wash National Register District
- Piute Pass Archaeological District
- Mojave Road
- Kelso Depot
- Rock Springs Land and Cattle Company
- Soda Springs Historic District
- Vulcan Mine Historic District
- Lanfair Butte
- Providence Townsite

Two additional NRHP-listed cultural landscapes fall within the confines of the Preserve or pass through it, but are not managed by the Preserve: the Union Pacific Los Angeles to Salt Lake City Line (landscape) and the Boulder Transmission Line (landscape).

In addition to the sites and districts listed above, the following cultural landscapes/historic districts and sites have been identified by the Preserve as being potentially eligible for listing on the NRHP (NPS 2002):

- Rock House (site)
- Marl Spring (site)
- Rock Spring (site)
- New York Hills Historic District (1890s landscape)
- Death Valley Mine (landscape)
- Vanderbilt Site (component)
- Foshay Pass (feature)
- Macedonia Mining District (landscape)
- Rock Spring/Government Holes (component)
- Ivanpah Historic District (landscape)
- Ivanpah (component)
- Clark Mountain Mining District (landscape)
- General Patton's Desert Training Center (Camp Essex) (landscape)
- Lanfair Valley (landscape)

A more recent NPS staff review of water features in the Preserve has identified 85 spring developments that are considered historic. Of these 85 developments, 47 were identified to have prehistoric significance. These sites, and the general nature of the development infrastructure at these sites, are described in greater detail in the "Water Resources" section of this chapter.

Wilderness Character

The 1994 CDPA, which established the Preserve, also designated nearly half of the land area in the Preserve (804,949 acres) as wilderness (Figure 20). The NPS manages the "Mojave Wilderness" in accordance with the 1964 Wilderness Act, the CDPA, NPS *Management Policies 2006*, and DO-41 – Wilderness Stewardship. The Mojave Wilderness is bordered by the BLM's Kelso Dunes Wilderness Area and Bristol Mountains Wilderness Area to the west. The amount and density of public use in the wilderness is low, and there is no permit or registration system for wilderness access or camping in the Preserve. A wilderness stewardship plan has not been completed for the Preserve.

The Wilderness Act PL 88-577 (16 USC 1131-1136) states that "each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area and shall so administer such area for such other purposes for which it may have been established as also to preserve its *wilderness character*" and that "wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use." Wilderness character is defined by four qualities that the NPS uses in wilderness planning, stewardship, and monitoring:

- *Untrammeled* – Wilderness is essentially unhindered and free from modern human control or manipulation. Purposeful actions that manipulate the biophysical environment affect the untrammeled quality of wilderness.
- *Natural* – Ecosystems in wilderness are substantially free from the effects of modern civilization. Impacts on plant and animal species and communities, physical resources, or biophysical processes affect the natural quality of wilderness.
- *Undeveloped* – Wilderness is without permanent improvements or human habitation. The presence of structures, installations, or developments and the use of motor vehicles, motorized equipment, or mechanical transport affect the undeveloped quality of wilderness.
- *Opportunity for Solitude or Primitive and Unconfined Recreation* – Sights and sounds of people inside wilderness, sights and sounds of occupied or modified areas outside

wilderness, facilities that decrease self-reliant recreation, and management restrictions on visitor behavior affect the quality of wilderness as a place with opportunities for solitude or primitive and unconfined recreation.

Water Resources in Wilderness

Most of the water resources that are described in this plan are located in wilderness, including 75 percent of the documented springs, nearly half of the small game guzzlers, and all six of the big game guzzlers. Although the wilderness boundaries were drawn to allow access to some known water sources for ranching (“cherry-stemmed”), many are in designated wilderness. This presents a dilemma for both water resources management and policy compliance, as most of these water sources provide some element of habitat for wildlife, and many require routine maintenance to ensure their effectiveness and safety. However, the existence of developed water features and the mechanized access and tools used for their maintenance are only permitted if they are necessary to meet minimum requirements for the administration of the area for wilderness purposes. While conservation and recreation are purposes of wilderness, and some guzzlers may help preserve some qualities of wilderness character (e.g., the “natural” quality associated with wildlife), the presence of structures and the use of motorized vehicles or equipment to maintain water structures may adversely affect other qualities of wilderness character (e.g., “undeveloped” and “untrammeled” qualities).

Mojave Wilderness Qualities

The NPS has not completed a wilderness character baseline of the Preserve or a wilderness stewardship plan. However, the 2013 Foundation Document includes the following statements about wilderness in the Preserve: “In Mojave Wilderness, natural processes are unrestrained and direct human impacts on the rich biodiversity so critical to the area’s ecological health are minimized” and “part of the Mojave Wilderness contributes to solitude, provides a refuge from urban areas and nearby developments, [and] contributes to scenic viewsheds” (NPS 2013b). Because of a long history of human use and development, the Mojave Wilderness is not devoid of human disturbance.