Mojave Population of the Desert Tortoise
(Gopherus agassizii)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Desert Tortoise Recovery Office
Reno, Nevada

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5-YEAR REVIEW

Mojave Population of the Desert Tortoise (*Gopherus agassizii*)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species and focus on new information since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

As summarized from the listing rule (USFWS 1990), Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994a), and the draft Revised Recovery Plan for the Mojave Population of the Desert Tortoise (USFWS 2008), the desert tortoise is a large, long-lived, herbivorous reptile that occurs in the Mojave and Sonoran deserts in southern California, southern Nevada, Arizona, and southwestern Utah in the U.S., as well as Sonora and northern Sinaloa in Mexico. Female desert tortoises have long-term home ranges that may be as little or less than half that of the average male, which can range to 80 or more hectares (200 acres) (Burge 1977; Berry 1986a; Duda *et al*. 1999; Harless *et al*. 2009) depending on the location and environmental conditions in any given year (Berry 1986a). The species occupies a variety of habitats from flats and slopes within creosote bush scrub dominated by *Larrea tridentata* (creosote bush) and *Ambrosia dumosa* (white bursage) at lower elevations to rocky slopes in blackbrush scrub and juniper woodland ecotones (transition zone) at higher elevations (Germano *et al.* 1994). The most favorable habitat for desert tortoises is thought to occur at elevations of approximately 305 to 914 meters (1,000 to 3,000 feet) (Luckenbach 1982); however, records of desert tortoises range from below sea level to an elevation of 2,225 meters (7,300 feet) (Luckenbach 1982; USFWS 2006a; USFWS unpubl. data 2007). Typical habitat for the desert tortoise in the Mojave Desert has been characterized as creosote bush scrub below 1,677 meters (5,500 feet) in which precipitation ranges from 5 to 20 centimeters (2 to 8 inches), where a diversity of perennial plants is relatively high, and production of ephemerals is high (Luckenbach 1982; Turner 1982; Turner and Brown 1982; Bury *et al*. 1994; Germano *et al.* 1994). Tortoises can live over 50 years in the wild and grow slowly, requiring 13 to 20 years to reach sexual maturity, and have low reproductive rates during a long period of reproductive potential (Turner *et al.* 1984; Bury 1987; Germano 1994).

Methodology Used to Complete This Review:
This review was prepared by the Desert Tortoise Recovery Office, following the Region 8 guidance issued in March 2008. We used information from the original listing rule (USFWS 1990), 1994 Recovery Plan (USFWS 1994a), the 2008 draft Revised Recovery Plan (USFWS 2008), data compiled in the development of a spatial decision support system as recommended by the 2008 draft Revised Recovery Plan, and survey information and research results from published literature by experts who have been monitoring and studying various aspects of this species. These sources together with personal communications with experts were our primary sources of information used to update the species' status and threats. One letter was received in response to our Federal Register notice initiating this 5-year review regarding the importance of considering the potential impact of drought, other global warming changes in precipitation, as well as other global warming induced changes on the species. This 5-year review contains updated information on the species' biology and threats and an assessment of that information compared to that known at the time of listing. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all of this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

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Federal Register (FR) Notice Citation Announcing Initiation of This Review:
A notice of review announcing initiation of the 5-year review of this species and the opening of a 60-day information request period was published in the Federal Register on March 5, 2008 (USFWS 2008a). One letter was received from the State of California Attorney General's Office requesting that the Service consider the potential impact of drought, other global warming changes in precipitation, as well as other global warming induced changes on the species when conducting our 5-year reviews. These concerns are discussed under Factor E.

Listing History:
<u>Original Listing</u>
FR Notice: Federal Register 45:55654-55666
Date of Final Listing Rule: August 20, 1980
Entity Listed: Beaver Dam Slope population of the desert tortoise in Utah
Classification: Threatened with Critical Habitat

<u>Revised Listing</u>
FR Notice: Federal Register 54:32326-32331
Date Listed: August 4, 1989
Entity Listed: Mojave population of desert tortoise
Classification: Emergency listing as endangered

No emergency action was taken under this rule to reclassify the Beaver Dam Slope subpopulation in Utah as endangered because it was already protected under the Act (USFWS 1980).

Revised Listing
FR Notice: Federal Register 55:12178-12191
Date Listed: April 2, 1990
Entity Listed: Mojave population of desert tortoise
Classification: Threatened

State Listing
The desert tortoise was listed by the State of California as threatened in 1989, although state laws have been in place since 1939 to protect the species.

In Arizona, desert tortoises are protected under the Arizona Revised Statutes Title 17 laws and the Reptile and Amphibian Regulations, under which it has been unlawful to collect this species since 1988.

In Nevada, the desert tortoise is protected under the Nevada Administrative Code 503.080, wherein the species was listed as a State protected reptile in 1969 and was further classified as threatened in 1991. Collection has been prohibited under section 503.093 since 1991.

Desert tortoises are listed as State endangered in Utah, where collection and importation have been prohibited since 1987. The species is protected under the Utah Division of Wildlife Resources Administrative Rule R657-53.

Associated Rulemakings:
Similarity of appearance
FR Notice: Federal Register 55:12178-12191
Date Listed: April 2, 1990
Entity Listed: Sonoran population of desert tortoise found outside its natural range in Arizona (south and east of the Colorado River) and Mexico
Classification: Threatened

Proposed determination of Critical Habitat
FR Notice: Federal Register 58:45748-45768
Date: August 30, 1993

Determination of Critical Habitat
FR Notice: Federal Register 59:5820-5866
Date: August 8, 1994

Critical Habitat was designated on over 6,000,000 acres (2,428,114 hectares) in portions of the Mojave and Colorado deserts. The Colorado Desert is a subdivision of the Sonoran Desert and is located in California west of the Colorado River. This designation includes primarily Federal lands in southwestern Utah, northwestern Arizona, southern Nevada, and southern California (USFWS 1994b).

Review History:
No previous 5-year reviews have been completed for this species.

Species' Recovery Priority Number at Start of 5-Year Review:
The recovery priority number for the desert tortoise is 12C according to the 2009 Recovery Data Call for the Nevada Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that the taxon is a species that faces a moderate degree of threat and has a low potential for recovery. The "C" indicates conflict with construction or other development projects or other forms of economic activity.

Recovery Plan or Outline
Name of Plan or Outline: Draft Revised Recovery Plan for the Mojave Population of the Desert Tortoise (*Gopherus agassizii*)
Date Issued: August 4, 2008
Dates of Previous Revisions: June 28, 1994

Comments received following publication of the public review draft are now being incorporated into the Revised Recovery Plan, after which a final Revised Recovery Plan will be published.

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy

The Act defines "species" as including any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate wildlife. This definition of species under the Act limits listing as distinct population segments to species of vertebrate fish or wildlife. The 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Act (61 FR 4722, February 7, 1996) clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act.

The Mojave population of the desert tortoise (all tortoises north and west of the Colorado River in Arizona, Utah, Nevada, and California) was listed as Threatened on April 2, 1990, prior to the 1996 DPS policy. Because the Mojave population of the desert tortoise was listed prior to the DPS policy, below we apply the 1996 DPS policy to this population. The assessment below applies the term "Mojave" tortoises as in the listing rule and the term "Sonoran" tortoises to all tortoises south and east of the Colorado River.

Two elements are considered in a decision regarding the status of a possible DPS as endangered or threatened under the Act, prior to evaluating the conservation status of that DPS:

1. Discreteness of the population segment in relation to the remainder of the species to which it belongs, and
2. The significance of the population segment to the species to which it belongs.

<u>Discreteness</u>
A population segment of a vertebrate species may be considered discrete if it satisfies either one of the following conditions:

- It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation.
- It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist. This condition is not applicable to the Mojave population of the desert tortoise and will not be considered further.

Major differences exist between the listed Mojave population of the desert tortoise and tortoises in the rest of the range, which are physically separated from each other by the Colorado River (USFWS 1990; Berry *et al*. 2002; Tracy *et al*. 2004).

Recognizably different shell morphology exists between populations east and west of the Colorado River. Mojave tortoises are generally wider, more domed, and with longer gular scutes (the front part of a tortoise's lower shell that extends below the throat), among other differences, than Sonoran tortoises (Weinstein and Berry 1987; Germano 1993; McLuckie *et al.* 1999).

Mojave tortoises lay up to 3 clutches (set of eggs laid at a single time) of eggs per year (Turner *et al.* 1984, 1986; Henen 1994; Karl 1998; Mueller *et al.* 1998; Wallis *et al.* 1999; McLuckie and Fridell 2002), while Sonoran tortoises lay a maximum of a single clutch per year (Averill-Murray 2002b; Averill-Murray *et al.* 2002). Mojave tortoises begin producing eggs at smaller sizes than Sonoran tortoises (Germano 1994; Karl 1998; Averill-Murray 2002b), and Mojave tortoises produce larger eggs relative to their body size than do Sonoran tortoises (Wallis *et al.* 1999; Averill-Murray 2002b).

Analyses of mitochondrial DNA have shown appreciable genetic divergence between the Mojave and Sonoran populations (Lamb *et al*. 1989; Lamb and McLuckie 2002; Murphy *et al*. 2007). These differences are significantly higher than those reported for any other turtle species and suggest that *Gopherus agassizii* is composed of more than one species (Lamb and McLuckie 2002; Murphy *et al.* 2007). The Mojave and Sonoran lineages diverged about 5 million years ago, about which time the area of the present-day lower Colorado River was first inundated (Lamb and McLuckie 2002).

This genetic divergence, along with the physical separation from the Sonoran population and morphological and physiological differences between the Mojave and Sonoran tortoises, qualify the Mojave population of the desert tortoise as discrete according to the 1996 DPS policy.

<u>Significance</u>

Under our 1996 DPS policy, once we have determined that a population segment is discrete, we consider its biological and ecological significance to the larger taxon to which it belongs The DPS policy states that a species' population can be considered significant based on factors that may include, but are not limited to:

- Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon;
- Evidence that loss of the discrete population segment would result in a significant gap in the range of a taxon;
- Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range (this factor does not apply to the Mojave population of the desert tortoise and will not be considered further); or
- Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

We have found substantial evidence that at least two of these significance factors are met by the Mojave population of the desert tortoise. The range of the Mojave population constitutes approximately 1/3 of the entire species' range, indicating that its loss would result in a significant gap in the range. In addition, as described above, genetic analyses show a level of genetic divergence between the Mojave and Sonoran populations that suggest that the populations actually may be separate species. Therefore, the Mojave population of the desert tortoise is significant according to the 1996 DPS policy.

<u>Currently Listed Population is a DPS</u>

As a result of this assessment, we consider the currently listed Mojave population of the desert tortoise to be a valid distinct population segment under the 1996 DPS policy. This population of tortoises is discrete based on physical separation from the Sonoran population by the Colorado River and based on physiological, morphological, and genetic differences between Mojave tortoises and Sonoran tortoises. The Mojave population of the desert tortoise is also considered significant in accordance with the criteria of the DPS policy, as the loss of this distinct population segment would result in a significant gap in the range (*i.e.*, a significant contraction of the range) of the taxon and the loss of unique genetic characteristics that are significant to the taxon as it is currently recognized.

Black Mountains, Arizona, Tortoises: A local population of tortoises with a Mojave genotype (that also share Mojave phenotype and habitat-use characteristics with the Mojave population) occurs within the unlisted Sonoran population east of the Colorado River in the Black Mountains near Kingman, Arizona (McLuckie *et al.* 1999). This population may have become isolated from the rest of the Mojave population as a result of natural dispersal north of the initial inundation, by floating across the inundation, by river meander separating the population from those now on the west side of the river, or by human transport (McLuckie *et al.* 1999). Allele frequencies in hybrids from the area indicate that admixture between Sonoran and Mojave tortoises has only occurred recently relative to the evolutionary history of the two populations. This suggests potential human influence (Edwards *et al.* 2006). However, the geographic extent of the Mojave-genotype, Black Mountains population is currently undefined. Further research is needed to clarify the boundaries of this population in order to appropriately assess it relative to the DPS policy.

<u>Does the Mojave DPS include Multiple DPSs?</u>

The notion that the Mojave DPS of the desert tortoise may be comprised of multiple DPSs has been a source of confusion. The confusion stems from two primary sources. First, the 1994 Recovery Plan, which was written prior to the 1996 DPS policy, described the initial recovery units as “distinct population segments” (DPSs). However, recovery units are not equivalent to DPSs. Recovery units are tools used to identify geographic units that are individually necessary to conserve the diversity necessary for long-term sustainability of the entire listed population. Recovery units are not equivalent to DPSs which have been identified in a formal rule-making process, nor are they determined by application of the 1996 DPS policy. Second, a recent population genetic analysis concluded that the recovery units described in the 1994 Recovery Plan, with further subdivision in the western Mojave Desert, qualify as DPSs: Upper Virgin River, Northeastern Mojave, Eastern Mojave, Northern Colorado, Eastern Colorado, and the former Western Mojave divided into the Central Mojave, Southern Mojave, and Western Mojave (Murphy *et al.* 2007). We discuss below why we do not consider smaller segments of the Mojave population of the desert tortoise to be DPSs.

Discreteness: In the absence of an international boundary, DPSs are considered discrete when they are markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation. The Mojave population is distinct from Sonoran tortoises based on physical separation as well as on physiological, morphological and genetic differences. We do not find evidence of marked separation in these characteristics among desert tortoises within the Mojave population.

First, major geographic discontinuities (such as the Colorado River) are not apparent within the range of the Mojave population. Desert tortoise habitat and populations are generally continuously distributed, especially relative to the more fragmented habitat occupied by the Sonoran population (Figure 1; see also Germano *et al*. 1994). Murphy *et al.* (2007) hypothesize that the Mojave River physically separated their "Southern Mojave" DPS from adjacent population segments to the north. However, Mojave River flows have fluctuated throughout the Holocene Period with only the largest floods reaching the lower river stretches (Enzel *et al*. 2003), suggesting opportunities for both historic and contemporary movement and gene exchange across this area. Landscape genetic data (see below) further support a conclusion that the Mojave River does not constitute a substantial population separation.

Second, variable foraging and activity patterns and life history characteristics correspond to a gradation in precipitation and food availability across the Mojave and Colorado deserts (USFWS 2008). Differences in reproduction throughout the Mojave population (as described in Wallis *et al.* 1999, Germano 1994, and Mueller *et al.* 1998) are probably related to the general gradation in environment across the range, rather than the fundamental difference in reproductive strategy compared to the Sonoran population previously described. As such, these differences do not constitute a marked separation in behavioral or physiological characteristics.

Third, all recent genetic studies of the desert tortoise have concluded that its population structure is characterized by isolation-by-distance (Britten *et al*. 1997; Murphy *et al*. 2007; Hagerty 2008; Hagerty and Tracy 2010). That is, populations at the farthest extremes of the distribution are the most differentiated, but a gradient of genetic differentiation occurs between those populations across the range of the species. This genetic gradient is similar to the ecological gradient across the Mojave and Colorado deserts, themselves. Recent genetic work also suggests that, historically, levels of gene flow among subpopulations were likely high, corresponding to high levels of connectivity among habitat types (Murphy *et al.* 2007; Hagerty 2008). The capability for long-distance dispersal (Berry 1986a; Edwards *et al*. 2004a), combined with longevity and opportunities to reproduce annually throughout adulthood, indicates high potential for gene exchange outside of local areas.

Based on the relatively continuous distribution of habitat occupied by the Mojave population of the desert tortoise (Figure 1; see also Germano *et al.* 1994), genetic differentiation within the Mojave population is consistent with a continuous-distribution model of gene flow. The continuous-distribution model of gene flow describes a situation in which populations of a particular neighborhood size could be identified anywhere, and individuals inside those

Figure 1. Distribution of habitat for the Mojave population of the desert tortoise (from Nussear *et al.* 2009).

neighborhoods would represent a panmictic (randomly mating) group (Allendorf and Luikart 2007:209-211). Population subunits defined in Murphy *et al.* (2007) result from this neighborhood effect. The sampling regime used by Murphy *et al.* had been previously criticized (Berry *et al.* 2002) as inadequate in determining critical population boundaries because the samples were taken from existing study plots established for monitoring population status and trends, for conducting research on health and disease, or established for a limited project, rather than spanning the entire range of the species. To describe genetic relationships within species, particularly boundaries between divergent units, methods require analysis of many individuals sampled across relatively evenly spaced locations to avoid wrongly inferring genetic discontinuities between disjunct sampling locations (Pritchard *et al*. 2000; Allendorf and Luikart 2007:400). Such an assessment of gene flow among subunits of the Mojave DPS revealed broad patterns of migration interrupted by major topographic barriers, such as the Spring Mountains in Nevada (Hagerty 2008). These patterns, combined with a lack of marked separation based on other factors (such as morphology and physiology), lead to the conclusion that subunits of the Mojave DPS do not themselves qualify as being discrete under the DPS policy.

Significance: Per the DPS policy, the significance of a population is considered if it is found to be discrete. We have not identified discrete segments within the Mojave population of the desert tortoise. Therefore, the significance criterion is not relevant.Summer temperatures are typically a few degrees cooler, except in the lowest elevations of Death Valley, than in areas to the south and west.

Conclusion: Individual subunits of the Mojave DPS do not qualify as distinct population segments under the 1996 DPS policy. Habitat occupied by the Mojave DPS is relatively continuously distributed, and genetic differentiation within the DPS is consistent with isolation by distance in a continuous-distribution model of gene flow. In addition, observed variation in behavioral and physiological characteristics across the DPS are likely related to the transitional nature of, or environmental gradations between, the described subdivisions of the Mojave and Colorado deserts. These factors disqualify subunits of the Mojave DPS according to the discreteness criterion of the policy.

Information on the Species and its Status

Species Biology and Life History

The desert tortoise is a large, herbivorous reptile that reaches 20 to 38 centimeters (8 to 15 inches) in carapace (upper shell) length and 10 to 15 centimeters (4 to 6 inches) in shell height. Hatchlings emerge from eggs at about 5 centimeters (2 inches) in length. Adults have a domed carapace and relatively flat, unhinged plastrons (lower shell). Their shells are greenish-tan to dark brown in color with tan scute (horny plate on the shell) centers. Adult desert tortoises weigh 3.6 to 6.8 kilograms (8 to 15 pounds). The forelimbs have heavy, claw-like scales and are flattened for digging. Hind limbs are more elephantine (Ernst *et al.* 1994).

Desert tortoises are well adapted to living in a highly variable and often harsh desert environment. They spend much of their lives in burrows, even during their seasons of activity. In late winter or early spring, they emerge from over-wintering burrows and typically remain active through fall. Activity does decrease in summer, but tortoises often emerge after summer rain storms to drink (Henen *et al.* 1998). Mating occurs both during spring and fall (Black 1976; Rostal *et al.* 1994). During activity periods, desert tortoises eat a wide variety of herbaceous vegetation, particularly grasses and the flowers of annual plants (Berry 1974; Luckenbach 1982; Esque 1994). During periods of inactivity, they reduce their metabolism and water loss and consume very little food. Adult desert tortoises lose water at such a slow rate that they can survive for more than a year without access to free water of any kind and can apparently tolerate large imbalances in their water and energy budgets (Nagy and Medica 1986; Peterson 1996a,b; Henen *et al.* 1998).

In drought years, the availability of surface water following rains may be crucial for desert tortoise survival (Nagy and Medica 1986). During these unfavorable periods, desert tortoises decrease surface activity and remain mostly inactive or dormant underground (Duda *et al.* 1999), which reduces water loss and minimizes energy expenditures (Nagy and Medica 1986). Duda *et al.* (1999) showed that home range size, number of different burrows used, average distances traveled per day, and levels of surface activity were significantly reduced during drought years.

The size of desert tortoise home ranges varies with respect to location and year (Berry 1986a) and also serves as an indicator of resource availability and opportunity for reproduction and social interactions (O'Connor *et al.* 1994). Females have long-term home ranges that may be as little or less than half that of the average male, which can range to 80 or more hectares (200 acres) (Burge 1977; Berry 1986a; Duda *et al*. 1999; Harless *et al*. 2009). Core areas used within tortoises' larger home ranges depend on the number of burrows used within those areas (Harless *et al*. 2009). Over its lifetime, each desert tortoise may use more than 3.9 square kilometers (1.5 square miles) of habitat and may make periodic forays of more than 11 kilometers (7 miles) at a time (Berry 1986a).

Tortoises are long-lived and grow slowly, requiring 13 to 20 years to reach sexual maturity, and have low reproductive rates during a long period of reproductive potential (Turner *et al.* 1984; Bury 1987; Germano 1994). Growth rates are greater in wet years with higher annual plant production (*e.g.*, desert tortoises grew an average of 12.3 millimeters [0.5 inch] in an El Niño year compared to 1.8 millimeters [0.07 inches] in a drought year in Rock Valley, Nevada; Medica *et al*. 1975). The number of eggs as well as the number of clutches that a female desert tortoise can produce in a season is dependent on a variety of factors including environment, habitat, availability of forage and drinking water, and physiological condition (Turner *et al.* 1986, 1987; Henen 1997; McLuckie and Fridell 2002). The success rate of clutches has proven difficult to measure, but predation, while highly variable (Bjurlin and Bissonette 2004), appears to play an important role in clutch failure (Germano 1994).

The most complete account of the biology, ecology, and natural history of a population of desert tortoises is that of Woodbury and Hardy (1948), wherein details regarding reproduction, growth and development, longevity, food habits, behavior, movement patterns, and general adaptations to desert conditions are provided for a population on the Beaver Dam Slope of Utah. These characteristics of tortoises do vary with changes in habitat and environment, and further information on the range, biology, and ecology of the desert tortoise is available in Bury and Germano (1994), Ernst *et al.* (1994), Luckenbach (1982), Van Devender (2002), and collected papers in Chelonian Conservation and Biology (2002, Vol. 4, No. 2), Herpetological Monographs (1994, No. 8), and the Desert Tortoise Council Proceedings.

Spatial Distribution

The designated Mojave population of the desert tortoise includes those animals living north and west of the Colorado River in the Mojave Desert of California, Nevada, Arizona, and southwestern Utah, and in the Sonoran (Colorado) Desert in California (USFWS 1990; USFWS 1994a) (Figure 2). At the time of listing, we thought that desert tortoise populations had been nearly extirpated from large portions of the western and northern portions of their geographic range in California (*e.g.*, Antelope, Indian Wells, and Searles valleys) (USFWS 1990; USFWS 1994a). At the current time, scattered desert tortoises remain in portions of Antelope, Indian Wells, and Searles valleys that have not been developed for industrial, residential, agricultural, or commercial uses.

The desert tortoise's range, outside the listed Mojave population, extends into the Sonoran Desert, where tortoises occur in the lower Colorado River Valley, Arizona uplands, plains of Sonora, and the central Gulf Coast; the species has not been documented in northeastern Baja California (Figure 2) (Germano *et al.* 1994). As in the Mojave Desert, *Larrea tridentata* (creosote bush) is a dominant species in areas occupied by tortoises, although this dominance is tempered by the relatively high abundance of several tree species (Turner and Brown 1982; Germano *et al.* 1994). In the Sonoran Desert, tortoises tend to inhabit bajadas (slope at the base of a mountain) and steep, rocky slopes and are not common in the valleys (Germano 1994; Van Devender 2002; Averill-Murray and Averill-Murray 2005). Desert tortoises are also found in the Sinaloan thornscrub, which is a transitional habitat between the Sonoran Desert and Sinaloan deciduous forest where the vegetation is dominated by drought-resistant shrubs and deciduous trees. The Sinaloan deciduous forests are differentiated from the thornscrub by taller plants with larger leaves and fewer thorny or succulent species (Germano *et al.* 1994; Fritts and Jennings 1994).

Abundance

Long-term Study Plots: Range-wide, thirty-one long-term study plots were in place when the desert tortoise was first listed under the Act (Tracy *et al.* 2004). The first long-term plot using 60-day mark-recapture estimation was established in 1976 and 1977 in California, but this technique was not implemented until later in Nevada and Utah (1981) and Arizona (1987). Because of the level of effort required, plots were resurveyed only every several years. While a substantial body of data has been collected from surveys of the original long-term study plots over the years, plot placement in non-representative (non-random) areas across the range is generally regarded as a factor limiting demographic and trend conclusions to only those specific areas. By the time

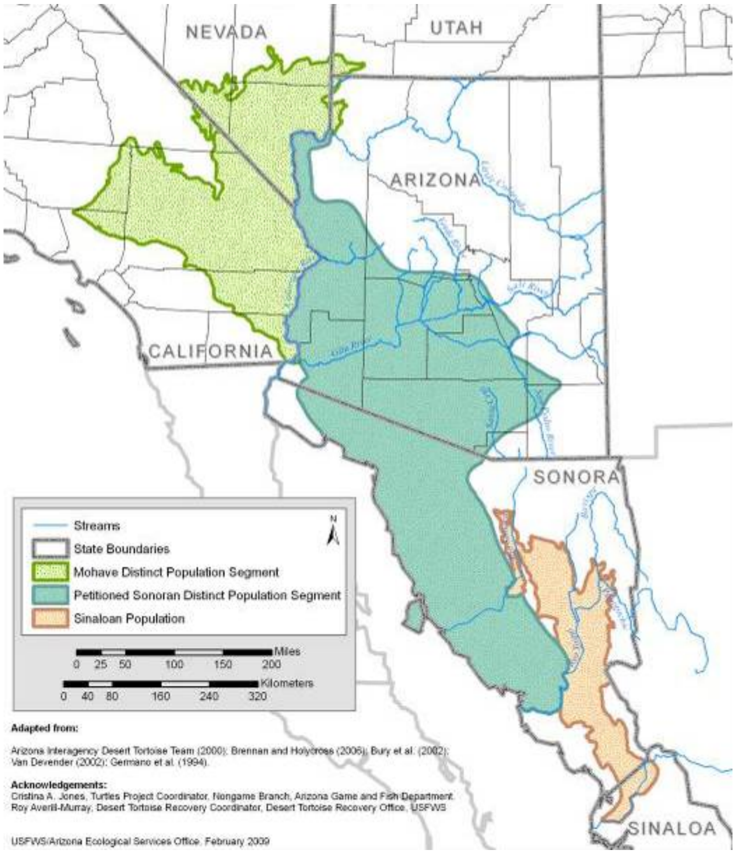

Figure 2. Range of the desert tortoise includes three populations: Mojave, Sonoran, and Sinaloan.

assessments of the recovery program and recovery plan were published by the General Accounting Office (2002) and Tracy *et al.* (2004), there were 49 long-term study plots in existence, but both of these reports concluded that it was not appropriate to extrapolate data from these plots to serve as a range-wide population baseline from which to assess recovery. Nevertheless, Tracy *et al.* (2004) concluded that the apparent downward trend in desert tortoise populations in the western portion of the range that was identified at the time of listing was valid and ongoing. Results from other portions of the range were inconclusive, but surveys of some populations found too few tortoises to produce population estimates (*e.g.*, 2000 survey of the Beaver Dam Slope, Arizona), suggesting that declines may have occurred more broadly.

Total Corrected Sign Surveys: In the late 1990s, the Bureau of Land Management (BLM) launched a set of total corrected sign (TCS) surveys ("sign" consists of scat, burrows, or other evidence of tortoise presence) to update information from the original (Berry 1984c) description of tortoise distribution and abundance in California. This effort was part of preparations for its West Mojave Plan (BLM *et al.* 2005) and was preceded by a set of analyses on the efficacy of TCS counts (BLM *et al.* 2005, Appendix K). The analyses concluded that although the predicted relationship between sign and tortoise counts was consistent, the correlation was relatively low and was only significant with large sample sizes. The low correlation meant that TCS was not reliably associated with tortoise numbers and was very likely to give an incorrect estimate of abundance class in a given survey. Further, the correlation between TCS and tortoise abundance was based primarily on burrow sign. Scat sign, which is much more common than burrows, was much less reliable at predicting tortoise counts, and shell counts were not correlated with live tortoise abundance. The analyses also noted that observers were similar in their reporting of burrow counts in any given study plot, whereas they usually differed in their counts of scat. For the above reasons, TCS data were used as an index of tortoise abundance, with relative sign counts assumed to reflect relative tortoise densities. For this planning effort, TCS were not used to estimate actual tortoise numbers.

In addition to data from the long-term study plots, Tracy *et al.* (2004) considered evidence from TCS and early line distance surveys (see below). Similar to the case of BLM *et al.* (2005), they did not use the TCS data to estimate abundance, but to describe presence/failure to detect. They used a single year of tortoise observations collected along 2,977 kilometers (1,850 miles) of line distance transects in 2001 to assess the combined distribution of live and dead tortoises. Although they were able to make qualitative conclusions (conclusions not expressed in terms of quantity) about population trends in individual recovery units, Tracy *et al.* (2004) also concluded that estimating accurate long-term trends of desert tortoise populations, habitat, and/or threats across the range was not feasible based on the combined suite of existing data and analyses.

Together with results from long-term plot surveys, these data provide qualitative - not quantitative - insight into the range-wide status of the species and show appreciable declines at the local level in many areas (Berry 1984a, Luke *et al.* 1991; Berry 2003; Tracy *et al.* 2004).

Range-wide Distance Sampling: Based on the 25-year horizon of the recovery criteria in the 1994 Recovery Plan (USFWS 1994a), a long-term monitoring program for the desert tortoise was implemented in 2001 (1999 in the Upper Virgin River Recovery Unit; McLuckie *et al.* 2002). This program was the first comprehensive effort undertaken to estimate densities across the range of the listed population (Table 1; USFWS 2006a; USFWS 2009a) and continues today. The monitoring strategy uses annual range-wide surveys on line distance transects, with effort levels designed to detect long-term population trends.

Density estimates of adult tortoises varied among recovery units and years. Over the first 6 years of range-wide monitoring (2001-2005, 2007), tortoises were least abundant in the Northeast Mojave Recovery Unit (1 to 3.7 tortoises per kilometer^2 [2 to 10 tortoises per mile^2]; USFWS 2009a), and the highest reported densities occurred in the Upper Virgin River Recovery Unit (16 to 27 tortoises per kilometer^2 [40 to 69 tortoises per mile^2]; McLuckie *et al.* 2007).

Considerable decreases in density were reported in 2003 in the Eastern Colorado and Western Mojave recovery units (USFWS 2006a). However, the variability between annual estimates among all years (Table 1) is consistent with variability due to sampling between years; only after several years of consistent patterns will the range-wide approach distinguish population trends from the variability due to sampling. Beyond noting that no range-wide population losses or gains were detected, inferences as to the meaning of these first years of data would be premature.

Please refer to *The Status of the Desert Tortoise (*Gopherus agassizii*) in the United States* (Berry 1984c) and the *Desert Tortoise Recovery Plan Assessment* (Tracy *et al.* 2004) for a detailed description of the methods and population trend and distribution analyses described above. In addition, *Range-wide Monitoring of the Mojave Population of the Desert Tortoise: 2007 Annual Report* (USFWS 2009a) provides information regarding the current monitoring effort.

Table 1. Summary of density estimates for each of the recovery units as defined in the 1994 recovery plan. "Adult tortoises" is the number of adults and subadults (midline carapace length ≥180mm). See USFWS (2006a, 2009a) for additional details.

Recovery Unit	Year	No. of Transects	Length (km)	Adult Tortoises	Density (km^2)	Coefficient of Variation (%)	95% Confidence Interval	
							Low	High
Northeast Mojave	2001	136	254.8	9	2.4	34.8	1.2	4.6
	2002	75	293.2	3	--[1]			
	2003	189	699.2	39	3.7	43.1	1.5	8.3
	2004	96	947.3	18	1.2	30.1	0.7	2.2
	2005	166	1754.4	40	1.8	25.8	1.1	3.0
	2007	240	2316.1	46	1.7	25.0	1.0	2.7
Eastern Mojave	2001	224	371.6	17	6.2	46.6	2.6	14.9
	2002	284	1120.4	56	4.1	22.1	2.6	6.2
	2003	59	215.1	11	--[1]			
	2004	140	1511.2	113	5.3	20.0	3.6	7.7
	2005	165	1839.5	108	7.2	20.1	4.9	10.7
	2007	76	803.9	40	5.8	25.0	3.6	9.3
Eastern Colorado	2001	205	328.0	54	10.1	18.3	7.0	14.4
	2002	104	416.7	42	7.7	28.8	4.4	13.4
	2003	108	431.7	32	4.0	22.7	2.6	6.3
	2004	132	1414.0	102	6.4	28.9	3.7	11.2
	2005	91	1094.3	74	7.9	26.7	4.7	13.2
	2007	100	1151.7	59	5.0	22.6	3.2	7.7
Northern Colorado	2001	201	321.6	39	7.2	22.6	4.6	11.2
	2002				--[1]			
	2003	112	445.2	54	6.3	20.6	4.2	9.3
	2004	76	835.9	79	6.9	22.8	4.5	10.8
	2005	94	1128.8	94	10.8	29.9	6.1	19.1
	2007	15	180.0	7	4.6	43.4	2.0	10.3
Western Mojave	2001	865	1384.0	160	5.6	13.8	4.3	7.4
	2002	547	2176.8	188	5.8	24.2	3.7	9.3
	2003	522	2083.2	218	3.8	10.6	3.0	4.6
	2004	166	1867.9	133	4.4	13.0	3.4	5.6
	2005	229	2746.6	173	6.1	17.2	4.4	8.5
	2007	97	1150.6	49	4.7	30.8	2.6	8.5
Upper Virgin River[2]	1999	158	306.5	168	27.3	14.8	20.4	36.5
	2000	153	301.9	170	28.1	14.2	21.2	37.1
	2001	159	313.8	169	26.8	13.4	20.6	39.9
	2003	157	309.1	97	15.6	12.8	12.1	20.1
	2005	155	304.5	151	24.7	12.6	19.3	31.7
	2007	157	308.3	92	14.9	13.7	11.3	19.5

[1]In the Northeastern Mojave, there are four long-term monitoring strata. Only one stratum could be analyzed in 2002, while in 2003 and 2004, three of the four could be analyzed. No recovery unit estimate is provided for 2002, and the 2003 and 2004 estimates are based on three of four strata. In the Eastern Mojave, only one of the three was surveyed in 2003, so no estimate is provided for the recovery unit. The single stratum in the Northern Colorado Recovery Unit was not surveyed in 2002.
[2]Data from McLuckie *et al.* (2007).

Habitat or Ecosystem

The desert tortoise occurs in the broadest latitudinal range, climatic regimes, habitats, and biotic regions of any North American tortoise species (Auffenberg and Franz 1978; Bury 1982; Patterson 1982; Bury *et al.* 1994; Germano 1994). The species occupies a variety of habitats from flats and slopes typically characterized by creosote bush scrub dominated by *Larrea tridentata* (creosote bush) and *Ambrosia dumosa* (white bursage) at lower elevations to rocky slopes in blackbrush scrub and juniper woodland ecotones (transition zone) at higher elevations (Germano *et al.* 1994). Throughout most of the Mojave Desert, tortoises occur most commonly on gently sloping terrain with sandy-gravel soils and where there is sparse cover of low-growing shrubs, which allows establishment of herbaceous (non-woody) plants (Germano *et al.* 1994; USFWS 1994a). However, surveys at the Nevada Test Site revealed that tortoise sign (*e.g.*, scat, burrows, tracks, shells) was more abundant on upper alluvial fans and low mountain slopes than on the valley bottom (Rautenstrauch and O'Farrell 1998). Soils must be friable (easily crumbled) enough for digging burrows, but firm enough so that burrows do not collapse (USFWS 1994a). During the winter, tortoises will opportunistically use burrows of various lengths, deep caves, rock and caliche crevices, or overhangs for cover (Bury *et al.* 1994).

Records of desert tortoises range from below sea level to an elevation of 2,225 meters (7,300 feet) (Luckenbach 1982). Typical habitat for the desert tortoise in the Mojave Desert has been characterized as creosote bush scrub below 1,677 meters (5,500 feet) in which precipitation ranges from 5 to 20 centimeters (2 to 8 inches), where a diversity of perennial plants is relatively high, and production of ephemerals is high (Luckenbach 1982; Turner 1982; Turner and Brown 1982; Bury *et al*. 1994; Germano *et al.* 1994).

The Mojave Desert is relatively rich in winter annuals, which serve as an important food source for the desert tortoise. Tortoises will also forage on perennial grasses, woody perennials, and cacti as well as non-native species such as *Bromus rubens* (red brome) and *Erodium cicutarium* (red-stem filaree). Ninety percent of the precipitation that facilitates germination of important forage species for desert tortoise occurs in winter and sometimes in the form of snow (Germano *et al.* 1994). Tortoises in the eastern Mojave Desert are more likely to be subjected to freezing winter temperatures and prolonged drought than tortoises in the Sonoran Desert and Sinaloan region where freezing temperatures are rare and rainfall is more predictable (Germano 1994).

The U.S. Geological Survey developed a quantitative, spatial habitat model for the desert tortoise north and west of the Colorado River to assist land managers in planning conservation efforts, guiding monitoring activities, monitoring changes in the amount and quality of habitat available, minimizing and mitigating disturbances, and ultimately in assessing the status of the tortoise and its habitat toward recovery of the species (Figure 1) (Nussear *et al.* 2009). The model incorporates 16 environmental variables such as those described above, including precipitation, geology, vegetation, and slope, and is based on desert tortoise occurrence data from sources spanning more than 80 years, especially including data from the 2001 to 2005 range-wide monitoring surveys (USFWS 2006a).

Throughout the Mojave and Colorado deserts, much of the tortoise habitat is public land. According to a surface ownership data set compiled from four BLM GIS sites between 2007 and 2009, all recovery units have well over half of the modeled tortoise habitat under Federal, State, local, and tribal management (Table 2). These data and all other references to modeled desert tortoise habitat reflect a 0.5 probability threshold based on the prevalence approach (Liu *et al*. 2005) within the recovery unit boundaries. This threshold depicts areas which have only a 0.5 or greater predicted value for desert tortoise habitat potential.

Changes in Taxonomic Classification or Nomenclature

The generic assignment of the desert tortoise has gone through a series of changes since its original description by Cooper (1863) as *Xerobates agassizii*. It has also been referred to in the literature as *Scaptochelys agassizii*. The currently accepted scientific name of *Gopherus agassizii* (Campbell 1988; Crumly 1994) was in use at the time of listing.

Genetics

See discussion under Application of the 1996 Distinct Population Segment (DPS) Policy.

Species-specific Research and/or Grant-supported Activities

Since the time of listing, a great deal of research relative to desert tortoise ecology (life history, demography), autecology (physiology, behavior, and morphology), threats, conservation and management, disease, and natural history has been conducted. Many project-specific reports also exist, but much remains unpublished. Extensive literature reviews are included in Grover and DeFalco (1995), Boarman (2002), Tracy *et al.* (2004), Boarman and Kristan (2006) and USFWS (2008). This 5-Year Review includes much of the literature that has been amassed since the listing of the desert tortoise in 1990.

Table 2. Amount of modeled desert tortoise habitat (Nussear *et al*. 2009) within recovery unit boundaries that is under Federal, State, local, tribal, and private ownership.

Recovery Unit	Ownership[1]	Modeled Habitat Acres	Percent of Total Modeled Habitat
Western Mojave	BLM	2,802,756	37
	DOD	2,087,764	28
	NPS	368,411	5
	State	102,403	1
	Local	70,816	1
	USFS	1,631	<1
	Tribal	1,197	<1
	Other/Private	2,147,113	28
Total		7,582,092	
Colorado Desert	BLM	3,154,899	64
	NPS	896,981	18
	DOD	293,086	6
	State	115,017	2
	Tribal	27,851	1
	BR	3,408	<1
	Local	300	<1
	USFWS	93	<1
	Other/Private	457,266	9
Total		4,948,899	
Eastern Mojave + Northeastern Mojave[2]	BLM	4,688,877	60
	NPS	1,205,319	15
	DOD	395,677	5
	DOE	303,426	4
	USFWS	298,412	4
	State	128,314	2
	Tribal	76,175	1
	BR	31,606	<1
	USFS	1,607	<1
	Other/private	647,521	8
Total		7,776,934	
Upper Virgin River	BLM	89,539	39
	State	30,851	13
	Tribal	21,366	9
	USFS	559	<1
	Other/private	90,006	39
Total		232,320	

[1]BLM; BR: Bureau of Reclamation; DOD: Department of Defense; DOE: Department of Energy; NPS: National Park Service; USFS: U.S. Forest Service; USFWS

[2]The boundary between the Eastern Mojave and Northeastern Mojave recovery units depicted in the draft Revised Recovery Plan is currently being re-evaluated in light of new information since that draft was published. For the purposes of this review, data summaries for these recovery units are combined.

Five-Factor Analysis

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act. Below is a synopsis of the threats that formed the basis for listing the tortoise as a threatened species (USFWS 1990), were further discussed in the 1994 Recovery Plan (USFWS 1994), were reviewed again in the 2008 draft Revised Recovery Plan, and continue to affect the species. A substantive body of data has been accumulated since 1994 for some of the threats, but others remain relatively unstudied. New information is provided where available, and all threats warrant continued attention and data collection that will inform management actions and recovery implementation.

The vast majority of threats to the desert tortoise or its habitat are associated with human land uses. Extensive research shows that all of these individual threats directly kill or indirectly affect tortoises. Research has also clarified many mechanisms by which these threats act on tortoises. However, despite the clear demonstration that these threats impact individual tortoises, there are few data available to evaluate or quantify the effects of threats on desert tortoise populations (Boarman 2002; Tracy *et al*. 2004). While current research results can lead to predictions about how local tortoise abundance should be affected by the presence of threats, quantitative estimates of the magnitude and relative importance of these threats have not yet been developed. Thus, it has not been practical to exclude some threats from consideration so as to enable one to focus on solutions to a different threat or subset of threats.

Instead, the assessment of the 1994 Recovery Plan emphasized the need for a greater appreciation of the implications of multiple, simultaneous threats facing tortoise populations and a better understanding of the relative contribution of multiple threats on demographic factors (*i.e*., birth rate, survivorship, fecundity, and death rate; Tracy *et al.* 2004). The approach of focusing on individual threats may not have produced expected gains toward desert tortoise recovery since 1994 because multiple threats act simultaneously to suppress tortoise populations at any given location within the species' range. Therefore, the 2008 draft Revised Recovery Plan focuses on expanding our knowledge of individual threats and places emphasis on understanding their multiple and combined effects on tortoise populations (USFWS 2008).

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Urbanization

At the time of listing, urbanization was identified as a significant threat to desert tortoise populations through fragmentation, permanent loss of habitat, and impacts associated with human activities such as off-highway vehicle use, illegal dumping, and the introduction of invasive species (USFWS 1990). Areas of the desert southwest occupied by desert tortoises have been subject to episodic human settlements and associated impacts since the mid to late 1800s (USFWS 1994). Urbanization within or in proximity to desert ecosystems took place at a rapid pace between 1994 and 2006 (Table 3). Currently more than 30 million people live near the Mojave or Colorado deserts, which is popular with recreationists (Berry *et al.* 2006; Hughson 2009). Between the years 2000 and 2005, the West (11 western states, including the 4 that encompass the range of the desert tortoise) experienced an 8.1 percent growth in population, compared to 7.3 percent in the South, 2.4 percent in the Midwest, and 2.0 percent in the Northeast (U.S. Census Bureau 2005). Nevada, Arizona, and Utah saw the greatest growth during this time period at 20.8, 15.8, and 10.6 percent, respectively, and California saw a 6.7 percent increase in population growth (U.S. Census Bureau 2005).

Table 3. Human population growth in the states and counties within the range of the Mojave population of the desert tortoise between 1994 (when the Recovery Plan was published) and 2006.

State/Counties	1994 Population Estimate[1]	2006 Population Estimate[2]	% Change
Arizona	4,147,561	6,166,318	48.7
Mohave	116,320	193,035	66.0[3]
California	31,317,179	36,457,549	16.4
Imperial	136,248	160,301	17.7
Inyo	18,450	17,980	-2.5
Kern	608,858	780,117	28.1
Los Angeles	9,048,129	9,948,081	9.9
Riverside	1,354,966	2,026,803	49.6
San Bernardino	1,553,732	1,999,332	28.7
Nevada	1,456,388	2,495,529	71.4
Clark	938,611	1,777,539	89.4
Esmeralda	1143	790	-30.9
Lincoln	3849	4738	23.1
Nye	21,648	42,693	97.2
Utah	1,930,436	2,550,063	32.1
Washington	65,520	126,312	92.8

[1] Byerly and Deardorff (1995)
[2] U.S. Census Bureau (2007b)
[3] Most population increase has been outside the Arizona Strip and the range of the Mojave population of the desert tortoise.

The city of St. George, Utah, was the fastest-growing metropolitan area in the U.S. between 2000 and 2006, with growth of 39.8 percent. Las Vegas, Nevada, grew 29.2 percent, making it one of the top five fastest-growing areas during this time period (U.S. Census Bureau 2007a). Rapid growth is not limited to metropolitan areas. Mohave County, Arizona, grew 66 percent between 1994 and

2006, and Nye County, Nevada, grew 97 percent during the same time period (Table 3). The Beaver Dam/Littlefield community (within the Virgin River Basin) on the Arizona Strip supported some 1,580 persons in 2000. This area saw more than 200 percent growth between 1990 and 2000.

According to the National Land Cover Database (Homer *et al*. 2004), between 1992 and 2001 (more recent data are not yet available), across the range of the desert tortoise, almost 80,000 acres of modeled habitat have been converted to urban (Table 4). Within desert tortoise Critical Habitat units, 378 acres have been converted to urban (Table 5). While these figures do not appear to correlate with the threat that was identified as significant at the time of listing in terms of direct habitat loss, urbanization results in increasing human populations that are in proximity to desert habitat. This corresponds to increases in both direct and indirect impacts to desert tortoise habitat through other human uses (for example, recreation in desert habitat or infrastructure development to support growing communities).

Lovich and Bainbridge (1999) identified various types of anthropogenic impacts from which desert ecosystems may take 50 to 300 years to recover to pre-disturbance plant cover levels. However, in areas where intense urbanization and direct habitat loss has occurred, habitat restoration or recovery would prove even more challenging and might take significantly longer to accomplish, if at all. In addition, urban environments have indirect impacts on desert tortoise populations and habitat at their interface with the desert (Berry and Burge 1984; Berry and Nicholson 1984). Unconfined pets may kill or wound tortoises (see section C(3), Predation), and unauthorized collecting of desert tortoises may affect populations (see section B(1), Collection by Humans). Human populations subsidize increasing predator populations, which then apply greater pressure on desert tortoise populations near the urban-wildland interface (see section C(3), Predation). Indiscriminate use of firearms and off-highway vehicles, dumping of trash, and removal of vegetation or unimproved road proliferation are activities that occur in and beyond the urban-desert interface that may result in injury and mortality to tortoises and degradation of their habitats (see section E, Other Natural or Manmade Factors). Pollution from increasing human populations leads to nitrogen deposition within the desert which can lead to increased biomass of non-native grasses and associated impacts (Allen *et al.* 2009). Habitat fragmentation resulting from infrastructure associated with urbanization such as residential fencing, roads, and railroad tracks, can greatly inhibit desert tortoise movements (Edwards *et al.* 2004; Brooks and Lair 2005). These barriers to movement and population connectivity can lead to inbreeding, and may result in mortality of individuals (Boarman and Sazaki 1996) (see section A(2), Roads).

Table 4. Amount (acres) of modeled habitat (Nussear *et al*. 2009) within desert tortoise recovery units that was converted to urban between 1992 and 2001.

Recovery Unit	Modeled Habitat Acres	Modeled Habitat Converted	Percent Modeled Habitat Converted
Western Mojave	7,582,092	16,175	<1
Colorado Desert	4,948,900	187	<1
Eastern Mojave + Northeastern Mojave[1]	7,776,934	58,920	<1
Upper Virgin River	232,320	4,390	2
TOTAL	20,540,246	79,912	<1

[1]The boundary between the Eastern Mojave and Northeastern Mojave recovery units depicted in the draft Revised Recovery Plan is currently being re-evaluated in light of new information since that draft was published. For the purposes of this review, data summaries for these recovery units are combined.

Table 5. Amount (acres) of modeled habitat (Nussear *et al*. 2009) within desert tortoise Critical Habitat units that was converted to urban between 1992 and 2001.

Critical Habitat Units	Modeled Habitat within CHU	Modeled Habitat Converted
Beaver Dam Slope	202,499	3
Chemehuevi	914,505	0
Chuckwalla	809,319	0
Fenner	452,359	0
Fremont-Kramer	501,095	130
Gold Butte-Pakoon	418,189	0
Ivanpah	510,711	1
Mormon Mesa	407,041	27
Ord-Rodman	194,155	0
Pinto Mountains	144,058	0
Piute-Eldorado	477,649	12
Superior-Cronese	724,967	24
Upper Virgin River	46,441	150
All CHUs	5,802,987	346

Paved and Unpaved Roads, Routes, Trails, and Railroads

At the time of listing, road proliferation in the Mojave Desert was identified as a threat to the desert tortoise through significant cumulative habitat loss and increased human access resulting in mortality from collection, gunshots, and crushing by vehicles (USFWS 1990). Vehicular roads, routes, and trails are the most common type of human disturbance observed in desert ecosystems, and much emphasis has been placed on understanding the impacts of these linear features on arid environments (Brooks and Lair 2005). Brooks and Lair (2005) cite vehicular routes as one of the biggest challenges to land managers in the desert southwest, especially as they relate to the conservation status of the desert tortoise.

Direct and indirect impacts of roads and railroads on desert tortoise populations are well documented and include habitat and population fragmentation and degradation as well as mortality of individual tortoises (USFWS 1994; Boarman 2002). Paved and unpaved roads serve as corridors for urbanization and dispersal of invasive species and provide access to recreation; railroads also facilitate urbanization and the spread of non-native plants. Roads and railroads also act as barriers to movement. Railroads are similar to roads as sources of mortality for desert tortoises, as they can become caught between the tracks causing them to overheat and die or be crushed by trains (U.S. Ecology 1989).

Direct effects to desert tortoise habitat from roads, routes, trails, and railroads also occur during initial stages of construction or off-highway vehicle route/trail establishment when vegetation and soils are lost or severely degraded. Construction of these features can result in physical and chemical changes to soils within unpaved roadways as well as in adjacent areas (Brooks and Lair 2005). In addition, roadside vegetation is often more robust and diverse because concentrated water along roadside berms promotes germination. This attracts tortoises to roads and puts them at higher risk of mortality as road-kill (Boarman *et al.* 1997). Raised roadbeds or other types of linear human infrastructure also affect water runoff patterns across the landscape, decreasing soil moisture in upland areas between downslope channels and resulting in lower shrub density and biomass (Schlesinger and Jones 1984; Brooks and Lair 2009).

Hoff and Marlow (2002) demonstrated that there is a detectable impact on the abundance of desert tortoise sign adjacent to roads and highways with traffic levels from 220 to over 5,000 vehicles per day. That is, the extent of the detectable impact was positively correlated with the measured traffic level; the higher the traffic counts, the greater the distance from the road reduced tortoise sign was observed (Hoff and Marlow 2002). This supports LaRue (1993) and Boarman *et al*. (1997), wherein depauperate desert tortoise populations were observed along highways. Subsequent research shows that populations may be depressed in a zone at least as far as 0.4 kilometers (0.25 miles) from the roadway (Boarman and Sazaki 2006). Hoff and Marlow (2002) also surmised that unpaved access roads with lower traffic levels may have significant effects on tortoises. Desert tortoise populations may also be indirectly affected by road corridors that fragment habitat and limit an animal's ability to migrate and disperse (Boarman *et al*. 1997). Subsequently, populations may become isolated and at higher risk of localized extirpation from stochastic events or from inbreeding depression (Boarman *et al.* 1997; Boarman and Sazaki 2006).

According to the 2008 U.S. Census Bureau's TIGER database (Topologically Integrated Geographic Encoding and Referencing system), highways and paved roads within Critical Habitat units have decreased by 394 kilometers (245 miles) between 1990 and 2008, approximately a 3 percent decrease (Table 6). However, according to the same data set, vehicular trails (*i.e.*, unpaved) within Critical Habitat have increased by 957 kilometers (595 miles), more than doubling the amount of trails between 1990 and 2008 (Table 7). The Chemehuevi Critical Habitat unit stands out with 858 kilometers (533 miles) of trails, which was the result of a 646 kilometer (401 mile) increase of such trails between 1990 and 2008. The Chuckwalla Critical Habitat unit saw the only substantial decrease in vehicular trails, dropping from 198 kilometers (123 miles) in 1990 to 170 kilometers (106 miles) in 2008 (Table 7).

Table 6. Length (kilometer) and density (kilometer/kilometer^2) of highways and paved roads within desert tortoise Critical Habitat in 1990 and in 2008.

	1990		***2008***		***Difference***	
Critical Habitat Unit	**Length**	**Density**	**Length**	**Density**	**Length[1]**	**Density**
Beaver Dam Slope	312	0.38	340	0.41	28	0.03
Chemehuevi	1,312	0.35	623	0.14	-690	-0.21
Chuckwalla	1,245	0.30	1,318	0.32	73	0.02
Fenner	1,343	0.73	1,343	0.73	1	0.00
Fremont-Kramer	2,304	1.10	2,386	1.14	83	0.04
Gold Butte-Pakoon	770	0.39	729	0.37	-41	-0.02
Ivanpah	1,526	0.60	1,595	0.62	69	0.03
Mormon Mesa	533	0.31	585	0.34	53	0.03
Ord-Rodman	702	0.68	662	0.64	-40	-0.04
Pinto Mountains	254	0.37	253	0.36	-1	0.00
Piute-Eldorado	1,118	0.53	1,028	0.49	-90	-0.04
Superior-Cronese	1,801	0.58	1,883	0.61	82	0.03
Upper Virgin River	131	0.59	212	0.96	81	0.37
TOTAL	**13,350**	**0.51**	**12,956**	**0.50**	**-394**	**-0.02**

[1]Discrepancies in subtraction are due to rounding.

Table 7. Length (kilometer) and density (kilometer/kilometer^2) of vehicular trails within desert tortoise Critical Habitat in 1990 and in 2008.

	1990		***2008***		***Difference***	
Critical Habitat Unit	**Length**	**Density**	**Length**	**Density**	**Length[1]**	**Density**
Beaver Dam Slope	27	0.03	52	0.06	25	0.03
Chemehuevi	212	0.06	858	0.23	646	0.17
Chuckwalla	198	0.05	170	0.04	-29	-0.01
Fenner	16	0.01	71	0.04	55	0.03
Fremont-Kramer	10	0.00	41	0.02	30	0.01
Gold Butte-Pakoon	96	0.05	154	0.08	58	0.03
Ivanpah	143	0.06	237	0.09	94	0.04
Mormon Mesa	75	0.04	71	0.04	-3	0.00
Ord-Rodman	43	0.04	80	0.08	37	0.04
Pinto Mountains	12	0.02	18	0.03	6	0.01
Piute-Eldorado	34	0.02	50	0.02	16	0.01
Superior-Cronese	13	0.00	34	0.01	21	0.01
Upper Virgin River	0	0	0	0	0	0.00
TOTAL	**880**	**0.03**	**1,837**	**0.07**	**957**	**0.04**

[1]Discrepancies in subtraction are due to rounding.

Data suggest fences to prevent desert tortoise from entering roads may reduce their mortality as well as the mortality of other wildlife species (Boarman *et al.* 1997), and tortoises have been documented to use culverts to cross beneath roadways (Boarman *et al.* 1998), although the degree to which this use mitigates population-fragmenting effects has not been investigated. Boarman (2009) suggested that fencing 1.61 kilometers (1 mile) of highway is equivalent to reclaiming 30 hectares (74 acres) of habitat; this represents 46 percent of the impacted habitat that extends 400 meters (1312 feet) from the highway. Despite the fence (near California State Highway 58) being in place for 18 years, road effects were still evident based on the presence of sign, and it is clear that the tortoise's life history traits require many years for depleted areas to be repopulated when left to natural processes, especially if other threats continue unabated (Boarman 2009).

Spread of Invasive Plants due to Roads, Routes, Trails, and Railroads: Construction and maintenance of roadways facilitate changes in plant species composition and diversity. Non-native, invasive species and edge-associated species often become dominant along these linear features, which serve as corridors for weed dispersal (Boarman and Sazaki 2006*;* Brooks 2009). Vegetation removal and manipulation and addition of soils in preparation for road construction, as well as grading of unpaved roads, create areas of disturbance that allow weedy species to become established and proliferate (Gelbard and Belnap 2003). Brooks and Berry (2006) found that dirt road density was the best predictor, among variables they investigated, of non-native plant proliferation as measured by non-native species richness and biomass of *Erodium cicutarium*. Vehicles serve as a major vector in dispersal of non-native species along roadways (Brooks and Lair 2005).

Near Canyonlands National Park in Utah, cover of the non-native grass *Bromus tectorum* (cheat grass) was three times greater along paved roads than along four-wheel-drive tracks, and richness (a measure of species diversity) and cover of non-native species were more than 50 percent greater, and native species richness was 30 percent lower, at interior sites along paved roads than along four-wheel-drive tracks (Gelbard and Belnap 2003). There appears to be a correlation between the level of road improvement (*i.e.*, paved, improved, unpaved) and the level of invasion by non-natives (Gelbard and Belnap 2003). Cover and richness of non-native species decreases as distance from the road increases (Boarman and Sazaki 2006).

As natural areas are impacted by linear features such as roads, routes, trails, and railroads, previously intact, contiguous habitats become degraded and fragmented, and non-native invasive species play a more dominant role in ecosystem dynamics. For instance, increases in plant cover due to the proliferation of non-natives have altered fire regimes throughout the Mojave Desert region (Brooks 1999; Brooks and Esque 2002; Esque *et al.* 2003; Brooks *et al.* 2004) (see sections A(4)(b) and A(5) on Invasive Species and Increasing Fuel Load and Fire).

Predator Subsidies due to Roads, Routes, Trails, and Railroads: In the desert southwest, common raven (*Corvus corax*) populations have increased over the past 25 years (greater than 1000 percent), probably in response to increased human populations and anthropogenic changes to the landscape, including roads, utility corridors, landfills, and sewage ponds (Knight and Kawashima 1993; Boarman and Berry 1995; Boarman *et al.* 1995; Knight *et al.* 1999; Boarman *et al.* 2006). See section C(3), Predation, for a detailed description of the effects of predator subsidies on the desert tortoise.

Off-Highway Vehicles

At the time of listing, off-highway vehicle use was identified as having a significant effect on desert tortoise abundance and distribution through direct mortality, disruptions in tortoise behavior, and reduction in forage within and adjacent to areas where off-highway vehicle activity occurs (USFWS 1990). Off-highway vehicle activities take many forms, from organized events, small- or large-scale competitive races involving up to thousands of motorcycles, to casual family activities. Organized events and off-highway vehicle tours are now reviewed and permitted by land managers. Generally, an education component and speed limitations are requirements of the permit.

Since the time of listing, designating areas and trail networks as open or closed to casual off-highway vehicle use has been undertaken across much of the range of the desert tortoise. In California, these designations occurred for most of the desert as part of California Desert Conservation Area Plan amendments. In Nevada, a few areas have been closed to off-highway vehicle use because there is no formal travel management plan in place; therefore, most public land is simply considered “Limited.” Typically, BLM lands that do not have some other designation (*i.e.*, open, closed, Wilderness, Wilderness Study Area, etc.) are considered “Limited,” which restricts off-highway vehicle use to designated or existing roads and trails.

According to state-level data from the four BLM GIS sites (CA: 2001; AZ: 2007/8; NV: 1997; UT: no off-highway vehicle data available), Mormon Mesa has the highest percentage area designated by the BLM as “Closed” (*i.e.*, completely off limits, as opposed to “Limited” or completely open access) to off-highway vehicle use. National Park Service roads are open to street legal vehicles only; there is no off-road travel in any National Park Service area. The Ivanpah and Fenner critical habitat units have the highest proportion of their area managed by the National Park Service and are therefore closed to off-highway vehicle use. In addition, all Wilderness and Wilderness Study Areas are completely off-limits to all motorized or mechanized transportation.

According to the final environmental impact statement for the West Mojave Plan published in 2005, the BLM off-highway vehicle route network was designated in six different efforts (Table 8; BLM 2005). Collectively, this network would make 21,137 kilometers (13,134 miles) of open routes available for motorized vehicle access and recreation within the California Desert District, of which 8,204 kilometers (5,098 miles), or 39 percent, would be within the Western Mojave Desert. In DWMAs, the network would result in the closure of 2,985 kilometers (1,855 miles) of the 6,799 total linear kilometers (4,225 miles) of routes on public land, which is a 44 percent reduction of routes in DWMAs.

Despite efforts to designate areas for off-highway vehicle use, unauthorized use continues to be of concern across the range of the species. For instance, managers in a recovery planning workshop noted that activities south of Interstate 10 in the Colorado Desert and adjacent to the Johnson Valley Open Area in the Western Mojave recovery unit present a variety of threats to the desert tortoise. Repeated off-highway vehicle trail use leads to new routes that are not included in road databases (Brooks and Lair 2009).

Impacts from off-highway vehicle use include mortality of tortoises on the surface and below ground, collapsing of desert tortoise burrows, damage or destruction of annual and perennial plants and soil crusts, soil erosion and compaction, proliferation of weeds, and increases in numbers and locations of wildfires (Brooks 2009; Lei 2009). Despite the many observations that have been documented and reported, statistical correlation between off-highway vehicle impacts and reduced desert tortoise densities continues to be lacking (Boarman 2002). However, it is evident that off-highway vehicle activities remain an important source of habitat degradation and could result in reductions in desert tortoise densities (Boarman 2002). Damage to or destruction of shrubs and burrows can lead to disruption of desert tortoises' water balance, thermoregulation, and energy requirements, and the loss of annual plants reduces the availability of food (USFWS 1994). One of the most significant ecological implications of off-highway vehicle routes is the exacerbation of erosion and changes in drainage patterns (Brooks and Lair 2005).

Table 8. Summary of California Desert District Route Network Mileages.

Plan Name[1]	**Plan Status**[2]	**Open Route Miles**	**Limited Route Miles**	**Closed Route Miles**	**Public Lands**
NECO	ROD 12/20/02	4,739	4	239	3,800,000
NEMO DWMAs	ROD 12/20/02	651	66	70	300,000
NEMO non-DWMA	ROD 07/02/04	1,527	32	128	2,400,000
WECO	DR 01/13/03	1,116	279	922	475,000
West Mojave	DR 06/30/03	5,054	51	2,391	3,200,000
Coachella Valley Plan Amendment	ROD 12/27/02	47	0	71	200,000
TOTAL		13,134	432	3,821	10,375,000

[1]: NECO = Northern and Eastern Colorado Desert; NEMO = Northern and Eastern Mojave Desert; WECO =Western and Eastern Colorado Desert; [2]: DR = Decision Record, ROD = Record of Decision

Bury and Luckenbach (2002) compared habitat, abundance, and life history features of desert tortoises on one unused, natural area and a nearby area used heavily by off-highway vehicles. The unused, natural area had 1.7 times the number of live plants, 3.9 times the plant cover, 3.9 times the number of desert tortoises, and 4 times the number of active tortoise burrows than the area used by off-highway vehicles. The two largest tortoises in the off-highway vehicle use area weighed less than would be expected based on what is known about season-to-season fluctuations. Despite the lack of pre-disturbance data for the off-highway vehicle area and the patchy distribution of tortoises, the areas furthest from concentrated off-highway vehicle activity (pit areas) still reflected the least amount of habitat impact and supported more tortoises (Bury and Lukenbach 2002).

Jennings (1997) found that desert tortoises are vulnerable to negative effects from off-highway vehicles because of their habitat preferences. Tortoises in a study at the Desert Tortoise Natural Area spent significantly more time traveling and foraging in hills and washes than on the flats. Tortoises use washes for travel, excavation of burrows, and foraging, and at least 25 percent of their forage plants were found to occur within washes. Hills and washes are also favored by users of motorcycles, trail bikes, all-terrain vehicles, and other four-wheel vehicles. Because tortoises prefer washes and hills, they are more vulnerable to direct mortality from off-highway vehicles. Additionally, off-highway vehicle use in these habitats causes degradation of vegetation and loss of forage species important in the desert tortoise diet (Jennings 1997).

Surface disturbance from off-highway vehicle activity can cause erosion and large amounts of dust to be discharged into the air. Recent studies addressing surface dust impacts on gas exchanges in Mojave Desert shrubs showed that plants encrusted by dust have reduced photosynthesis and decreased water-use efficiency, which may decrease primary production during seasons when photosynthesis occurs (Wijayratne *et al*. 2005; Sharifi *et al.* 1997). Sharifi *et al.* (1997) also showed reduction in maximum leaf conductance, transpiration, and water-use efficiency due to dust. These effects may impact desert annuals, an important food source for tortoises.

Off-highway vehicle activity can also disturb fragile cyanobacterial-lichen soil crusts, a dominant source of nitrogen in desert ecosystems (Belnap 1996). Belnap (1996) showed that anthropogenic surface disturbances may have serious implications for nitrogen budgets in cold-desert ecosystems, and this may also hold true for the hot deserts that tortoises occupy. Soil crusts also appear to be an important source of water for plants, as crusts were shown to have 53 percent greater volumetric water content than bare soils during the late fall when winter annuals are becoming established (DeFalco *et al.* 2001). Once the soil crusts are disturbed, non-native plants may colonize, become established, and out-compete native perennial and annual plant species (DeFalco *et al.* 2001; D'Antonio and Vitousek 1992). Invasion of non-native plants can affect the quality and quantity of plant foods available to desert tortoises (see section A(4)(a), Invasive Plants and Nutrition). Increased presence of invasive plants can also contribute to increased fire frequency (see sections A(4)(b) and A(5), Increasing Fuel Load and Fire). Brooks and Lair (2009) provide a comprehensive overview of the ecological effects of various types of vehicular routes in the Mojave Desert.

<u>Non-native Invasive Plants</u>
Invasion of wildlands by non-native, annual plant species was identified at the time of listing as a threat to desert tortoises and their habitats through changes in the fire regime in the desert (increased frequency) and reduced nutritional value of available forage species (USFWS 1990). Proliferation of invasive plants is increasing in the Mojave and Sonoran deserts, largely as a result of human disturbance, and is recognized as a significant threat to desert tortoise habitat

(Brooks 2009). Spread of invasive plants continues to increase in the Mojave and Sonoran deserts and many species of non-native plants from Europe and Asia have become common to abundant in some areas, particularly where disturbance has occurred and is ongoing. As non-native plant species become established, native perennial and annual plant species that are important to desert tortoises for cover and forage may decrease, diminish, or die out (D'Antonio and Vitousek 1992). Land managers and field scientists identified 116 species of non-native plants in the Mojave and Colorado deserts (Tierra Madre Consultants, Inc.1991; Brooks and Esque 2002). *Brassica tournefortii* (Sahara mustard) and *Hirschfeldia incana* (Mediterranean mustard) are rapidly spreading, non-native winter annuals more recently invading the desert southwest, especially in sandy soils (LaBerteaux 2006).

Brooks and Berry (2006) found that while non-native plant species comprised only a small fraction of the total annual plant flora, they were the dominant component of the annual plant community biomass. For instance, in 1995, a high rainfall year in the Mojave Desert, non-native species comprised 6 percent of the flora and 66 percent of the biomass; in 1999, a low rainfall year, non-natives comprised 27 percent of the flora and 91 percent of the biomass. Annual species dominate the non-native flora, with *Bromus madritensis* subsp. *rubens*, *Schismus barbatus*, and *Erodium cicutarium* comprising up to 99 percent of the non-native biomass. Brooks and Berry (2006) also found that proliferation of non-native plants was best predicted by disturbance, specifically frequency and size of recent fires for biomass of *Bromus madritensis* subsp. *rubens*. Once fires occur (see below), opportunities for invasion and proliferation of non natives increase because they regenerate on burned areas more quickly than native plants (Brown and Minnich 1986).

Increased levels of atmospheric pollution and nitrogen deposition related to increased human presence and combustion of fossil fuels can cause increased levels of soil nitrogen, which in turn may result in significant changes in plant community composition (Aber *et al.* 1989; Allen *et al.* 2009). Many of the non-native annual plant species in the Mojave region evolved in more fertile Mediterranean regions and benefit from increased levels of soil nitrogen, which gives them a competitive edge over native annuals. Studies at three sites within the central, southern, and western Mojave Desert indicated that increased levels of soil nitrogen can increase the dominance of non-native annual plants and promote the invasion of new species in desert regions. Furthermore, increased dominance by non-native annuals may decrease the diversity of native annual plants, and increased biomass of non-native annual grasses may increase fire frequency (Brooks 2003).

Nutrition: Nutritional intake affects growth rates in juvenile desert tortoises (Medica *et al.* 1975) and female reproductive output (Turner *et al.* 1986, 1987; Henen 1992). Invasion of non-native plants can alter the quality and quantity of plant foods available to desert tortoises, and thereby impact nutritional intake.

Desert tortoises are generally quite selective in their choices of foods (Burge 1977; Nagy and Medica 1986; Turner *et al.* 1987; Avery 1992; Henen 1992; Jennings 1992, 1993; Esque 1992, 1994), and in some areas the preferences are clearly for native plants over the weedy non-natives.

As native plants are displaced by non-native, invasive species in some areas of the Mojave Desert, non-native plants may be used as a food source for some desert tortoises. However, non-native plants may not be as nutritious as native plants. Results of feeding trials using native and non-native grasses [*Achnatherum hymenoides* (Indian ricegrass) and *Schismus barbatus* (split grass)] and native and non-native forbs [*Malacothrix glabrata* (desert dandelion) and *Erodium cicutarium* (red-stemmed filaree)] to compare the nutritional qualities for the desert tortoise suggest that the proliferation of non-native grasses such as *Schismus* to the exclusion of forbs (D'Antonio and Vitousek 1992) places desert tortoises at a nutritional disadvantage (Nagy *et al.* 1998; Hazard *et al.* 2002). Furthermore, if, instead of eating to obtain a given volume of food, tortoises consume just enough food to satisfy their energy needs (as commonly noted in other vertebrate groups), then the native forbs provide significantly more nitrogen and water than the non-native forbs (Nagy *et al.* 1998).

Changes in the abundance and distribution of native plants also may affect desert tortoises in more subtle ways. In the Mojave Desert, many food plants are high in potassium (Minnich 1979), which is difficult for desert tortoises to excrete due to the lack of salt glands that are found in other reptilian herbivores such as chuckwallas (*Sauromalus obesus*) and desert iguanas (*Dipsosaurus dorsalis*) (Minnich 1970; Nagy 1972). Reptiles are also unable to produce concentrated urine, which further complicates the ability for desert tortoises to expel excess potassium (Oftedal and Allen 1996). Oftedal (2002) suggested that desert tortoises may be vulnerable to disease as a result of physiological stress associated with foraging on food plants with insufficient water and nitrogen to counteract the negative effects of dietary potassium. Only high quality food plants (as expressed by the Potassium Excretion Potential, or PEP, index) allow substantial storage of protein (nitrogen) that is used for growth and reproduction, or to sustain the animals during drought. Non-native, annual grasses have lower PEP indices than most native forbs (Oftedal 2002; Oftedal *et al.* 2002). Oftedal *et al.* (2002) found that foraging juvenile tortoises favored water-rich, high-PEP, native forbs. Much of the nutritional difference between available and selected forage was attributable to avoidance of abundant, non-native *Schismus* spp. with mature fruit, which is very low in water, protein, and PEP. Of the species eaten, *Camissonia claviformis*, a native Mojave desert primrose, accounted for nearly 50 percent of all bites, even though it accounted for less than 5 percent of the biomass encountered, and was largely responsible for the high PEP of the overall diet. Impacts to vegetation (such as livestock grazing, invasion of non-native plants, and soil disturbance) that reduce the abundance and distribution of high

PEP plants may result in additional challenges for foraging desert tortoises (Oftedal *et al.* 2002).

Tracy *et al.* (2006) also quantified the rates of passage of digesta (food in the stomach) in young desert tortoises in relation to body size and diet quality. They observed that, compared to adults, young, growing tortoises need higher rates of nutrient assimilation to support their higher metabolic rates. Juvenile desert tortoises also forage selectively by consuming plant species and plant parts of higher quality (Oftedal *et al.* 2002) and pass food through the gut more quickly (Tracy *et al.* 2006). Hence, these findings of differential passage rates suggest that it is beneficial for young tortoises to specialize on low-fiber diets, as this would allow for more efficient uptake of nutrients. In addition, habitat disturbances (*e.g.*, invasion of annual grasses) that favor species with little nutritional value and preclude access to low-fiber foods may negatively impact the physiological and behavioral ecology of young desert tortoises. Adults, on the other hand, may be better adapted to tolerate low-quality foods for a longer period of time because of their lower metabolism, more voluminous guts compared to subadults, and consequently longer retention times (Tracy *et al.* 2006).

Increasing Fuel Load: Invasive, non-native annual grasses and forbs increasingly spread over the desert floor and resist decomposition because of their fibrous structure. The proliferation of non-native plant species has contributed to an increase in fire frequency in tortoise habitat by providing sufficient fuel to carry fires, especially in the inter-shrub spaces that are mostly devoid of native vegetation (Brown and Minnich 1986; Brooks 1998; see also discussion under section A(5), Fire, below).

Fire

At the time of listing, wildland fire was becoming more of a concern in desert tortoise habitats because these ecosystems, especially the perennial shrub component, are so slow to recover from fire (USFWS 1990). In addition, the non-native annual grasses that are thought to be responsible for shortened fire frequency in the desert thrive under this type of disturbance regime (USFWS 1990). Fire has the potential to be an important force governing habitat quality and persistence of desert tortoises. Tortoises can be killed or seriously injured by burning and smoke inhalation during fire events. The extent of the direct impacts experienced by tortoises is influenced by tortoise activity at the time of fire (whether inside or outside burrow), depth of burrow (to afford protection), fire intensity (amount of heat generated), speed of fire (how quickly it moves through an area), and patchiness (extent of an area burned) (Esque *et al.* 2003). Early-season fires may be more threatening than summer fires because desert tortoises are active above ground and more vulnerable to direct effects of fire at that time. Fire can also compromise the quality of tortoise habitat by reducing the vegetation that provides shelter, cover, and nutrition (key forage plants) for tortoises (Brooks and Esque 2002; Esque *et al.* 2003).

Natural fire regimes have been altered due to profuse invasions of non-native grasses throughout much of the range of the desert tortoise. The biomass of weedy species has increased remarkably in the desert Southwest as a result of disturbance from vehicles, grazing, agriculture, urbanization, and other human land uses (Brooks and Berry 1999; Brooks and Esque 2002; Brooks *et al.* 2003; Brooks and Berry 2006; Brooks and Matchett 2006). Fuel loads that consist of dense annual grasses rather than sparse cover of native species make it more likely for fire to become hot enough to damage native shrubs, which are poorly adapted to survive and/or regenerate quickly after fire and are poor colonizers (Tratz and Vogl 1977; Tratz 1978). Ultimately, recurrent fire can result in conversion of shrublands to annual grasslands, which can be devastating for desert tortoises that depend upon shrubs for cover (Brooks and Esque 2002). Conversion to grassland also tends to create a self-perpetuating grass/fire cycle as fuels continuously reestablish in burned areas (D'Antonio and Vitousek 1992).

Years of high rainfall promote the growth of invasive annuals that increase the fine fuel loads (fast-drying fuels, generally with a comparatively high surface area-to-volume ratio), but high rainfall also increases food and water availability for desert tortoises. Desert tortoise reproduction also increases in high rainfall years. Small hatchlings are more vulnerable to fire than larger tortoises, and tortoises in general are more vulnerable to fire when they are above ground foraging. Thus, the high rainfall episodes that are important to maintaining healthy desert tortoise populations may also create the highest fire risk (Brooks and Esque 2002).

Plant litter produced by non-native annual grasses decomposes more slowly than native annuals and accumulates during successive years, thus providing an excess of fine fuels that sustains and spreads fires throughout the desert ecosystem (Brooks 1999). *Bromus madritensis* subsp. *rubens* in particular has contributed to significant increases in fire frequency since the 1970s (Kemp and Brooks 1998; Brooks *et al.* 2003). Historical fire intervals of 30 to greater than 100 years have been shortened to an average of 5 years in some areas of the Mojave Desert, due to the invasion of non-native grasses. Additionally, fires can increase the frequency and cover of non-native annual grasses within 3 to 5 years of a fire event, thus promoting the continuity of this grass/fire cycle that shortens the fire interval (Brooks *et al.* 1999; Brooks and Esque 2002; Brooks and Minnich 2006). Increased levels of surface-disturbing activities, rainfall, and atmospheric nitrogen and carbon dioxide may also increase the dominance of non-native plants and frequency of fires in the future (Brooks and Esque 2002; Brooks *et al.* 2003).

The most striking changes in fire frequency in the Mojave Desert have been observed in the middle elevations dominated by *Larrea tridentata*, *Yucca brevifolia* (Joshua tree), and *Coleogyne ramosissima*, at the upper limits of desert tortoise distribution, where most of the fires occurred between 1980 and 2004

(Brooks and Matchett 2006). The combination of enough cover of native vegetation to carry a fire and the accumulation of fuels from non-native annual grasses following years of above average rainfall may result in significantly larger fires at shorter return intervals than normally expected in this zone. Lower elevations are less susceptible to larger fires because of the natural lack of native plant cover, whereas upper elevations may experience larger fires as they generally support enough native fuels to carry large fires (Brooks and Matchett 2006). Brooks and Matchett (2006) advise, however, that additional research is necessary to confirm their results due to a limited dataset, and that longitude, elevation, and regional climatic conditions may cause substantial variation in observations.

A particularly bad fire year in the Mojave Desert was in 2005. According to fire history data from the BLM in Nevada, Utah, and Arizona, the 2005 wildfires burned over 140,000 acres of Critical Habitat (Table 9). The BLM's geospatial fire data depict slightly different acreages than have been reported elsewhere. According to the Utah Department of Wildlife Resources publication, *Tortoise Mortality within the Red Cliffs Desert Reserve Following the 2005 Wildfires* (Pub #07-05), 7,885 acres burned within the Red Cliffs Desert Preserve, which encompasses the majority of the Critical Habitat within the Upper Virgin River Recovery Unit.

Table 9. Area (acres) of desert tortoise Critical Habitat burned in the northeastern Mojave Desert during 2005*.

Critical Habitat Unit	Total Area Burned	Percent Burned
Beaver Dam Slope	53,528	26
Gold-Butte Pakoon	65,339	13
Mormon Mesa	12,952	3
Upper Virgin River	10,557	19

*Complete data sources: NV fire data from BLM as a single 2005 file: http://www.blm.gov/nv/st/en/prog/more_programs/geographic_sciences/gis/geospatial_data.html; AZ fire data from Forest Service, part of historic files [cross referenced against BLM ADSO fire data]: http://www.fs.fed.us/r3/gis/datasets.shtml; UT fire data from BLM, as part of historic fires file: http://www.blm.gov/ut/st/en/prog/more/geographic_information/gis_data_and_maps.print.html.

Studies were conducted in five burned areas within the range of the desert tortoise to determine immediate effects of the fire and fire suppression tactics, and to monitor the recovery of habitats (Esque *et al.* 1994, 2003). Between 16 to 81 hectares (40 and 200 acres) were surveyed for wildlife remains on each fire via walking transects 9 to 15 meters (30 to 50 feet) apart. Desert tortoise mortality was documented at 0 to 7 per transect, but live tortoises were also observed. There were statistically significant losses of perennial cover, but some fires left unburned patches of vegetation that can serve as refugia for tortoises and plants. These refugia may be important to the long-term recovery of burned desert ecosystems, as they provide cover sites for wildlife and serve as a source of plant propagules into adjacent burned areas. No destroyed burrows or desert tortoise mortalities were observed in surveys of routes used for off-road fire suppression activities in Utah, indicating that carefully planned and monitored fire suppression maneuvers can help stop the spread of damaging wildfires while reducing immediate and long-term tortoise mortality (Esque *et al.* 1994, 2003).

In general, as fire becomes more prevalent throughout the range of the desert tortoise, the threats to the species from mortality or injury by burning and smoke inhalation during fire events and impacts to desert habitats will also increase (Brooks and Berry 1999; Brooks and Esque 2002; Brooks *et al.* 2003; Brooks and Berry 2006; Brooks and Matchett 2006). Changes in habitat structure from shrub-dominated communities to non-native annual grasslands would limit the availability of cover sites for tortoises as well as alter species composition of food plants (Brooks and Esque 2002; Esque *et al.* 2003).

Grazing

At the time of listing, poor grazing management was thought to be a factor contributing to the degradation of desert tortoise habitats throughout the range of the species, but little research had been conducted that provided any direct correlations (USFWS 1990). Since then, impacts to tortoises from grazing on arid lands have been well documented (Fleischner 1994; Jones 2000), and grazing has been removed from the majority of desert tortoise habitat on public lands.

Since the time of listing, many grazing allotments within Critical Habitat have been retired; however large areas are also still grazed. Using a mosaic of data from the four BLM state GIS sites, verified for accuracy by the appropriate BLM field offices in 2009, we found that the Piute Eldorado and Ivanpah Critical Habitat units have had 99 and 97 percent, respectively, of the total area in each Critical Habitat Unit closed to grazing. However, 95 percent of Beaver Dam Slope, 41 percent of Mormon Mesa, and 33 percent of both Ord-Rodman and Fenner Critical Habitat units still remain available to grazing (Table 10).

Recovery of the landscape from grazing impacts is variable, but can take decades, and will likely require significant management effort beyond excluding livestock, and will be affected by other factors such as drought (GAO 1991; Friedel 1991; Laycock 1991). Poor grazing management can have direct and indirect impacts on desert tortoises and their habitats through trampling that results in direct mortality either while above ground or in burrows, and degradation of vegetation and soils (Boarman 2002). The magnitude of the threat on desert tortoise populations remains unclear, and the degree of impact depends on a number of factors including, but not limited to, resiliency of soil and vegetation types, type of livestock, stocking rates, season of use, and years of use with and without rest

(USFWS 1994). Other factors that interact with livestock grazing and can affect the degree and extent of impacts to desert tortoises include introduction and spread of weeds (Brooks 2009), previous grazing-induced changes in vegetation, fire, drought, and other land uses (USFWS 1994).

Table 10. Status of grazing allotments within desert tortoise Critical Habitat units.

Critical Habitat Unit	Allotment Status	Total Acres*	Percent of CHU
Beaver Dam Slope	Closed	6,754	3
	Open	150,871	74
	Open (seasonal)	43,249	21
Chemehuevi	Closed	113,313	12
	Open	238,537	25
Chuckwalla	Closed	1482	<1
	Open	0	0
Fenner	Closed	234,128	52
	Open	151,600	33
Fremont-Kramer	Closed		
	Open	18,050	3
Gold Butte-Pakoon	Closed	317,108	65
	Open	95,254	20
	Open (seasonal or inactive)	74,082	15
Ivanpah	Closed	615,121	97
	Open	7408	1
	Open (inactive)	5435	<1
Mormon Mesa	Closed	250,589	59
	Open	176,751	41
Ord-Rodman	Closed	78,459	31
	Open	84,764	33
Pinto Mountains	Closed	0	0
	Open	0	0
Piute-Eldorado	Closed	50,9194	99
	Open	922	<1
Superior-Cronese	Closed	398,142	52
	Open	1,927	<1
	Open (inactive)	55,762	7
Upper Virgin River	Closed	29,396	54
	Open	1,111	2

*These calculations are based on a mosaic of data from the four BLM state GIS sites, verified for accuracy by the appropriate BLM field offices in 2009; however, other sources (e.g., the Ely RMP) indicate further reduced acreages for some areas.

Oldemeyer (1994) suggests that the primary evidence that grazing adversely affects desert tortoises relates to an overlap in food habits of livestock and tortoises. Grazing is thought to reduce cover of shrubs and annual forbs. Studies in the eastern Mojave Desert on foraging behavior and food preferences of range cattle and desert tortoises showed that a dietary overlap (spatial and temporal) exists and that this overlap is greatest in the spring when fresh annual plants preferred by both desert tortoise and livestock are at their peak biomass and densities. Competition for these food plants is expected to be greatest when annual plants start to dry in the spring, before cattle and tortoises switch to other forage plants (Avery and Neibergs 1997).

Avery and Neibergs (1997) observed direct and indirect interactions between cattle and tortoises. Their study indicates that grazing during winter may destroy a large percentage of active tortoise burrows. They noted that tortoises outside an ungrazed cattle exclosure spent more nights outside of burrows than tortoises within the exclusion area, because more burrows were destroyed in the grazed area than in the ungrazed area. Almost 200 tortoise burrows were recorded as having been trampled during a survey of the 2.6-square-kilometer (1-square-mile) East Bajada (of the Black Mountains), Arizona, study plot in 1997 (Woodman *et al*. 1998). The presence of cattle dung, tracks, and trails suggested that most trampled burrows were caused by livestock, but some may have been due to horses or burros. In a study on translocated tortoises in the northwest Mojave Desert, one tortoise was found alive in its hibernation burrow even though the burrow had been crushed by cattle. It had skin lesions and had been parasitized by fly larvae. The tortoise was removed from the study because it was assumed that it would have died if it had remained trapped in the crushed burrow (Nussear 2004). Tortoises with home ranges located in areas of poorly managed cattle grazing may experience increased risk of mortality, increased energetic costs, and changes in activity time budgets (caused by additional time and effort required to build new burrows).

Comparative studies of historically grazed and never-grazed grasslands in southeast Utah (Neff *et al.* 2005) showed that grazing can continue to impact soil biogeochemical characteristics three decades after grazing had been removed. Reduced soil nutrient levels in the historically grazed site compared to the never-grazed site were attributed to erosion of nutrient-rich fine soil materials due to disturbance caused by grazing practices. Another factor that may contribute significantly to loss of soil nutrient content is wind erosion. Soil organic matter, carbon and nitrogen content, and microbial biomass were also lower in the grazed site. The decline of organic matter content may be attributed to the destruction of biological soil crusts or long-term changes in vegetation cover/composition resulting from grazing. This study illustrates the sensitivity of arid land biogeochemical processes to land use change and the need for a better understanding of potential long-term impacts from grazing practices in the southwestern United States (Neff *et al.* 2005).

Unmanaged livestock grazing, especially where plants are not adapted to large herbivorous mammals or where the non-native species are less palatable than the natives, can preferentially remove native vegetation, leaving non-native plants to grow under reduced competition (Wittenberg and Cock 2005:228). Studies at the Desert Tortoise Natural Area also showed that both abundance and diversity of native plants and animals were higher inside than outside of the protected desert tortoise habitat (Brooks 2000). It should be noted that the Desert Tortoise Natural Area has received limited protection since 1973, but has been effectively protected from sheep grazing and off-highway vehicle use through the installation of exclusion fencing since 1990 (Brooks 2000). Similarly, grazing (and simulated grazing treatments) negatively impacted native plant species, while non-native species were unaffected and demonstrated superior competitive abilities, at Carrizo Plain National Monument, California (Kimball and Schiffman 2003).

Agriculture

At the time of listing, agricultural land conversion was identified as one of the causes of large-scale, permanent habitat loss for the desert tortoise (USFWS 1990). Since that time, census data generally show a decline in the number of active farms and croplands as well as the number of acres used for these purposes in Arizona, California, and Nevada (U.S. Department of Agriculture 2007). Utah is the only state within the range of the Mojave population of the desert tortoise that has experienced an increase in agricultural land uses, although in Washington County where the tortoise primarily occurs, fewer than 121,405 hectares (300,000 acres) have been identified as farms or croplands (U.S. Department of Agriculture 2007). Currently, the primary threats to the desert tortoise from agriculture are the incidental use of these lands by ravens, which prey upon juvenile tortoises (Knowles *et al.* 1989a,b; Camp *et al.* 1993; Knight *et al.* 1999), and the susceptibility of fallow lands to become infested by non-native, potentially invasive species that can spread into adjacent wildlands. Agricultural activities may also impact desert tortoises through mortality to tortoises that have entered agricultural lands to forage, drawdown of the water table, introduction of invasive plants, production of fugitive dust, and possible introduction of toxic chemicals (Koehler 1977; Wilshire 1980; Berry and Nicholson 1984; R. Bransfield pers comm. 2010).

According to the National Land-Cover Database, between 1992 and 2001, <1 percent of area within any Critical Habitat unit is in agriculture (Table 11). These data suggest that this rate of land conversion to agriculture in the Mojave desert may not be a significant threat to the desert tortoise.

Table 11. Critical Habitat unit area (acres) converted from or to agriculture between 1992 and 2001 and total acres of agriculture in 2001.

Critical Habitat Unit	Converted to Agriculture ('92-'01)	2001 total in Agriculture
Beaver Dam Slope	33	54
Chemehuevi	-	-
Chuckwalla	7	82
Fenner	-	-
Fremont-Kramer	-	-
Gold Butte-Pakoon	9	15
Ivanpah	-	-
Mormon Mesa	0	2
Ord-Rodman	-	4
Pinto Mountains	-	-
Piute-Eldorado	-	-
Superior-Cronese	108	441
Upper Virgin River	-	532
TOTAL	157	1130

Energy and Mineral Development

At the time of listing, mining was identified as another cause of large-scale, permanent loss and fragmentation of desert tortoise habitat (USFWS 1990). Exploration for and development of energy and mineral resources, as well as sand and gravel extraction, result in habitat fragmentation and permanent habitat loss due to haul roads, development of facilities necessary to support large mining operations, ancillary facilities, leachate (solution resulting from leaching mining materials) ponds, and mine tailings. Additional impacts to the desert tortoise may result from fugitive dust and soil erosion, establishment of invasive plant species in disturbance zones, and introduction of toxins (see section C(1), Disease). Tortoises may be killed during exploration, construction and ongoing operations, and maintenance activities (USFWS 1994; Boarman 2002).

Currently in the desert southwest, there are more than 220 pending applications for renewable energy projects on over 2.3 million acres (this includes applications in Colorado and New Mexico, which are outside the range of the Mojave desert tortoise); over 100 of these applications are in California and over 70 are in Nevada. The vast majority of these projects are proposed on public lands managed by the BLM. Direct impacts, such as habitat loss, from energy development are expected to be extensive and will likely result in the need to translocate hundreds of desert tortoises out of harm's way. The energy development process on BLM lands, however, is constantly changing, with applicants submitting multiple requests to modify their projects or withdrawing their applications altogether (J. Crisp, BLM, pers. comm. 2007).

At the time the 1994 Recovery Plan was approved, it was estimated that 41 percent of high-density tortoise habitat throughout the species' range was leased or partially leased for oil or gas, and 2 percent was directly impacted by mining operations or leased for geothermal development (Luke *et al.* 1991; USFWS 1994). The extent of impacts to desert tortoise habitat and effects to tortoise populations from energy and mineral development is still not well documented. Cumulative habitat loss from mining-related disturbances combined with increased development to support those operations may pose the most significant impact (Lovich and Bainbridge 1999; Boarman 2002). However, very few oil and gas projects have been developed to date within the range of the Mojave population. According to 2007 data from the Great Basin Center for Geothermal Energy (oil and gas well sites) and the 2008 BLM's National Integrated Land System (NILS) information (oil and gas pipeline leases), there are 38 oil and gas well sites and 98,077 acres of oil and gas pipeline leases within desert tortoise critical habitat.

Landfills

Waste disposal areas were identified as permanent land uses that result in adverse impacts to desert tortoises and their habitats at the time of listing (USFWS 1990). There are more than 50 authorized sanitary landfills and waste disposal facilities known in the California and Nevada deserts (Boarman 2002). In other urban areas throughout the range of the tortoise, all communities produce solid waste that must be transported to appropriate facilities. Landfills and other waste disposal facilities potentially affect desert tortoises and their habitat through fragmentation and permanent loss of habitat, spread of garbage that attracts predators, introduction of toxic chemicals, increased road kill of tortoises on access roads, and increased predator populations (Boarman 2002) (see also section C(3), Disease and Predation).

According to a mosaic of landfill location data created from four State GIS sites, there are many types of landfills which occur within the range of the desert tortoise. All types of landfills potentially affect desert tortoises and their habitat through fragmentation and permanent habitat loss. Both composting and disposal landfills potentially also attract desert tortoise predators. Ravens nest disproportionately near point sources of food and water subsidies, such as landfills, which are expected to promote raven population growth and to allow ravens to occupy parts of the desert that otherwise would not support them (Kristan and Boarman 2007). Ravens are known to fly up to at least 40 miles (65 kilometers) in a day (Engel and Young 1992), and throughout the year ravens may travel over several hundred kilometers (Stiehl 1978, Heinrich *et al.* 1994). Hence, any given landfill may influence raven populations over a broad area. Waste tire sites may introduce toxic chemicals. Only three waste-handling and disposal sites occur within desert tortoise Critical Habitat: 1) the Barstow Sanitary Landfill within Ord-Rodman (disposal); 2) the Randsburg Transfer Station within Fremont-Kramer (transfer/processing); and 3) the Yermo/Calico Collection Center within Superior-Cronese (transfer/processing). However with the exception of raven predation, which is considered one of the most important consequences of landfills on desert tortoise, negative effects on tortoises associated with the presence of landfills have not been quantified (Boarman 2002).

Military Operations

Military operations in the Mojave Desert have taken place since as early as 1859 and were identified as a threat to desert tortoises at the time of listing because of the large-scale, permanent impacts that result from these activities (USFWS 1990, 1994; Boarman 2002). The military bases and test ranges in the Mojave Desert include the Nevada Test and Training Range, Nellis Air Force Range in Nevada; and the Edwards Air Force Base, Twentynine Palms Marine Corps Air Ground Combat Center, Barstow Marine Corps Logistics Bases (includes the Yermo Annex, Main Base at Nebo, and the Marine Corps Rifle Range), Fort Irwin National Training Center, and China Lake Naval Air Weapons Station in California. The Chocolate Mountains Aerial Gunnery Range in California is the primary base affecting desert tortoise habitat in the Colorado Desert (USFWS 1994). All of these military facilities encompass and can impact desert tortoise habitat. It is important to also recognize, however, the value of military lands to conservation (Stein *et al*. 2008). Restricted-access military lands (at least those not under intensive, surface-disturbing training) provide important habitat and connectivity between public lands designated for conservation.

Military activities that impact desert tortoises and their habitats can be categorized as: (1) construction, operation, and maintenance of bases and support facilities (air strips, roads, etc.); (2) development of local support communities, including urban, industrial, and commercial facilities; (3) field maneuvers including tank traffic, air to ground bombing, static testing of explosives, and removal or detontation of unexploded ordnance, shell casings, and ration cans; and (4) release of toxic chemicals into the environment and their remediation.

According to land ownership information from four BLM state GIS sites from 2007-2009, in the Western Mojave Recovery Unit, 27 percent of desert tortoise habitat is on Department of Defense land. Over 25 percent of the Superior-Cronese Critical Habitat Unit and 12 percent of the Ord-Rodman unit is on military lands. Although only 6 percent of the modeled habitat within the Colorado Desert Recovery Unit is managed by the Department of Defense, military lands make up 19 percent of the Chuckwalla unit (Tables 12 and 13).

Table 12. Area (acres) of modeled desert tortoise habitat (Nussear *et al.* 2009) on Department of Defense (DOD) land for each Recovery Unit.

Recovery Unit	Habitat within RU	Modeled habitat on DOD land	Percent of all Habitat within RU
Western Mojave	7,582,092	2,071,987	27
Colorado Desert	4,948,900	293,086	6
Eastern Mojave + Northeastern Mojave[1]	7,776,934	395,677	5
Upper Virgin River	232,320	0	0

[1]The boundary between the Eastern Mojave and Northeastern Mojave recovery units depicted in the draft Revised Recovery Plan is currently being re-evaluated in light of new information since that draft was published. For the purposes of this review, data summaries for these recovery units are combined.

Table 13. Area (acres) modeled habitat (Nussear *et al.* 2009) within Critical Habitat Units (CHU) on Department of Defense (DOD) land.

Name	Modeled Habitat on DOD land	Total Critical Habitat on DOD land	Percent CHU area on DOD land
Beaver Dam Slope	0	0	-
Chemehuevi	0	0	-
Chuckwalla	187,413	189,479	19
Fenner	0	0	-
Fremont-Kramer	63,337	63,516	12
Gold Butte-Pakoon	0	0	-
Ivanpah	0	0	-
Mormon Mesa	7	30	<1
Ord-Rodman	728	728	<1
Pinto Mountains	0	0	-
Piute-Eldorado	0	0	-
Superior-Cronese	180,737	191,569	25
Upper Virgin River	0	0	-

All of the threats associated with military activities described above continue to affect desert tortoises and their habitats today. For example, in a study of tortoise populations at several sites on the Fort Irwin National Training Center in California, tortoises living in historically or recently used military maneuver areas had significantly higher shell disease than a site where military activities had not taken place (Berry *et al.* 2006). The expansion of military bases and associated activities into previously unused areas occupied by desert tortoises also negatively impacts the species. In 2004, we issued a biological opinion to the Department of the Army for the use of additional training lands at the Fort Irwin National Training Center. This expansion will result in the loss or degradation of approximately 76,081 hectares (188,000 acres) of desert tortoise habitat, including approximately 30,351 hectares (75,000 acres) within the

Superior-Cronese Critical Habitat Unit, and the likely translocation of over a thousand desert tortoises to areas off base; to date, approximately 600 individuals have been moved. To mitigate this effect, the Department of the Army has purchased approximately 39,000 hectares (97,000 acres) of lands formerly owned by the Catellus Development Corporation and the private land base properties of three cattle allotments (Harper Lake, Cronese Lakes, and Cady Mountain) in the western Mojave Desert to minimize impacts associated with the expanded training areas (R. Bransfield, USFWS, pers. comm. 2007). The BLM subsequently retired these grazing allotments, comprising approximately 101,000 hectares (250,000 acres), of which approximately 20,750 hectares (51,000 acres) are within Critical Habitat. A plan guiding the translocation of tortoises in the expansion area uses this as an opportunity to investigate the effects of such translocation/population augmentation activities on the subject population, which will inform future recovery efforts (Esque *et al.* 2005). Finally, the Marine Corps Air Ground Combat Center is also evaluating alternatives for expanding its training areas (U.S. Department of the Navy 2008).

Utility Corridors

At the time of listing, construction and maintenance of power plants and utility lines were identified as threats to the desert tortoise and its habitats (USFWS 1990). By 1994, most Critical Habitat units had one or more power lines, natural gas pipelines, fiber optic cables, and/or communication sites within their proposed boundaries (USFWS 1994). Disturbances associated with these corridors are usually linear in nature, and the zone of disturbance can vary in width from 15.2 meters (50 feet) to several hundred meters or yards, depending on the nature of the utility (USFWS 1994). The 2008 Programmatic Environmental Impact Statement for *Designation of Energy Corridors on Federal Land in the 11 Western States* designated west-wide energy corridors totaling almost 10,000 kilometers (6,214 miles) in length with a maximum width of approximately 1.1 kilometers (3,500 feet). Impacts to desert tortoise habitat and individuals from utility corridor development occur both during initial construction as well as during long-term maintenance activities (Boarman 2002). Additionally, utility corridors are often used by the public for off-highway vehicle and recreational access.

Using 2003 U.S. Geological Survey Snake River Field Station data for the occurrence of powerlines in the Western U.S., we found a total of 1,634 kilometers (1,015 miles) of utility lines within desert tortoise critical habitat (Table 14). Using a mosaic of utility corridor information compiled from the BLM (Arizona: 2008; California: 1994; Nevada: 2007) and Argonne National Laboratory (2008 Programmatic Environmental Impact Statement, Designation of Energy Corridors on Federal Land in the 11 Western States) with the standard width of 1,067 meters (3,500 feet), we found 189,956 hectares (469,391 acres) of utility corridors within desert tortoise critical habitat (Table 14).

LaRue and Dougherty (1999) interviewed biological monitors responsible for tracking impacts to desert tortoises under more than 230 biological opinions issued by our southern California and Nevada offices. They reported that 80 percent of the tortoises that were killed in these two states were found along utility corridors. Most of these mortalities resulted from the construction of two large pipeline projects; very few tortoises have been killed during utility maintenance projects (R. Bransfield, pers. comm. 2007). While tortoises may be observed within these corridors, continual vehicular use along access roads may result in road-kills (Boarman 2002). Utility towers also provide nesting substrate and hunting perches to avian predators, such as ravens.

Table 14. Length (kilometers) of utility lines and area (1,067 meter [3,500 feet] width) of utility corridors (acres) within desert tortoise Critical Habitat units.

Critical Habitat Unit	Utility Line length	Utility Corridor Area
Beaver Dam Slope	71	16,509
Chemehuevi	285	89,914
Chuckwalla	158	43,919
Fenner	155	27,914
Fremont-Kramer	134	41,396
Gold Butte-Pakoon	0	885
Ivanpah	173	41,073
Mormon Mesa	149	40,019
Ord-Rodman	136	19,241
Pinto Mountains	35	3
Piute-Eldorado	251	72,733
Superior-Cronese	102	75,782
Upper Virgin River	16	0
TOTAL	1,634	469,391

Vandalism and Harvest of Vegetation

Vandalism and harvest of vegetation, particularly cacti and yuccas, were identified as potential threats to desert tortoises and their habitats in the 1994 Recovery Plan (USFWS 1994a). Harvest of vegetation includes the removal of vegetation for personal or economic purposes (*i.e.*, use in landscaping or sale for profit). Vandalism of vegetation is considered to be the deliberate destruction of vegetation (*i.e.*, shooting, crushing). While these activities may still occur on a relatively small scale and may pose some threat on a localized level, there is no recent documentation that indicates this activity poses a significant or widespread threat to tortoise populations throughout their range.

Summary of Factor A

Since the time of listing, many threats associated with Factor A continue to impact the desert tortoise. In particular, human populations, paved and unpaved roads, non-native invasive plants and the associated threat of wildfire, and prospective energy development (especially renewable energy development and associated utility corridors) have increased. These threats result in continued habitat loss, population fragmentation, nutritional compromise, soil erosion, and indirect impacts associated with increased human presence, including illegal dumping, human-subsidies for predators, and introduction of toxins. Since the time of listing, off-highway vehicle areas and trails have been formally designated, but unauthorized use continues to be a significant source of habitat degradation. Many grazing allotments within Critical Habitat have been retired; however large areas are also still grazed.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Collection by Humans

Threats to the desert tortoise identified in the listing rule and 1994 Recovery Plan include the deliberate removal of desert tortoises by humans for use as food (Berry and Nicholson 1984; Swingland and Klemens 1989; Schneider and Everson 1989; USFWS 1990; Ditzler 1991; USFWS 1994; BLM files 2006), and collection and commercial trade for pets (Berry and Nicholson 1984; St. Amant 1984; Berry and Burge 1984; USFWS 1990, 1994). Desert tortoises are protected from collection under both Federal and State law in all states where it occurs; however, the legal status has not always served as a deterrent to this activity (Boarman 2002). For example, nine cases of illegal collection were documented from the Red Cliffs Desert Reserve, Washington County, Utah, between May 2003 and May 2006, including four cases within five weeks during 2006 (A. McLuckie, Utah Division of Wildlife Resources, pers. comm. 2006). While illegal collection of desert tortoises still occurs and could possibly impact local populations, little quantitative evidence exists to support it as a significant threat causing declines in the Mojave populations (Boarman 2002). Also, information specific to this threat is limited owing to the wide distribution of the species coupled with limited resources available to provide for additional law enforcement officers and wardens on the ground (see section D, Inadequacy of Existing Regulatory Mechanisms).

Deliberate Maiming and Killing by Humans

Little additional information regarding maiming and killing of desert tortoises has been obtained since the time of listing (USFWS 1990) or the publication of the 1994 Recovery Plan (USFWS 1994a) and the relative significance of this threat remains unknown. Postmortem forensic analyses determined that 14.3 percent of 635 carcasses collected at 11 of 27 California desert sites between 1976 and 1982 showed evidence of gunshots (Berry 1986b). Evidence of gunshot was significantly higher in carcasses from the western Mojave than from the east Mojave or Colorado Desert (Berry 1986b), which may be a function of the proximity of human populations in the western Mojave region compared to that in the east Mojave or Colorado Desert.

Research Activities

Research activities were not identified as threats to desert tortoise at the time of listing, nor do we consider research a threat at this time. Potential stress to desert tortoises from handling may vary depending on the time, frequency, and activity involved. Invasive procedures associated with obtaining physiological data for research can cause significant stress to individuals (Berry *et al.* 2002a). For example, female tortoises that void their bladders during handling may be at a reproductive disadvantage since the loss of fluid may negatively affect egg production, which requires higher total body water in reproductive females than non-reproductive females (Averill-Murray 2002a). In one study, tortoises that urinated during handling had lower survival than those that did not (Averill-Murray 2002a).

Despite the inherent low-level risk associated with research activities covered under recovery permits, incidental injury or mortality of desert tortoises is rare. However, if injury or mortality should occur, the permit is suspended until the circumstances surrounding the incident are reviewed and appropriate procedures are in place to prevent further injury or mortality. In any given year, we generally issue fewer than 15 recovery permits for desert tortoise research. Because of the emphasis that we, through the Desert Tortoise Recovery Office, intend to place on recovery-related research activities pertaining to the desert tortoise, the number of permits issued may increase over the next few years.

Summary of Factor B

Little quantitative evidence regarding collection and deliberate maiming and killing of desert tortoise by humans has been obtained since time of listing, and the relative significance of this threat remains unknown.

FACTOR C: Disease or Predation

Disease

Disease was identified at the time of listing as an increasing concern relative to the health of desert tortoise populations, particularly in the western Mojave Desert (USFWS 1990). Disease is a natural phenomenon within wild animal populations, and epidemic outbreaks can have catastrophic effects on small or declining populations. To date the available evidence indicates that upper respiratory tract disease is probably the most important infectious disease for desert tortoises (Hudson *et al*. 2009). Less is known about other diseases that have been identified in the desert tortoise (*e.g.*, herpesvirus, cutaneous dyskeratosis or shell disease, shell necrosis, bacterial and fungal infections, and urolithiasis or bladder stones) (Jacobson *et al.* 1994, 1995; Homer *et al.* 1998; Berry *et al.* 2002b; Origgi *et al.* 2002).

Upper respiratory tract disease: At least two pathogenic species of *Mycoplasma* known to cause upper respiratory tract disease in desert and gopher tortoises have been identified (*M. agassizii* and *M. testudineum*) (Brown *et al.* 1994, 1999, 2001; Brown *et al*. 2002; Berry 1997; Jones 2008). The pathogens are likely transmitted by contact with an infected individual or aerosols (airborne liquid droplets or solid particles). Once infected, tortoises may develop lesions in the nasal cavity, excessive nasal discharge, swollen eyelids, sunken eyes, lethargy, and possible death (Jacobson *et al.* 1991; Schumacher *et al.* 1997; Homer *et al.* 1998; Berry and Christopher 2001). However, in-depth study of the desert tortoise's immune system and epidemiological study of disease dynamics across space and time are necessary to more thoroughly understand the factors involved in the spread and virulence of the disease in the wild (Boarman 2002; Sandmeier *et al*. 2009).

Because the release or escape of infected captive tortoises has been implicated as a potential cause of outbreaks of upper respiratory tract disease in natural populations in the Mojave Desert, Johnson *et al.* (2006) evaluated captive tortoises in Barstow, California, to investigate pathogen exposure. Anti-*Mycoplasma* antibodies were present in 82.7 percent of the tortoises tested (sample size of 179), and anti-herpesvirus antibodies were observed in 26.6 percent of the animals (sample size of 109). Jones (2008) also found captive tortoises to be 1.8 to 5.4 times more likely to test positive for anti-*Mycoplasma* antibodies than free-ranging Sonoran desert tortoises around Tucson, Arizona. Further, a higher incidence of disease was found in suburban areas around Tucson, suggesting that habitat degradation associated with urbanization may be a stressor that contributes to disease outbreaks (Jones 2008). These studies, however, were completed prior to Hunter *et al.*'s (2008) work that indicates some tortoises may carry innate anti-*Mycoplasma* antibodies. Reasons for the susceptibility of tortoises to upper respiratory tract disease remain speculative and require further study (Boarman 2002).

Shell disease: The most commonly described shell disease in desert tortoises is cutaneous dyskeratosis, which manifests itself as lesions along scute sutures of the plastron and sometimes on the carapace; lesions then spread to the scutes themselves (Jacobson *et al*. 1994; Homer *et al*. 1998). Shell diseases have been seen in tortoise populations in the eastern Mojave and Colorado deserts of California but less so in the western Mojave Desert (Jacobson *et al*. 1994; Christopher *et al*. 2003), occurring in all sizes and ages of desert tortoises but usually more commonly in adults (Jacobson *et al*. 1994; Homer *et al*. 1998). It appears that shell diseases reflect metabolic and physiological changes that involve more than the shell itself (Homer *et al*. 1998, 2001). Little is known about the causes of shell disease; no evidence has yet been found to indicate a bacterial or viral origin, in spite of directed research efforts by pathologists (Jacobson *et al*. 1994; Homer *et al*. 1998). Five-years of health profiles at three sites in the California Mojave Desert (Desert Tortoise Research Natural Area, Ivanpah Valley, Goffs) found that the numbers of tortoises with moderate to severe plastron disease and active carapace lesions increased significantly between 1990 and 1995, especially at Goffs (Christopher *et al*. 2003). Shell disease was also found significantly more severe with increasing tortoise age, suggesting a chronic, cumulative problem (Christopher *et al*. 2003). Cutaneous dyskeratosis has been associated with mortality on the Chuckwalla Bench in California (Berry 1997). However the extent to which shell diseases contribute to population declines in desert tortoises remains unclear (Jacobson *et al*. 1994).

Herpesvirus: In tortoises with herpesvirus infection, clinical signs range from a mild conjunctivitis (inflammation of the membrane surrounding the eye) to severe lesions and plaques on the tongue and hard palate (Johnson *et al*. 2006). Plaques (small growths) typical of herpesvirus were reported in tortoises in Goffs and Ivanpah (Christopher *et al*. 2003). Herpesvirus infections have also been reported in other species of turtles and tortoises, especially in those associated with the exotic trade (Martel *et al*. 2009).

The contribution of herpesvirus to population declines in desert tortoise is unknown. However, herpesvirus infections have been reported in captive desert tortoises and have been associated with illness and mortality (Johnson *et al*. 2006). Clinical herpesvirus infections can be rapid and progressive, resulting in large die-offs in other species of vertebrate animals as well (Johnson *et al*. 2006). Therefore, herpesvirus could become a serious threat to desert tortoise populations, especially for those living near the urban-desert interface where wild individuals are more likely to encounter infected captive tortoises or turtles.

Effects of one disease on susceptibility to other diseases: There is evidence that any one disease may predispose desert tortoises to other diseases (Christopher *et al*. 2003). However, it is not known whether this is a cause or effect. That is, it is not known whether disease in an individual increases susceptibility to other diseases in that individual or whether an individual's baseline susceptibility to disease causes that individual to get more diseases. Nevertheless, positive nasal cultures for *Mycoplasma agassizii* had relatively high positive predictive values for tortoises with moderate to severe shell disease (Christopher *et al*. 2003). Pathologists also report that the location and histologic (structural) appearance of lesions seen in tortoises with cutaneous dyskeratosis are suggestive of either a deficiency disease or toxicosis or both (Jacobson *et al*. 1994, Homer *et al*. 1998).

Toxicants and Disease Susceptibility

Bioaccumulation of mercury was identified at the time of listing as a potential health concern in desert tortoise populations (USFWS 1990). The role of environmental contaminants in directly inducing toxicosis-related diseases (*e.g.*, liver diseases) and increasing susceptibility to infectious diseases has been suggested as a significant source of mortality (Homer *et al.* 1994, 1996; Berry 1997; Boarman 2002; Christopher *et al*. 2003). Elevated mercury and arsenic levels have been associated with diseased tortoises in the wild (Jacobson *et al*. 1991; Homer *et al*. 1998; Seltzer and Berry 2005; Chaffee and Berry 2006). Necropsy and analyses of kidney, liver, and scute tissues suggested that tortoises from California with a variety of diseases (upper respiratory tract infection, urolithiasis, metabolic disease, and shell diseases) had statistically significantly higher levels of potentially toxic elements as compared to healthy tortoises (Berry *et al*. 1997). No one single element or group of known or potentially toxic elements was found at elevated levels in the tissues of diseased and dying tortoises. Instead, various elements can be found both at the same and different sites. It has been hypothesized that elemental toxicity may compromise the immune system of desert tortoises or otherwise detrimentally affect physiological function, rendering them more susceptible to disease, but further investigation is needed.

Illegal dumping of hazardous wastes may expose tortoises to increased levels and possible consumption of toxic substances. Garbage, litter, and toxic spills may affect tortoises on a localized level where these activities are concentrated (Boarman 2002). Toxicant load in the environment may also be a factor that induces diseases related to toxicosis (*e.g.*, liver disease) and influences the susceptibility of tortoises to infectious diseases and mortality. For example, tortoises that died of mycoplasmosis at the Desert Tortoise Natural Area in 1989 through 1990 had 11 times the mercury content in their livers than tortoises from a control area (Jacobson *et al.* 1991). Some necropsies showed elevated levels of arsenic in scutes (Seltzer and Berry 2005).

Fugitive dust containing toxicants that affect tortoises may be released from anthropogenic sites such as mines, roads, construction, and other disturbances. Chaffee and Berry (2006) collected soil, stream sediment, and plant samples at six tortoise habitat study areas in the Mojave and Colorado deserts. They analyzed samples for up to 66 different elements to determine their distribution and abundance at a regional and local level, to identify potential sources of toxicants in desert tortoise habitats. Some measurements of high concentrations of arsenic, mercury, and lead, were attributed to mining and vehicle exhaust. High levels of soil and plant arsenic extended more than 14 kilometers (9 miles) from some existing mine sites, and mercury was detected more than 5 kilometers (3 miles) from some mine tailings. Traces of lead were found more than 21 kilometers (13 miles) from a paved road and likely had been redistributed by vehicle exhaust, wind, and rain events. Elevated levels of these elements have been observed in ill tortoises found in these areas; however, additional research is necessary to ascertain the direct effects of elemental toxicants on desert tortoise health and their susceptibility to disease (Chaffee and Berry 2006).

<u>Predation</u>

Desert tortoises, particularly hatchlings and juveniles, are preyed upon by several native species of mammals, reptiles, and birds. The common raven has been the most highly visible predator of small tortoises, while coyotes (*Canis latrans*) have been commonly implicated in deaths of adult tortoises. The population-level effects of these or other predators are unknown. Natural predation in undisturbed, healthy ecosystems is generally not considered a threat, but under some circumstances predation comes to the forefront as a management concern, especially where landscapes have been altered and intensive human use occurs or in times of extreme drought. During times of drought when typical prey species are limited, food habits of predators may shift and tortoises become more frequent components of their diets (USFWS 1994; Boarman 2002). This reiterates the importance of combined and synergistic effects of threats. For example, predation pressure by ravens is increased through elevated raven populations as a result of resource subsidies associated with human activities.

Other avian predators of the desert tortoise include red-tailed hawks (*Buteo jamaicensis*), golden eagles (*Aquila chrysaetos*), loggerhead shrikes (*Lanius ludovicianus*), American kestrels (*Falco sparvarius*), burrowing owls (*Athene cunicularia*), and greater roadrunners (*Geococcyx californianus*) (Boarman 1993). Coyotes, kit foxes (*Vulpes macrotis*), mountain lions (*Felis concolor*), ground squirrels (*Spermophilus* spp.), and free-roaming dogs are some of the known mammalian predators (Bjurlin and Bissonette 2001; Boarman 2002; M. McDermott, Southern Nevada Environmental, Inc., pers. comm. 2006, K. Nagy, University of California-Los Angeles, pers. comm. 2006; Medica and Greger 2009, Riedle *et al*. 2009).

While few data exist to quantify the impact of mammalian predation on desert tortoises, in 2008 elevated mortality (as high as 45 percent) occurred at sites throughout the listed range of the desert tortoise (Esque *et al.* submitted). Although no temporal prey base data are available for analysis from any of the study sites, Esque *et al*. hypothesized that high predation rates were influenced by low population levels of typical prey for coyotes due to drought conditions in previous years. Finally, invertebrate predators of eggs and hatchling tortoises include native fire ants (*Solenopsis* spp.) (Nagy *et al*. 2007).

The best-documented predator of small tortoises is the common raven. In the desert southwest, common raven populations have increased over the past 25 years (greater than 1000 percent), probably in response to increased human populations, associated food and water subsidies, and anthropogenic changes to the landscape (Boarman and Berry 1995; Boarman *et al.* 1995; Boarman *et al.* 2006). For instance, ravens obtain food in the form of organic garbage from landfills and trash containers, water from sewage ponds and municipal areas, and nesting substrates on billboards, utility towers, bridges, and buildings (Boarman *et al.* 2006). Particularly in the Western Mojave and Coachella Valley, linear features such as roads and utility corridors and other urban sites such as landfills and sewage ponds have been shown to attract common ravens (Knight and Kawashima 1993; Boarman *et al.* 1995; Knight *et al.* 1999). The use of anthropogenic nesting substrates facilitates increased predation of juvenile tortoises, especially within about 0.4 kilometers (0.25 miles) of the raven nest (Boarman 2002; Kristan and Boarman 2003). The presence of roads may encourage such opportunistic species because road-killed animals are a reliable food source (Camp *et al.* 1993; Boarman and Sazaki 2006).

Raven numbers were shown to decrease with distance from urban sites in the Western Mojave, placing tortoises that occur in the urban-desert interface at higher risk of predation (Kristan and Boarman 2003). This risk also increases with the numbers of ravens in the vicinity, and the distribution of breeding and non-breeding ravens is likely to influence patterns of predation across the landscape. Breeding ravens tend to disperse more evenly across suitable habitats, whereas non-breeding birds are concentrated around anthropogenic sites. This suggests that occupied desert tortoise habitats distant from population centers and the urban-desert interface experience reduced predation pressures from ravens (Boarman 2002; Kristan and Boarman 2003). For example, Campbell (1986) found 136 carcasses of juvenile desert tortoises with evidence of raven predation at the base of fence posts on the perimeter of the Desert Tortoise Natural Area. Berry *et al*. (1990) reported that 30 and 45 percent, respectively, of all desert tortoise deaths at 2 study plots during a 6-year period were probably caused by raven predation; up to 75 percent of deaths of tortoises less than 103 millimeters (4 inches) carapace length were attributed to raven predation at these plots.

Determining precise demographic impacts of (increased) raven predation on desert tortoise populations is complicated because of the difficulty of monitoring small, hard to find juvenile tortoises (Boarman 2002). Nevertheless, the potential impact to desert tortoise populations from raven predation is a conservation concern, especially where subsidized predators are able to persist in large numbers despite declines in their prey base. Populations of long-lived animals like the desert tortoise can sustain moderate levels of annual juvenile mortality (*e.g.*, 25 percent), but in the face of depressed adult survival, juvenile mortality must be reduced to approximately 5 percent to ensure recruitment into the breeding population (Congdon *et al*. 1993). Human-subsidized predators thus put at great disadvantage any prey species such as the desert tortoise that is unable to rebound from predation pressures (Kristan and Boarman 2003).

<u>Summary of Factor C</u>

The available evidence indicates that upper respiratory tract disease is probably the most important infectious disease for desert tortoises, and external factors, such as environmental contaminants and drought, may increase susceptibility. However, additional research is needed to clarify the role of disease in desert tortoise population dynamics relative to other threats. Ravens and coyotes have dramatically increased in the desert southwest over the past 25 years due to anthropogenic subsidization and have been commonly implicated in tortoise predation. Instances of isolated, very intense predation suggest predation comes to the forefront as a management concern, especially where landscapes have been altered and intensive human use occurs or in times of extreme drought. The population-level effects of these or other predators, however, are unknown.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

State Laws

The final listing rule acknowledged that all four states within the range of the Mojave population of the desert tortoise have regulatory mechanisms in place to protect the species (USFWS 1990). These included protection under Arizona Revised Statutes Title 17; Nevada Administrative Code 503.080, under which the species is listed as threatened; Utah Division of Wildlife Resources Administrative Rule R657-53; and listing under the California Endangered Species Act (CESA). The federal listing rule (USFWS 1990) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms.

State laws in Arizona, Nevada, and Utah do not regulate degradation of habitat, making mitigation of impacts to potentially unoccupied but suitable habitat difficult. Additionally, there are several State and Federal laws and regulations that are pertinent to federally listed species, each of which may contribute in varying degrees to the conservation of federally listed and non-listed species. These laws, most of which have been enacted in the past 30 to 40 years, have greatly reduced or eliminated the threat of wholesale habitat destruction. Also, a great deal of effort has been dedicated to planning by the various land management agencies whose jurisdictions include desert tortoise habitat. Many of the existing plans include language specific to protection of the species, such as designating wildlife habitat management areas, which calls for limitations on off-highway vehicle use and competitive/organized events, grazing, vegetation harvest, and collection of desert tortoises (see Conservation Efforts).

Federal Protections

The Federal Endangered Species Act: The Endangered Species Act of 1973, as amended (Act), is the primary Federal law that has provided protection for the desert tortoise since its listing as a threatened species in 1990. Section 7(a)(2) requires Federal agencies to consult with the Service to ensure that any project that is federally funded, authorized, or carried out does not jeopardize a listed species or adversely modify its Critical Habitat. The projects have included urban, residential, and commercial development, expansion of military installations and training activities, highway-widening projects, energy and utility corridor projects, grazing, revegetation projects subsequent to wildfire, and programmatic land and resource management planning. Consultations are primarily conducted with the BLM range-wide and Department of Defense in California and Nevada.

For projects without a Federal nexus that would likely result in incidental take of listed species, the Service may issue incidental take permits to non-Federal applicants pursuant to 10(a)(1)(B) of the Act. To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved habitat conservation plan (HCP) that details measures to minimize and mitigate the project's adverse impacts to listed species. Regional HCPs in some areas now provide an additional layer of regulatory protection for covered species. The various HCPs that address desert tortoise are discussed under Conservation Efforts.

Other listed species in the Mojave Desert overlap only minimally, if at all, with the desert tortoise. These species include the Amargosa vole (*Microtus californicus scirpensis)*, southwestern willow flycatcher (*Empidonax traillii extimus)*, Coachella valley fringe-toed lizard (*Uma inornata), Astragalus albens* (Cushenberry milk-vetch), *Astragalus phoenix* (Ash Meadows milk-vetch) and *Erigeron parishii* (Parish's daisy). Thus, the desert tortoise would not be afforded vicarious protection of the Act by other sympatric species.

National Environmental Policy Act (NEPA): NEPA (42 U.S.C. 4371 *et seq*.) provides some protection for listed species, including the desert tortoise, that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires the Federal agency to analyze the project for potential impacts to the human environment, including natural resources. However, NEPA does not require that adverse impacts be mitigated, only that impacts be assessed and the analysis disclosed to the public.

Federal Clean Water Act: Section 404 of the Clean Water Act may afford very limited protection to the desert tortoise. The Army Corps of Engineers (Corps) issues permits for the discharge of dredged or fill material into navigable waters of the United States. The Corps interprets "the waters of the United States to be those that are navigable at least in part, those that cross state lines, and some of their tributaries." The Clean Water Act requires project proponents to obtain a permit from the Corps before initiating many types of activities (such as grading or discharge of soil) that could harm jurisdictional waters.

Sikes Act: The Sikes Act (16 U.S.C. 670) authorizes the Secretary of Defense to develop cooperative plans with the Secretaries of Agriculture and Interior for natural resources on public lands. The Sikes Act Improvement Act of 1997 requires Department of Defense installations to prepare Integrated Natural Resource Management Plans (INRMPs) that provide for the conservation and rehabilitation of natural resources on military lands consistent with the mission of military installations to ensure the readiness of the Armed Forces. The INRMPs incorporate, to the maximum extent practicable, ecosystem management principles and provide the landscape necessary to sustain military land uses. While INRMPs are not technically regulatory mechanisms because their implementation is subject to funding availability, they can be an added conservation tool in promoting the recovery of endangered and threatened species on military lands. All of the INRMPs for the military bases and test ranges in the Mojave Desert address the desert tortoise.

National Park Service (NPS) Organic Act: The NPS Organic Act of 1916 (39 Stat. 535, 16 U.S.C. 1, as amended), states that the National Park Service “shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations … to conserve the scenery and the national and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.” The National Park Service Management Policies indicate that Parks will “meet its obligations under the National Park Service Organic Act and the Act to both pro-actively conserve listed species and prevent detrimental effects on these species.” This includes working with the Service and undertaking active management programs to inventory, monitor, restore, and maintain listed species habitats, among other actions.

National Forest Service Management Act (NFMA): The National Forest Management Act (36 C.F.R. 219.20(b)(i)) has required the USFS to incorporate standards and guidelines into Land and Resource Management Plans, including provisions to support and manage plant and animal communities for diversity and for the long-term, range-wide viability of native species. Very little tortoise habitat is found on National Forests (Table 6).

Federal Land Policy and Management Act of 1976 (FLPMA): The BLM is required to incorporate Federal, State, and local input into its management decisions through Federal law. The FLPMA (Public Law 94-579, 43 U.S.C. 1701) was written “to establish public land policy; to establish guidelines for its administration; to provide for the management, protection, development and enhancement of the public lands; and for other purposes.” Section 102(f) of the FLPMA states that “the Secretary [of the Interior] shall allow an opportunity for public involvement and by regulation shall establish procedures … to give Federal, State, and local governments and the public, adequate notice and opportunity to comment upon and participate in the formulation of plans and programs relating to the management of the public lands.” Additionally, section 102(c) of the FLPMA states that the Secretary shall “give priority to the designation and protection of areas of critical environmental concern” in the development of plans for public lands. Although the BLM has a multiple-use mandate under the FLPMA which allows for grazing, mining, and off-road vehicle use, it also has the ability under the FLPMA to establish and implement special management areas such as areas of critical environmental concern, wilderness, research areas, etc., that can reduce or eliminate actions that adversely affect species of concern, including listed species (see Conservation Efforts below for a list of management plans that include desert tortoise).

The Lacey Act: The Lacey Act (P.L. 97-79), as amended in 16 U.S.C. 3371, makes unlawful the import, export, or transport of any wild animals whether alive or dead taken in violation of any U.S. or Indian tribal law, treaty, or regulation, as well as the trade of any of these items acquired through violations of foreign law. The Lacey Act further makes unlawful the selling, receiving, acquiring, or purchasing of any wild animal, alive or dead. The designation of "wild animal" includes parts, products, eggs, or offspring.

In summary, the Endangered Species Act remains the primary Federal law that provides protection for the desert tortoise since its listing as threatened in 1990. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but, with the exception of the California Fish and Game Code, do not guarantee protection for the species absent its status under the Federal Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Act, especially on Federal lands.

Law Enforcement

A great deal of effort has been dedicated to planning by the various Federal and State land management agencies whose jurisdictions include desert tortoise habitat. While many of the existing land use plans include language specific to protection of the species, such as limiting off-highway vehicle use and competitive/organized events, grazing, vegetation harvest, and collection of desert tortoises, agency multiple-use mandates require a complex balance of natural resource conservation and public use of Federal and State lands. Also, land management agencies frequently do not have sufficient funding to enforce their land use regulations and personnel are often spread across vast landscapes and have multiple resource responsibilities (USFWS 2008). Current information indicates that each law enforcement officer is responsible for an average of more than 89,000 hectares (220,000 acres), although this varies widely among field offices.

Land Acquisitions, Exchanges, and Transfers

Land exchanges and transfers were identified at the time of listing as potential threats that could result in habitat loss and increased fragmentation of desert tortoise populations (USFWS 1990). Tortoise habitat that is exchanged out of Federal ownership is at greater risk of development, resulting in loss of habitat on the new private holdings (Sievers *et al.* 1988). Transactions may also be executed in the interest of securing additional lands targeted for conservation of the desert tortoise and other sensitive species or habitats. For example, between 1999 and 2004, the U.S. Department of the Interior acquired over 237,551 hectares (587,000 acres) of land through the California Desert Lands Acquisition, led by The Wildlands Conservancy, a non-profit conservation organization (see Conservation Efforts section).

In 1988, BLM exchanged 11,758 hectares (29,055 acres) of public land in the Coyote Springs Valley in southern Nevada to Aerojet-General Corporation for private wetlands in Florida for wildlife conservation under the Nevada-Florida Land Exchange Authorization Act. In addition, 5,571 hectares (13,767 acres), which are surrounded by the above 11,758 hectares (29,055 acres), were leased to Aerojet for an initial term of 99 years with a 99-year extension. Development of 2,785 hectares (6,881 acres) in Clark County is addressed under the Clark County Multiple Species Habitat Conservation Plan (MSHCP). Adjacent private lands (8,682 hectares (21,454 acres)) and the land leased to Aerojet will be addressed under a separate HCP specific to the Coyote Springs Investment development project.

Under the BLM's Western Mojave Land Tenure Adjustment Program, which provides a mechanism pursuant to the FLPMA to acquire lands within and dispose of Federal lands outside of DWMAs, approximately 21,044 hectares (52,000 acres) of land within desert tortoise Critical Habitat have been acquired and approximately 6,880 hectares (17,000 acres) outside of designated Critical Habitat have been transferred out of Federal management since 1990. The overall ratio of acquired to disposed habitat of the desert tortoise is expected to be approximately 2.3:1 at the completion of the Western Mojave Land Tenure Adjustment Program, for a net benefit to the amount of desert tortoise habitat protected on Federal lands (BLM 2005).

The Southern Nevada Public Lands Management Act of 1998, as amended (Public Law [PL]-105-263), provides for the "disposal of certain Federal lands in Clark County, Nevada, and for the acquisition of environmentally sensitive lands in the State of Nevada." This legislation provided the mechanism for significant changes in human occupation and urban development to take place in the Las Vegas area of the Mojave Desert wherein over 58,600 hectares (145,000 acres) of Federal land are identified for disposal and sale to the private sector.

A series of other related public laws have connections to the Southern Nevada Public Lands Management Act and facilitate the transfer or disposal of public lands. These laws include the Lincoln County Conservation, Recreation, and Development Act of 2004 (PL-108-424); the Lincoln County Land Act of 2000 (PL-106-298); the Clark County Conservation of Public Land and Natural Resource Act of 2002 (PL-107-282); the Fiscal Year 2004 Appropriations Act amending the Southern Nevada Public Lands Management Act (PL -105-263); the Lake Tahoe Restoration Act; the Mesquite Lands Act of 1986 (PL-99-548) and 1988 and PL-104-208 (1996 amendment to the Mesquite Lands Act of 1988); the Ivanpah Valley Airport Public Lands Transfer Act of 2000; and the Federal Land Transaction Facilitation Act of 2000.

Summary of Factor D

There are Federal and State regulatory mechanisms which provide discretionary protections for the desert tortoise based on current management direction, but with the exception of the California Fish and Game Code, none guarantee protection absent the Endangered Species Act. While many land use plans completed since time of listing include language specific to protection of the tortoise, land management agencies frequently do not have sufficient funding to enforce their land use regulations, and personnel are often spread across vast landscapes with multiple resource responsibilities.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Climate Change

At the time of listing, climate change was not regarded as a threat to the desert tortoise, and drought was identified as a concern because the Mojave region had been experiencing a prolonged dry period (USFWS 1990). Since then, it has become apparent that the combined effects of global climate change (*i.e.*, increased ambient temperatures and altered precipitation patterns) and drought may become significant factors in the long-term persistence of the species. The Earth's climate has warmed by nearly 1.5 degrees Fahrenheit over the past 100 years (Walther *et al.* 2002), and anthropogenic emissions of greenhouse gases play a major role in this process (Weltzin *et al.* 2003). Warming in the Mojave Desert region began approximately in the late 1970s, and recent average temperatures have climbed well above prior values (Redmond 2009). While warming, as well as changes in precipitation patterns, is not uniform with regard to time and space, the rate of warming during the last 30 years has generally been greater than at any other time during the last 1,000 years, and this variation in warming and precipitation is also likely to contribute to variation in ecological dynamics across ecosystems. There is now evidence that recent climatic changes have affected a broad range of organisms with diverse geographical distributions (Walther *et al.* 2002). Interactions between altered precipitation patterns and other aspects of global change are likely to affect natural and managed terrestrial ecosystems. For example, climate models predict that Joshua trees would likely no longer be able to persist within Joshua Tree National Park through the 21st century (Cole *et al.* 2005). Human responses to climate change (*e.g.*, increased infrastructure for the capture and use of water) may also negatively affect desert ecosystems. While little is known regarding direct effects of climate change on the desert tortoise and its habitat, predictions can be made about how global and regional precipitation regimes may be altered and the consequences of these changes (Weltzin *et al.* 2003; Seager *et al.* 2007).

The 2007 Intergovernmental Panel on Climate Change has suggested that increasingly reliable climate change projections are now available as the result of improved modeling capabilities and advanced understanding of climate systems (Christensen *et al*. 2007). The report discussed the results of 21 Atmosphere-Ocean General Circulation Models that were run to estimate regional changes in temperature and precipitation in 2080 to 2099 compared to conditions that occurred between 1980 and 1999. Generally, estimates for the geographic range of the desert tortoise's listed population suggest more frequent and/or prolonged droughts. For example, annual mean temperature is likely to increase by 3.5 to 4.0 degrees Celsius (6.3 to 7.2 degrees Fahrenheit), with the greatest increases occurring in summer (June-July-August mean increase of as much as 5 degrees Celsius [9 degrees Fahrenheit]) (Christensen *et al*. 2007). In summer, the highest temperatures will likely increase even more than the average temperatures. Precipitation will likely decrease by 5 to 15 percent annually in the region, with winter precipitation decreasing in the range of 5 to 20 percent. More than half of the models estimate that reductions in summer precipitation may be more moderate (decrease by as much as 10 percent), with the possibility for a 5 percent increase according to some models (Christensen *et al*. 2007). This overall estimate for more drying in winter than in summer differs from estimates for much of the United States, but given variation among models, we are unable to confidently estimate specific precipitation regimes in the future (Smith *et al.* 2009). Because germination of the tortoise's food plants is highly dependent on cool-season rains, the forage base could be reduced due to increasing temperatures and decreasing precipitation in winter. Drought is a normal phenomenon in the Mojave Desert (Peterson 1994a; Hereford *et al.* 2006). Extended periods of drought, however, have the potential to affect desert tortoises and their habitats through physiological effects to individuals (*i.e.*, stress) and limited forage availability.

Recent findings demonstrate that the Mojave Desert shrub ecosystem is a significant sink for carbon dioxide (CO_2) on an annual basis, suggesting that desert ecosystems may be vital contributors to counteracting global and local climate change (Wohlfahrt *et al*. 2008). In particular, expansion and growth of cryptobiotic crust organisms (lichens, mosses, and cyanobacteria) may account for a significant portion of the carbon accretion in the Mojave Desert system, but further investigation into cryptobiotic crust productivity is needed. Experiments in Nevada at the Free-Air CO_2 Enrichment Facility to predict the possible complex ecological and biogeochemical changes in semidesert ecosystems caused by increasing atmospheric CO_2 have been ongoing since 1997 (Hamerlynck *et al.* 2000; Smith *et al.* 2000; Huxman and Smith 2001). Because deserts are both water- and nutrient-limited systems and many native desert plants are slow-growing, it is still too early to say with any confidence how even the most intensively studied desert shrub communities of the southwestern United States will respond to rising CO_2 (Lioubimtseva and Adams 2004). However, results from the Free-Air CO_2 Enrichment Facility site demonstrate that the non-native grass *Bromus tectorum* responds to increases in CO_2 (a component required for photosynthesis) with far greater productivity than that of native plants during wet years (Smith *et al.* 2000). As discussed in sections A(4)(b) and A(5), Increasing Fuel Load and Fire, colonization by non-native annual grasses is known to increase the frequency and intensity of fires, both of which have dramatic negative effects on desert water cycles and wildlife habitat (Hamerlynck *et al.* 2000). The overall response of non-native grasses to increased CO_2 is uncertain, though, given expected reductions in precipitation.

Climatic regimes are believed to influence the distribution of plants and animals through species-specific physiological thresholds of temperature and precipitation tolerance. Warming temperatures and altered precipitation patterns may result in distributions shifting northward and/or to higher elevations, depending on resource availability (Walther *et al.* 2002). We may expect this response in the desert tortoise to reduce the viability of lands currently identified as "refuges" or Critical Habitat for the species (Barrows 2009). Seager *et al.*

(2007) ran a series of climate models and simulations on the precipitation history and future of the southwestern United States and parts of northern Mexico that consistently showed a severe drying trend in this region throughout the 21st century, especially in areas where evapotranspiration exceeds precipitation (such as most desert regions). The non-native grass *Bromus tectorum* is expected to retreat with climate change however, from the northern portion of the desert tortoise's range (Bradley *et al*. 2009). How the closely related invasive grass *Bromus madritensis* subsp. *rubens* responds and whether it replaces *B. tectorum* in the absence of active restoration efforts is uncertain. Models demonstrate large shifts in plant distributions that over a long period of time may allow opportunities for migration and adaptation. Under the current scenario, however, where change may occur within a few decades, it cannot be predicted whether or not plants and animals would be able to readily migrate into new habitats (Thompson *et al.* 2003).

Some evidence suggests that desert tortoises may be capable of adapting to changes in the environment through modification of their behavior, periods of activity, and diet (Morafka and Berry 2002). The desert tortoise evolved millions of years before the formation of the North American deserts, and the species experienced both more mesic (moist) and more xeric (dry) conditions within the last several thousand years (Morafka and Berry 2002). Paleoclimate indicators show that severe, multi-year droughts, some lasting up to a decade or two, occur at least once or twice a century (Redmond 2009). Still unknown though is whether the desert tortoise will be able to survive ongoing changes in vegetation and food sources or temperature and precipitation patterns, especially in light of continued anthropogenic alterations of the environment (Morafka and Berry 2002).

Direct climatic effects on growth and development, spatial distribution, and species interactions are apparent in amphibians and reptiles, which, in common with other ectotherms, are heavily influenced by environmental conditions. Both seasonal temperature and humidity affect their reproductive physiology and population dynamics (Walther *et al.* 2002). In addition, desert tortoises have temperature-dependent sex determination (*i.e.*, the sex of the hatchlings is determined by the temperatures in the nest), with 1:1 sex ratios produced at approximately 32.5 degrees Celsius (90.5 degrees Fahrenheit), all males produced at 30.5 degrees Celsius (86.9 degrees Fahrenheit) and below, and all females produced at 32.5 degrees Celsius and above (Rostal *et al*. 2002). Although there has been some speculation that global temperature increases may skew sex ratios or eliminate male offspring altogether for some turtles (Janzen 1994), there is also evidence that maternal nesting behavior associated with temperature-dependent sex determination may be able to effectively respond if gradual changes in climate would otherwise result in skewed sex ratios (Janzen and Morjan 2002). As long as eggs experience daily fluctuating temperatures, sex ratios of reptiles may be largely unaffected by moderate temperature increases (Booth 2006). Additionally, the varying environments in which tortoises nest provide opportunities to choose nests with a variety of temperature regimes. Following nest choice, nest placement within the burrow can further influence nest temperature during incubation. Thus, there are many potential opportunities for desert tortoises to prevent a shift in hatchling sex ratio that could otherwise be caused by climate change (Baxter *et al*. 2008). The survival of reptile species with temperature-dependent sex determination through gradual cycles of warming and cooling over the last 100,000 years suggests that changes in climate were such that species were capable of shifting the time of nesting, choice of nest sites, the range occupied, or even temperature at which the sexes were produced (Booth 2006). Still, rapid changes in climate may challenge the ability of the desert tortoise to make such shifts.

Smith *et al.* (2009) review various types of global change relative to expected effects in the Mojave Desert, such as elevated carbon dioxide and altered precipitation regimes facilitating invasive plant species, thereby increasing fire frequency. Effects of altered nitrogen dynamics on the Mojave Desert are less clear. For example, increased nitrogen deposition from dust in the vicinity of metropolitan areas could result in higher plant production, exacerbating the effects from carbon dioxide noted above (Smith *et al*. 2009). Alternatively, increased temperatures may release nitrogen gases from Mojave Desert soils, reducing fertility of those soils and the ability to support plant life (McCalley and Sparks 2009). While it remains unclear as to how global and regional changes in climate may affect the desert tortoise, continued research and monitoring relative to behavioral and life history traits of the species under climate change will inform conservation and management decisions regarding recovery of the species in the Mojave Desert.

<u>Drought</u>. Data exist on some of the effects of drought on the desert tortoise. Drought is a normal phenomenon in the Mojave Desert; desert tortoises have been inhabitants of this region for over 10,000 years and have adapted to variable conditions (Nagy and Medica 1986; Peterson 1994a,b; 1996a; Henen 1997; Hereford *et al.* 2006). As noted above, extended periods of drought may affect desert tortoises through physiological effects to individuals (*i.e.*, stress) and limited forage availability. Energy acquisition and expenditure in desert tortoises are strongly constrained by the contingencies of rainfall, both indirectly through effects on availability and quality of food, and directly through reliance on free-standing water for drinking (Peterson 1996a; Wilson *et al*. 2001).

The effect of drought on demographic parameters of tortoise populations (*i.e.*, birth, death, recruitment, and growth rates) is not well understood (Avery *et al.* 2002; Boarman 2002). However, studies have attributed many adverse effects to periods of drought, including dehydration, malnutrition, and starvation; reduced reproductive output of females; altered behavior such as failure to seek shelter and reduced movement and surface activity (O'Connor *et al.* 1994; Homer *et al.* 1996; Duda *et al.* 1999; Berry *et al.* 2002b); and increased susceptibility to predation and disease (Peterson 1994a,b).

Since 1975, a tortoise population on the Beaver Dam Slope in Arizona and Utah experienced high mortality, where malnutrition caused by reduced nutrient availability was considered responsible for osteoporosis and subsequent mortality (Jacobson 1994). Increased mortality in the Ivanpah Valley in 1981 and 1982 was attributed to drought conditions (Turner *et al.* 1984), and abnormally high levels of mortality were recorded in the eastern and western Mojave Desert during a three-year drought period (1988 through 1990). Deaths in the Ivanpah Valley study site were attributed to drought-induced starvation and dehydration (Turner *et al.* 1984). Peterson (1994a) found that high mortality in two desert tortoise populations between 1988 and 1990 was attributable to drought, directly in the eastern Mojave population through starvation and dehydration, and indirectly in the western Mojave population through functional responses of predators to a diminished prey base and, possibly, increased susceptibility of tortoises to disease.

Research conducted in the early 1980s indicated a strong correlation between clutch frequency (the number of clutches produced by a female in one reproductive season) and biomass of annual plants used by tortoises for food (Turner *et al.* 1986, 1987). Studies conducted at five sites (Joshua Tree National Park, Mojave National Preserve, Palm Springs, Piute Valley, and St. George) supported the results in Turner *et al.* (1984, 1986, 1987). Studies indicated that in high-rainfall years with corresponding abundant food plant availability, more females reproduced and reproducing females laid more clutches per reproductive season, compared with low-rainfall years (Lovich *et al.* 1999). Clutch size (number of eggs per clutch) was relatively constant regardless of conditions; however, Avery *et al.* (2002) noted that females at higher elevations with greater annual rainfall had a larger mean clutch size.

Recent studies also indicate that even a relatively short-term drought combined with little or no biomass of annual plants can cause a severe reduction in adult tortoise survival. A study of adult tortoise survival rates at two sites in the eastern Mojave desert (near or adjacent to Piute-Eldorado Critical Habitat unit) attributed die-offs in 1996 to a period of drought that began in the summer of 1995, coupled with failure of annual vegetation production in 1996 (Longshore *et al.* 2003). During three years of no or minimal biomass production of annual plants (1996, 1997, and 1999), adult tortoise survival decreased. In 1996, 30 percent (15 individuals) of radio-monitored adults died following a drought that began in the summer of 1995. Although the researchers obtained no physiological evidence, they believed these deaths likely resulted from dehydration (Longshore *et al.* 2003).

Levels of predation on tortoises may be related to drought. During drought, when typical prey species are limited, food habits of coyotes may shift, with tortoises becoming more frequent components of their diets (Woodbury and Hardy 1948; Turner *et al.* 1984; Peterson 1994; Boarman 2002). During a drought, coyotes killed most of the study tortoises at the Desert Tortoise Natural Area, and in a twelve-month period 21 to 28 percent of the study population near Ridgecrest, California, was killed (Berry 1974). Predators were also a suspected source of mortality near Fort Irwin, California, with 0 to >50 percent of remains showing signs of drought-correlated mammalian predation (Berry *et al.* 2006). Nussear (2004) suspected that drought-related predation was the cause of death of most wild resident and first-season translocated tortoises at Bird Spring Valley, Nevada, and Field *et al.* (2007) reported that half the carcasses at their Nevada study site showed signs of having been eaten by coyotes during the same drought. Most recently, during spring 2008, tortoise mortality levels attributed to coyote predation exceeded 30 percent at several sites in the Mojave Desert also thought to be related to drought (Esque *et al.* unpubl. data 2009).

Garbage, Trash, and Balloons
The 1994 Recovery Plan identified the ingestion of non-food objects, such as balloons, plastic, and other garbage as a concern to desert tortoise health (USFWS 1994a). Turtles and tortoises are known to eat non-food objects, such as rocks, balloons, plastic, and other garbage. Such objects can become lodged in the gastrointestinal tract or entangle heads and legs, causing injury or death (Burge 1989; USFWS 1994a; Walde *et al*. 2007). Unauthorized deposition and dumping of refuse is most prevalent near towns, cities, and settlements in remote areas as well as at the urban-desert interface. Such garbage not only contributes to direct mortality and habitat degradation, but also attracts ravens and other desert tortoise predators, as discussed in section C(3), Predation. Some trash, such as balloons, may also pollute more remote areas. Walde *et al*. (2007) counted the number of balloons encountered during field work approximately 40 kilometers (25 miles) northeast of Barstow, California. They found that in 8 months, 178 new balloons arrived at the remote site and observed a tortoise partially ingesting a balloon, suggesting that the prevalence of garbage in the desert may not be as localized as previously suggested (Boarman 2002). Likewise, Averill-Murray and Averill-Murray (2002) estimated that 11,207 balloons were distributed across the 76,800-hectare (189,776-acre) Ironwood Forest National Monument, Arizona, in 2001.

Noise and Vibration
The 1994 Recovery Plan cited noise and vibration as having potentially significant effects on desert tortoise's behavior, communication, and hearing apparatus (USFWS 1994a). Very limited additional data have been obtained specific to this potential threat. Studies on the effects of flight noise from jet aircraft and sonic booms on hearing, behavior, heart rate, and oxygen consumption of desert tortoises concluded that hearing loss and physiological changes are not likely to be dangerous during occasional short-term exposures; however, those results cannot be extrapolated to chronic exposures over a tortoise's lifetime (Bowles *et al.* 1999). The authors advise that their results are "best viewed as a first-order effort to determine the effects of subsonic and supersonic aircraft noise on a desert reptile." They recommend that changes in tortoise activity with repeated exposure to aircraft noise should be investigated

under natural conditions, including during food and water deprivation, torpor, or exposure to dangers such as rivals and predators (Bowles *et al.* 1999).

Non-motorized Recreation and Miscellaneous Human Activities

Non-motorized recreation includes activities such as camping, hunting, target practice, rock collecting, hiking, horseback riding, biking, and sight-seeing were identified in the 1994 Recovery Plan as potential, low-effect threats to desert tortoises or their habitat (USFWS 1994). While there are no data correlating these activities with impacts to the desert tortoise, it may be inferred that these activities bring with them many of threats associated with increased human presence, such as loss of habitat from development of recreational facilities and guzzlers (wildlife watering holes) (Hoover 1996); handling and disturbance of tortoises; increased collection, road kill, and vandalism of tortoises; and increased raven populations (USFWS 1994; Boarman 2002). Off-trail use can degrade habitat by damaging vegetation and soil crusts (Belnap 1996) and by compacting soils (Lei 2009).

Unauthorized Release or Escape of Captive Tortoises to the Wild

Implications of infectious disease spread by the release of captive-bred animals and relocation of wild animals are a major concern in conservation biology (Wolff and Seal 1993). Captive releases have the potential to introduce disease into wild populations of desert tortoises (Johnson *et al*. 2006; Martel *et al*. 2009). Tomlinson and Hardenbrook (1993) reported that the highest prevalence of clinical signs of upper respiratory tract disease was observed in tortoises removed from areas where previous releases of captive animals had occurred. Release or escape of captive tortoises genetically different from the resident population can also lead to disrupted local adaptation (Tallmon *et al*. 2004).

A large captive population of desert tortoises, dating prior to listing under the Act and enactment of State regulations, magnifies these risks associated with disease and genetics. Unauthorized breeding of pet tortoises further exacerbates these risks and can lead to pressures on management agencies that must direct resources toward managing the captive population rather than focusing resources on recovering wild populations.

Summary of Factor E

Captive releases continue to have the potential to introduce disease and genetic contamination into wild populations of desert tortoises, although the magnitude of such releases and their effects on tortoise populations remains unknown. Since the time of listing, it has become apparent that the combined effects of global climate change (*i.e.*, increased ambient temperatures and altered precipitation patterns) and drought may become significant factors in the long-term persistence of the species. Little is known regarding direct effects of climate change on the desert tortoise and its habitat, although increased drought will likely affect desert tortoises, directly through habitat loss and indirectly through decreased availability/quality of food and increased predation and possibly disease. Little information is available on the actual or relative impacts of other potential threats documented under Factor E.

Conservation Efforts

The General Accounting Office (2002) assessed the effectiveness of recovery actions and the cost of implementation. The report found that the effectiveness of actions implemented by Federal agencies and others to benefit desert tortoises was not monitored adequately and remains largely unknown. Because much was unknown about the severity of specific threats to desert tortoises at the time the 1994 Recovery Plan was written, the recommendations were made without establishing priorities that would reflect differences in the seriousness of the threats. The General Accounting Office report recommended that the Service develop and implement a coordinated research strategy for linking land management decisions with research results. Without such a strategy, recovery of the desert tortoise would be left to chance rather than informed decisions based on science.

In response to the Government Accounting Office recommendations, the Service impaneled the Desert Tortoise Recovery Plan Assessment Committee to conduct a thorough review of the Recovery Plan in the context of scientific and analytical advances made since its publication in 1994. The assessment provided a detailed description of population trend and distribution analyses and made recommendations on how to better monitor the population status of the species. The conclusion of the committee was that the 1994 Recovery Plan was fundamentally strong but could benefit substantially from modification, and strategies that would promote a more cohesive, scientifically powerful recovery program were identified (Tracy *et al.* 2004).

Boarman and Kristan (2006) subsequently conducted an evaluation of the effectiveness of desert tortoise recovery actions. This report considered how much and what kind of information was available to evaluate recovery and whether scientific principles had been applied during implementation of recovery actions. Their findings indicate that research efforts have largely focused on characterizing threats, ecology and life history traits, and estimating population status and trends, while few studies have been designed specifically to determine effectiveness of recovery actions. This does not translate, however, to ineffectiveness of these actions or obviate the continued need for recovery actions. Incorporating a coordinated, science-based monitoring program will assist land and resource managers to further recovery of the desert tortoise on lands under their purview and is a high priority under the 2008 draft Revised Recovery Plan (USFWS 2008).

The following are examples of existing conservation guidance and strategies for recovering the desert tortoise.

Desert Wildlife Management Areas (DWMAs)

Among the most important recovery actions implemented pursuant to the 1994 Recovery Plan has been formalizing DWMAs through Federal land use planning processes (Figure 3). Particularly on BLM lands, DWMAs are administered and designated as areas of critical environmental concern (ACEC; BLM 1998a, 1999b, 2000, 2002a, 2002b, BLM *et al.* 2005, 2008, BLM and NPS 2008). These ACECs define specific management areas based on the general recommendations for DWMAs in the 1994 Recovery Plan. Boundaries of the ACECs were refined slightly from the Critical Habitat designation based on various management and biological considerations. The BLM DWMAs/ACECs, together with National Park Service lands, designated wilderness areas, other lands allocated for resource conservation, as well as restricted-access military lands provide an extensive network of habitats that are managed either directly or indirectly (*e.g.*, wilderness areas outside desert tortoise ACECs) for desert tortoise conservation (Figure 4).

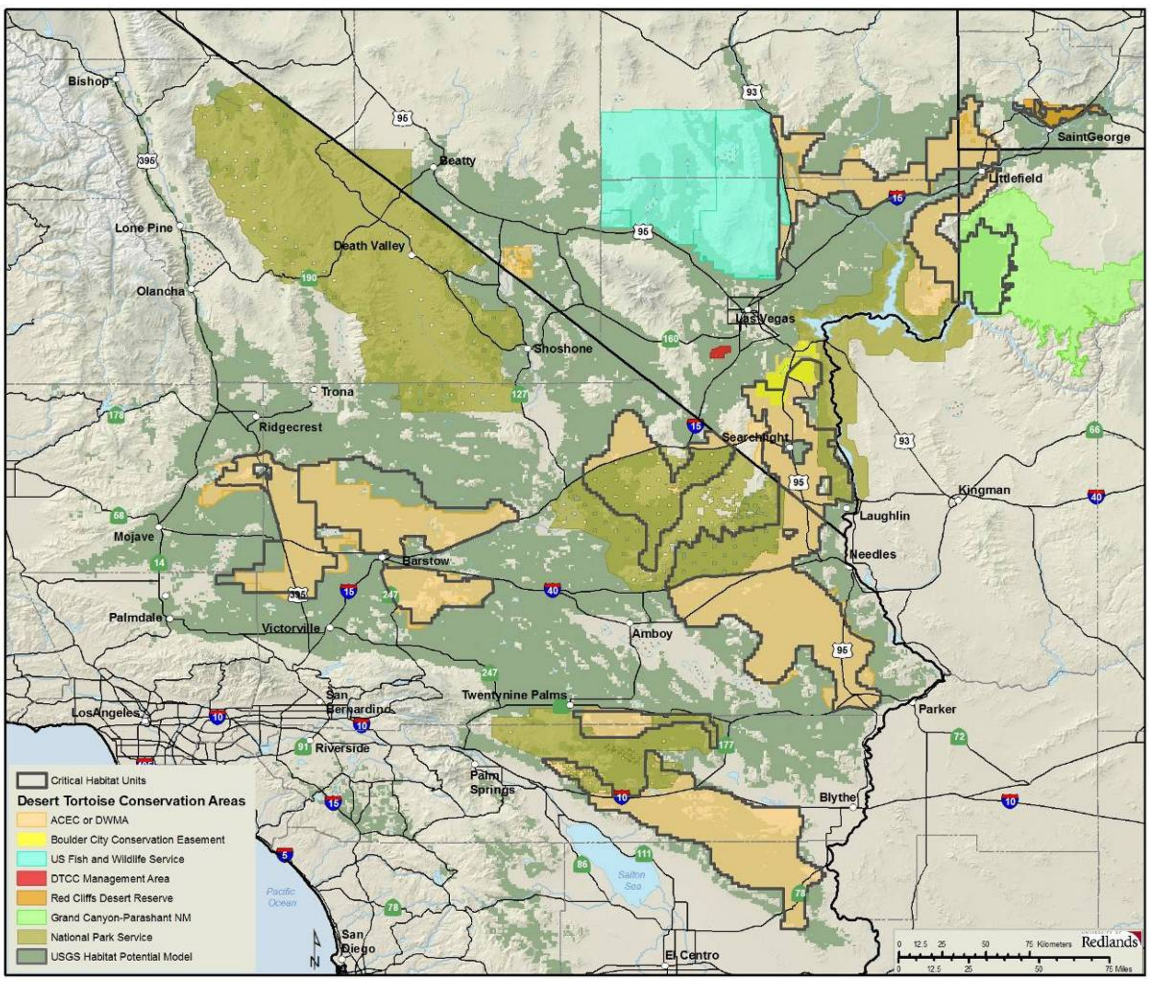

Figure 3. Desert tortoise conservation areas. DWMA = Desert Wildlife Management Area; ACEC = Areas of Critical Environmental Concern; DTCC = Desert Tortoise Conservation Center.

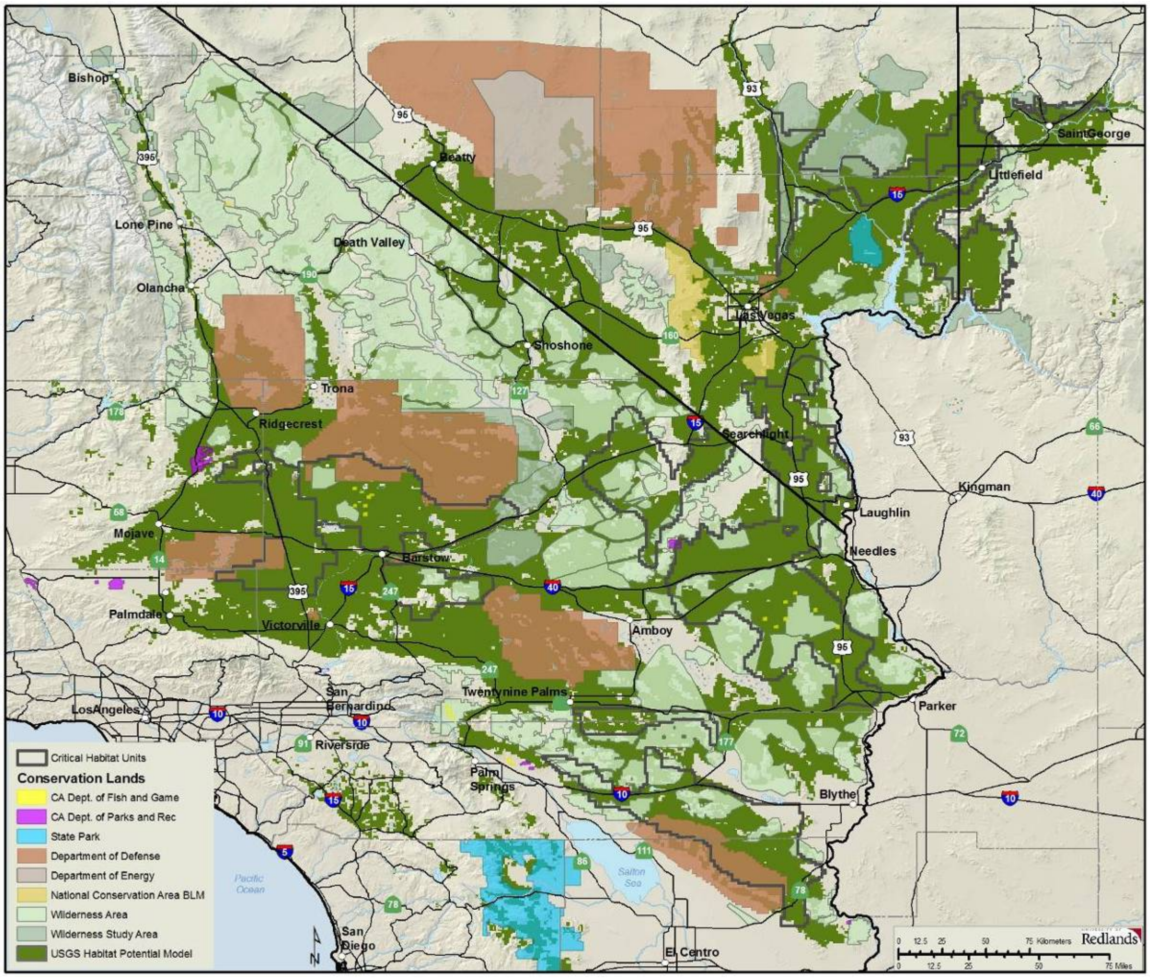

Figure 4. Additional land designations providing conservation benefits to the desert tortoise. Conservation areas for other species not shown (*e.g.,* Mohave ground squirrel (*Spermophilus mohavensis*), *Mimulus mohavensis* (Mojave monkeyflower)) may also provide benefit to the desert tortoise.

Wildlife Conservation Strategies

In 2000, Congress enacted the State Wildlife Grants Program to fund activities that benefit species of concern and their habitats. To receive funding under this program, state wildlife agencies needed to complete a Service-approved wildlife action plan (or comprehensive wildlife conservation strategy). All four states where the Mojave population of the desert tortoise occurs are currently implementing these strategies to guide species and habitat management through 2015 (Gorrell *et al.* 2005; Abele *et al.* 2006; Arizona Game and Fish Department 2006; Bunn *et al.* 2006).

Each state has identified conservation priorities and recommendations that are both species and habitat specific. Some of these actions include, but are not limited to, the following:

- improve stewardship on federally managed lands to protect wildlife diversity;
- work cooperatively with landowners/permittees by providing financial and technical assistance, through incentive programs, for conservation projects;
- work with city and county planners to incorporate wildlife values in urban/rural development plans;
- promote design and construction of overpasses, underpasses, or culverts to facilitate desert movement and dispersal;
- identify and protect key wildlife corridors for landscape connectivity;
- reduce off-highway vehicle damage to wildlife habitats;
- encourage revegetation and restoration of existing unauthorized roads and trails;
- improve efforts and partnerships for controlling existing occurrences of invasive species and prevent new introductions;
- rehabilitate burned and disturbed areas with native plants;
- pursue projects to limit spread of disease to sensitive wildlife populations;
- use fencing and/or increased law enforcement presence to reduce unauthorized use and access to sensitive habitats; and,
- implement a statistically robust range-wide monitoring program and adaptive management framework that captures population trends and impacts to the species.

<u>Federal Land Management Plans</u>
Land use management plans provide guidance and establish a mechanism by which Federal agencies implement actions on lands under their purview. Throughout the range of the desert tortoise, multiple Federal agencies are involved in the long-term management and conservation of the species as part of their respective missions. These include the Bureau of Land Management, National Park Service, Bureau of Indian Affairs, U.S. Fish and Wildlife Service, Bureau of Reclamation, U.S. Forest Service, Department of Defense, and Department of Energy. In addition to Federal land use plans, counties and local jurisdictions draft general plans to guide their activities.

Within the range of the desert tortoise, the following programmatic level documents are currently in place or in preparation. Many of the respective plans include language specific to the protection and conservation of natural resources including desert tortoises and their habitats. These are often supplemented by more specific guiding documents, such as habitat management plans or wilderness management plans:

Bureau of Land Management (BLM):

- Arizona Strip Field Office Record of Decision and Resource Management Plan/ General Management Plan (BLM 2008), and Grand

Canyon-Parashant National Monument Record of Decision and Resource Management Plan/ General Management Plan (BLM and NPS 2008).

- California Desert Conservation Area Plan of 1980, as updated by the (WEMO, NECO, NECO), and other bioregional plans (BLM 1999a)
- Northern and Eastern Mojave Desert Management Plan (BLM 2002a)
- Northern and Eastern Colorado Desert Coordinated Management Plan (BLM 2002b)
- West Mojave Plan (BLM *et al.* 2005)
- Tonopah Resource Management Plan (BLM 1997)
- Las Vegas Resource Management Plan (BLM 1998a)
- Red Rock Canyon National Conservation Area Resource Management Plan (BLM 2001)
- Sloan Canyon National Conservation Area Resource Management Plan (BLM 2006b)
- Nevada Test and Training Range Resource Management Plan (BLM 2004)
- Caliente Management Framework Plan (BLM 2000)
- St. George Resource Management Plan (BLM 1999b)

U.S. Fish and Wildlife Service:

- Desert National Wildlife Refuge Comprehensive Conservation Plan (USFWS 2009b)

National Park Service (NPS):

- Joshua Tree National Park General Management Plan, as amended (NPS 2000a)
- Death Valley National Park General Management Plan (NPS 2002a)
- Mojave National Preserve General Management Plan (NPS 2002b)
- Lake Mead National Recreation Area, Arizona and California, Strategic Plan Fiscal Year 2001-2005 (NPS 2000b)

U.S. Forest Service (USFS):

- General Management Plan for the Spring Mountains National Recreation Area, An Amendment to the Land and Resource Management Plan (U.S. Forest Service 1996)

Department of Defense (DOD):

- Draft Nellis AFB and Nevada Test and Training Range Integrated Natural Resources Management Plan (U.S. Air Force 2007)
- Marine Corps Air Ground Combat Center, Twentynine Palms, Integrated Natural Resources Management Plan, Fiscal Years 2007-2011 (U.S. Marine Corps 2007)
- National Training Center at Fort Irwin Integrated Natural Resources Management Plan (U.S. Army 2006)

- Marine Corps Logistics Base, Barstow, Integrated Natural Resources Management Plan (Tierra Data, Inc. 2005)
- Naval Air Weapons Station, China Lake, Comprehensive Land Use Management Plan and Integrated Natural Resources Management Plan (Naval Air Weapons Station, China Lake and BLM 2004)
- Edwards Air Force Base Integrated Natural Resources Management Plan (U.S. Air Force 2001)
- Yuma Training Range Complex, Arizona and California (U.S. Navy 2001)
- Nevada Test Site Resource Management Plan (Department of Energy 1998)

An example of landscape-level conservation is the withdrawal of locatable mineral entry within ACECs on the Southern Nevada District of the BLM (BLM 2009). Locatable minerals are those that have been described as "valuable mineral deposits" and include metal ores such as gold, silver, copper, or lead, and certain industrial minerals such as gypsum, chemical-grade limestone, and diatomaceous earth. Uncommon varieties of mineral materials such as pumice, rock, and cinders also are regulated as locatable minerals. The BLM withdrew approximately 382,024 hectares (944,000 acres) of public lands from locatable mineral entry under the U.S. mining laws for a period of 20 years to protect desert tortoise habitat, archaeological and cultural resources, and special wildlife and riparian values on 24 ACECs. Four of these 24 ACECs coincide with desert tortoise Critical Habitat (Piute/Eldorado, Coyote Springs, Mormon Mesa, and Gold Butte). This action was included as one of the most important conservation actions in the Las Vegas Resource Management Plan (BLM 1998a). All valid existing rights including, but not limited to, mining, recreation, and/or rights of way will remain unaffected (BLM 2009).

One of the most extensive land and resource management plans currently in place was developed for the 10,117,141-hectare (25,000,000-acre) California Desert Conservation Area. In 1976, Congress passed the Federal Land Policy Management Act to direct the management of the public lands of the United States. Under that law, the California Desert Conservation Area was established, with 4,856,228 hectares (12,000,000 acres) of public lands administered by the BLM. The California Desert Conservation Area Plan of 1980 as amended provides guidance relative to the use of the public lands and resources of the California Desert Conservation Area, including economic, educational, scientific, and recreational uses, in a manner that enhances wherever possible, and does not diminish the environmental, cultural, and aesthetic values of the desert and its productivity. Under the California Desert Conservation Area Plan, all state and federally listed species and their habitats are to be managed so that the continued existence of each is not jeopardized. Consultation for federally listed species would be conducted as appropriate (BLM 1999a).

The California Desert Conservation Area Plan was subsequently amended by region, which generally corresponded to the recovery units delineated in the 1994 Recovery Plan. The Northern and Eastern Mojave Desert Management Plan (BLM 2002a), the West Mojave Plan (BLM *et al.* 2005), and the Northern and Eastern Colorado Desert Coordinated Management Plan (BLM 2002b) all designated DWMAs/ACECs and included new management measures for desert tortoise conservation, including limiting various recreational activities such as off-highway vehicle races, within the conservation areas.

The California Desert Conservation Area also encompasses the 10,117-hectare (25,000-acre) Desert Tortoise Natural Area, which was established in the western Mojave Desert in 1972. The Mojave National Preserve was created under the California Desert Protection Act in 1994 for which a general management plan was drafted in 2002 (NPS 2002b). The California Desert Protection Act also expanded the boundaries of both Death Valley and Joshua Tree National Parks and designated millions of acres of wilderness, which eliminated vehicle access to these areas.

Grazing Management and Limitations

A specific example of landscape-scale conservation of desert tortoise habitat was the removal of grazing and the implementation of seasonal grazing restrictions on several grazing allotments within designated Critical Habitat on public lands (Figure 10, Table 14). This was identified in the 1994 Recovery Plan as an important component in the recovery of the species. For example, in 1995 the Desert Tortoise Preserve Committee and The Wildlands Conservancy bought the 550-hectare (1,360-acre) Blackwater Well Ranch in northwestern San Bernardino County and gained control (and is seeking retirement) of grazing on the 19,830-hectare (49,000-acre) Pilot Knob cattle grazing allotment.

Under the West Mojave Plan (BLM *et al.* 2005), grazing has been retired on several grazing allotments mostly within designated Critical Habitat or DWMAs. Additional restrictions such as season of use and forage type (ephemeral or perennial) have also been instituted on some grazing allotments within the plan area. Fort Irwin, which lies within the West Mojave Plan area, purchased fee lands within three cattle allotments in the Western Mojave Recovery Unit to partially offset the effects of its base expansion, and the BLM subsequently retired these grazing allotments. The BLM has removed grazing from at least four other allotments in the plan area.

Where grazing will continue within the West Mojave Plan area, the BLM has identified a number of conservation prescriptions to be implemented within cattle and sheep allotments, which include existing Regional Public Land Health Standards and Guidelines for Grazing Management, utilization restrictions, guidelines for grazing both within and outside of desert tortoise habitats and DWMAs, terms and conditions of existing Service biological opinions, and new management prescriptions contained in the plan (BLM *et al.* 2005; USFWS 2006b).

Through the Northern and Eastern Mojave Desert Management Plan, the BLM (2002a) removed or restricted grazing in the Shadow Valley and Ivanpah Valley DWMAs. One relatively small grazing allotment within the Ivanpah Valley DWMA will remain open with some utilization restrictions, and all ephemeral (seasonal) allotments within DWMAs will be terminated (USFWS 2005).

The Northern and Eastern Colorado Desert Coordinated Management Plan (BLM 2002b) established two DWMAs that encompass over 647,500 hectares (1,600,000 acres). Only one grazing allotment remains within designated Critical Habitat or a DWMA. Approximately 8,090 hectares (20,000 acres) of this active allotment were closed to grazing due to high tortoise densities, and in other portions of the allotment, utilization restrictions and season of use requirements will be implemented (USFWS 2005).

Under the Mojave National Preserve General Management Plan (NPS 2002b), grazing has been removed on nine allotments and remains active on another two (D. Hughson, pers. comm. 2007). The overall management goal is to completely remove grazing on the entire Preserve through voluntary relinquishment by lessees or acquisition of grazing permits and water rights by conservation organizations. These activities will be managed according to BLM allotment management plans and National Park Service grazing management plans (NPS 2002b). In Joshua Tree National Park, there are no active grazing allotments (M. Vamstad, Joshua Tree National Park, pers. comm. 2008).

Since 1994, the BLM and USFS have closed 70 ephemeral grazing allotments in Clark and southern Nye counties. Approximately 22,600 hectares (56,000 acres) currently remain available for grazing in 5 allotments in Clark and southern Nye counties (E. Masters, pers. comm. 2007). According to the Las Vegas Resource Management Plan, no legal grazing occurs within ACECs in Clark County and southern Nye County (BLM 1998a). Under the Clark County Multiple Species Habitat Conservation Plan (MSHCP) and its predecessor (see discussion below), which lies within the Las Vegas District of the BLM, the County has been actively purchasing the rights to permanently remove grazing from over 809,370 hectares (2,000,000 acres) of public lands within and outside of DWMAs (J. Bair, USFWS, pers. comm. 2007).

Under the Caliente Management Framework Plan Amendment (Lincoln County, Nevada), all allotments or portions of allotments within ACECs were closed to livestock grazing (85,996 hectares (212,500 acres)). Outside ACECs, season of use on all perennial allotments was established through allotment evaluation and multiple-use decision processes. It was determined that for areas outside ACECs, livestock use could occur between March 15 and October 15 provided forage utilization does not exceed 40 percent for key perennial grasses, forbs, and shrubs (BLM 2000).

Seasonal grazing restrictions were also instituted on the BLM's Arizona Strip Field Office within ACECs and within portions of some grazing allotments in the Grand Canyon-Parashant National Monument. Portions of some grazing allotments are currently unavailable to grazing (BLM 2008; BLM and NPS 2008). However, grazing may become available in the future, if conditions are favorable for livestock.

Finally, the Department of the Army purchased approximately 39,000 hectares (97,000 acres) of lands formerly owned by the Catellus Development Corporation and fee lands within three cattle allotments in the Western Mojave Recovery Unit to partially offset the effects of the National Training Center expansion; the BLM subsequently retired these allotments. This mitigation resulted in the relinquishment of grazing on over 129,500 hectares (320,000 acres) (R. Bransfield, pers. comm. 2007).

Land Acquisitions and Habitat Conservation Plans (HCPs)
Though land acquisitions and transfers may negatively impact desert tortoises and their habitats when the lands are targeted for urban development, these transactions may result in conservation benefits when valuable conservation lands are acquired in place of land that is already impacted or substantially degraded by human use. For instance, since 1986, California Department of Fish and Game has acquired over 19,670 hectares (48,000 acres) of desert tortoise habitat within Critical Habitat, and additional lands with endowment fees have been and continue to be acquired through mitigation for projects that impact tortoise habitats. To ensure management of these lands, endowment fees are collected for each parcel acquired (Steele and Jones 2006). In addition, under the Southern Nevada Public Lands Management Act, approximately 1,500 hectares (3,725 acres) within occupied or suitable desert tortoise habitat have been purchased since 2000 through the land acquisition program for environmentally sensitive lands (BLM 2007).

Between 1999 and 2004, the U.S. Department of the Interior acquired over 237,551 hectares (587,000 acres) through the California Desert Lands Acquisition, led by The Wildlands Conservancy, a non-profit conservation organization. The land was acquired from SF Pacific Properties, Catellus Development Corporation, which owned every other section of public land in an 80.5-kilometer (50-mile) swath along what are now Interstate 40 and Route 66. The Catellus acquisition was the largest non-profit land acquisition donated to the American people in U.S. history. It included funding the acquisition of over 34,398 hectares (85,000 acres) in Mojave National Preserve, over 8,094 hectares (20,000 acres) in Joshua Tree National Park, over 84,984 hectares (210,000 acres) in 20 BLM wilderness areas, and hundreds of thousands of acres of other habitat (The Wildlands Conservancy 2007).

According to acquisition data acquired from The Wildlands Conservancy, in the Fenner Critical Habitat Unit, over 18 percent of the area was brought into public ownership as part of the California Desert Acquisition, over 99 percent of which is desert tortoise habitat. Within both the Chuckwalla and Ord-Rodman Critical Habitat units, over 12 percent of the area was acquired, of which 98 percent and 67 percent, respectively, is desert tortoise habitat (Table 15).

Table 15. Land (acres) acquired in the California Desert Acquisition within California Critical Habitat units (CHU). Modeled desert tortoise habitat area is based on ≥0.5 habitat potential in Nussear *et al.* 2009.

Critical Habitat Units	**Modeled Desert Tortoise Habitat**	**Total Acquisition**	**Percent within CHU**
Chemehuevi	107,432	109,608	12
Chuckwalla	31,209	48,445	5
Fenner	79,987	80,129	18
Fremont-Kramer	0	0	-
Ivanpah	474	700	1
Ord-Rodman	20,918	31,349	12
Pinto Mountains	57	57	<1
Superior-Cronese	16,311	16,400	2

Several HCPs have been developed for private lands within desert tortoise habitat that include provisions for acquisitions and transfers that would meet the objectives of the HCP as well as secure conservation lands for tortoises. However, land acquisition can be an expensive, time-consuming task. For example, 61 separate actions were necessary to acquire just over 3,760 hectares (9,300 acres) within the 25,090-hectare (62,000-acre) Red Cliffs Desert Reserve, which was established to provide protection for the desert tortoise and its habitat under the 1996 Washington County HCP in Utah. Approximately 2,995 hectares (7,400 acres) remain to be acquired within the present boundaries of the Reserve. The approximate value of the lands acquired stands at $87,073,000 (not adjusted for present value) (J. Crisp, pers. comm. 2007).

In southern Nevada, the Clark County Multiple Species Habitat Conservation Plan (MSHCP) was completed in 2000. The Clark County MSHCP superseded the Desert Conservation Plan, which was prepared in response to the Federal listing of the desert tortoise as a threatened species. The MSHCP plan area encompasses a total of 169,160 hectares (418,000 acres) (all of Clark County and, for the Nevada Department of Transportation, portions of Nye, Lincoln, Mineral, and Esmeralda counties, Nevada) (RECON 2000). The underlying purpose of the MSHCP is to achieve a balance between the long-term conservation of listed species and natural resources that are an important part of the natural heritage and economic development of Clark County (USFWS 2000a). As additional mitigation under the MSHCP, Clark County purchased a 34,800-hectare (86,000-acre), long-term conservation easement (50 years) from Boulder City. Under the Clark County MSHCP, conservation management strategies were required for each of the DWMAs within the county; these include Coyote Springs, Gold Butte, Mormon Mesa, and Piute-Eldorado (Clark County 2007a,b,c,d, respectively). The purpose of each conservation management strategy is to guide species and habitat management using a coordinated, adaptively managed approach. Each strategy identifies management actions, protective measures, restoration efforts, public outreach and education, inventory and monitoring actions, applied research actions, and impact mitigation measures that will direct conservation of tortoises and their habitats.

Habitat conservation plans are also being developed for other parts of southern Nevada. An HCP for the Coyote Springs Valley in Lincoln County includes allowing development of 8,680 hectares (21,454 acres) over 40 years while setting aside a 5,570-hectare (13,767-acre) reserve for the desert tortoise and other sensitive species (ENTRIX *et al*. 2008). In addition, mitigation fees paid by the applicant for the loss of desert tortoise habitat would be used to fund management of the reserve and desert tortoise research. The Southeastern Lincoln County HCP is in the final planning stages. The plan area totals 720,400 hectares (1,780,140 acres), of which 311,365 hectares (769,400 acres) is desert tortoise habitat. Approximately 9,090 hectares (20,000 acres) of the tortoise habitat within the Southeastern Lincoln County HCP area will be developed over a 30-year time frame. The focus of this plan is to provide a mechanism to allow orderly growth and development north of Mesquite and urban expansion in the Alamo area in Lincoln County (J. Brown, USFWS, pers. comm. 2007). The loss of desert tortoise habitat in Lincoln County will be mitigated through funding of restoration efforts within the Beaver Dam Slope and Mormon Mesa Critical Habitat units and various research and monitoring activities (J. Krueger, USFWS, pers. comm. 2009). In Nye County, efforts continue to work with landowners and local governments to develop HCPs for projects that may adversely affect desert tortoises in the Pahrump Valley.

The Coachella Valley MSHCP in Riverside County, California would establish conservation areas and a reserve system for species and natural communities covered under the plan, including the desert tortoise. These lands constitute approximately 301,855 hectares (745,900 acres) within the 485,620-hectare (1,200,000-acre) plan area boundary. About 199,000 hectares (491,000 acres) of desert tortoise habitat are targeted for conservation within the areas identified as Conservation Areas under the Coachella Valley MSHCP, with about 59,000 hectares (146,000 acres) not yet secured for these purposes. The existing conserved lands include the 9,090-hectare (20,000-acre) Coachella Valley Preserve that was established in 1986 for Coachella Valley fringe-toed lizard (*Uma inornata*). Over 27,000 hectares (67,000 acres) (12 percent of all habitat and 28 percent of non-Federal land within the plan area) are subject to disturbance under the plan. This includes about 4,450 hectares (11,000 acres) of what is considered "core" habitat for this species as described in the Coachella Valley MSHCP (Coachella Valley Association of Governments 2007; USFWS 2008a).

The California Desert Conservation Area Plan Amendment for the Coachella Valley specifically commits the BLM to conserving at least 99 percent of vegetation community types on the lands it administers within the MSHCP reserve system. In the portion of the MSHCP area where the Northern and Eastern Colorado Desert Coordinated Management Plan applies to federal land, new surface disturbance is cumulatively limited to 1 percent of the federal portion of each Critical Habitat unit, which is consistent with the other large regional plans (Coachella Valley Association of Governments 2007; BLM 2002c).

Within the region covered by the West Mojave Plan (BLM *et al.* 2005), a MSHCP is currently being drafted for development on approximately 1,214,000 hectares (3,000,000 acres) of private lands. This plan may cover as many as 15 species, including the desert tortoise. The MSHCP is still in the planning stages and the specific goals and objectives have yet to be determined.

While desert tortoise population monitoring has occurred in association with the Washington County HCP and Clark County MSHCP, in particular, monitoring has not occurred for a long enough time to be able to observe detectable, large-scale changes in tortoise populations or habitat condition (see Population Trends and Distribution). Continued management and focused monitoring, similar to the recovery strategy outlined below, are required to determine whether the HCPs are meeting their objectives.

<u>Other Activities</u>
Fire Management: Over 404,685 hectares (1,000,000 acres) of the eastern Mojave Desert vegetation burned in wildfires in 2005 and 2006, fueled largely by invasive, non-native grasses. Because of this recent devastating fire activity in the Mojave Desert, research scientists, land managers, and agency biologists in Arizona, Nevada, and Utah have come together to develop an initiative (the Mojave Desert Initiative) designed to protect intact, functional habitats and restore key areas that have burned. This initiative is a collaborative effort among Federal, state, and local jurisdictions and will focus on fire management and habitat protection and restoration.

During the summer of 2005, wildfires burned much of the Pakoon Basin of the Grand Canyon Parashant National Monument and Gold Butte-Pakoon Critical Habitat Unit (Figure 10, Table 13). As a result, the Arizona Strip District of the BLM initiated soil stabilization and revegetation efforts of desert tortoise habitats using a variety of treatments, including aerial seed application, mechanical seed incorporation, and grazing exclusion (fencing). Rehabilitation objectives and success criteria were developed and control efforts for invasive species were initiated (USFWS 2006c). The BLM and the U.S. Geological Survey in Nevada have also implemented emergency rehabilitation projects after wildfires (DeFalco *et al*. 2007). Restoration efforts in response to wildfires and other land disturbances have been long practiced in the Mojave Desert. Because natural plant succession is variable over time subsequent to disturbance, land managers and researchers attempt to facilitate revegetation of disturbed sites and typically observe mixed results (Ostler *et al*. 2002; Warren and Ostler 2002; Ostler and Hansen 2003; Abella *et al*. 2007; DeFalco *et al*. 2007). Site treatment, soil amendments, timing of the projects, and the environmental conditions all work to influence effectiveness of these efforts.

To facilitate fire suppression activities, the Service issued a memo to the Desert Tortoise Management Oversight Group in May 2006 recommending that, when feasible, implementing suppression techniques that minimize impacts to the habitat is desirable; however, reduction of total acreage lost to fire, especially in Critical Habitat, through the use of mobile attack with engines, fireline construction with bulldozers, aerial fire retardant, or other necessary techniques should be prioritized. Subsequently, the Mojave Desert Initiative developed more specific priorities and guidance for incident commanders. The Service is actively working with our partners to identify the most appropriate locations for firefighting personnel and ways to improve communication during incidents.

Raven Management: The Service is currently undertaking efforts to reduce human subsidies of food, water, and nest sites to the common raven in the California desert. Activities designed to reduce raven predation on desert tortoises include reducing trash availability at landfills, removing illegal dumps, fencing along highways to reduce road-kills, and removing or modifying nesting and roost sites. The program also provides immediate protection to hatchling and juvenile desert tortoises by identifying and removing ravens that have preyed or attempted to prey on desert tortoises (*e.g.*, approximately 14 offending ravens were removed in 2009; USFWS unpubl. data). The environmental assessment for this program provides a full description of the proposed activities (USFWS *et al.* 2008).

In addition, BLM's West Mojave Plan includes a series of recommendations to reduce raven predation on the desert tortoise. These include, but are not limited to, controlling solid and organic wastes and standing water at and outside of sanitary landfills; encouraging livestock operators to reduce availability of food sources for ravens; limiting availability of nesting and perch substrates, especially in the urban interface; selectively removing problem ravens especially within the Desert Tortoise Natural Area, Critical Habitat units, and head-starting sites (areas in which young tortoises are being reared for experimental release to the wild); conducting additional research on raven life history, behavior, and efficacy of control methods; and implementing adaptive management and public education programs (BLM *et al.* 2005). In addition, some counties and local jurisdictions, such as San Bernardino and Kern counties, have taken steps to improve their landfill operations to minimize windblown litter and subsidized bird populations.

Environmental Education: The California Desert Managers Group oversees a program to develop and implement an information and education campaign about the desert tortoise to build public support for, and involvement in, its recovery. The Clark County (Nevada) Desert Conservation Program also includes an education component that targets communities in southern Nevada and extends into portions of Arizona. The outreach efforts attempt to inform the public about desert tortoise conservation issues through brochures, surveys and feedback, and educational materials for schools.

III. RECOVERY CRITERIA

Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, overall, the threats have been minimized sufficiently, and the species is robust enough, to downlist or delist the species. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated. The Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994) is currently being revised to reflect the current state of knowledge regarding the species, threats still facing the species and its habitats, conservation and management needs and actions, and quantifiable recovery criteria (USFWS 2008). Because the plan is undergoing revision, progress toward achieving the goals and objectives of the newly established criteria cannot yet be measured. The recovery strategy, criteria, objectives, and recovery actions contained in the draft revised plan, with minor clarifying modifications, are briefly described herein (USFWS 2008).

Recovery Goals, Objectives, Criteria, and Rationale

The goals of the recovery plan are recovery and delisting of the desert tortoise. The recovery criteria represent our best assessment of the conditions that would most likely result in a determination that delisting of the desert tortoise is warranted. Recovery criteria should ideally include the management or elimination of threats, addressing the five statutory (de-)listing factors. However, even though a wide range of threats affect desert tortoises and their habitat, very little is known about their demographic impacts on tortoise populations or the relative contributions each threat makes to tortoise mortality. Therefore, specific and meaningful threats-based recovery criteria cannot be identified at this time. In the meantime, we assume that threat mitigation will have been successful if the current recovery criteria have been met (taking into consideration any head-starting or translocation efforts). Specific recovery actions, including research, must be implemented to identify sets of threats that contribute to a greater number of mortality mechanisms or affect size structure or fecundity. As quantitative information on threats and tortoise mortality is obtained, more specific threats-based recovery criteria may be defined during future recovery plan review and revision.

Recovery Objective 1 (Demography). Maintain self-sustaining populations of desert tortoises within each recovery unit into the future.

Recovery Criterion 1. Rates of population change (λ) for desert tortoises are increasing (*i.e.*, $\lambda > 1$) over at least 25 years (a single tortoise generation), as measured

a) by extensive, range-wide monitoring across tortoise conservation areas within each recovery unit, and

b) by direct monitoring and estimation of vital rates (recruitment, survival) from demographic study areas within each recovery unit.

Rationale. This objective and associated criteria emphasize the need to increase desert tortoise populations across tortoise conservation areas in each recovery unit over 25 years (a tortoise generation). Achievement of these criteria will indicate that all listing factors (A-E) will have successfully been addressed.

Recovery Objective 2 (Distribution). Maintain well-distributed populations of desert tortoises throughout each recovery unit.

Recovery Criterion 2. Distribution of desert tortoises throughout each tortoise conservation area is increasing over at least 25 years (*i.e.*, $\psi > 0$).

Rationale. This objective and associated criterion emphasize increasing the distribution of desert tortoises (within tortoise conservation areas) over 25 years. As such, it applies to Listing Factor A, the present or threatened destruction, modification, or curtailment of the tortoise's habitat or range. Recovery Criterion 1 focuses on population growth.

Recovery Objective 3 (Habitat). Ensure that habitat within each recovery unit is protected and managed to support long-term viability of desert tortoise populations.

Recovery Criterion 3. The quantity of desert tortoise habitat within each desert tortoise conservation area is maintained with no net loss until tortoise population viability is ensured. When parameters relating habitat quality to tortoise populations are defined and a mechanism to track these parameters established, the condition of desert tortoise habitat should also be demonstrably improving.

Rationale. This objective and associated criterion emphasize maintaining desert tortoise habitat within desert tortoise conservation areas, but are not meant to diminish the importance of populations and habitat outside the conservation areas. Therefore, they directly apply to Listing Factor A, the present or threatened destruction, modification, or curtailment of the tortoise's habitat or range.

IV. SYNTHESIS

At the time the desert tortoise was listed in 1990, available data from long-term study plots established in the late 1970s in the western Mojave Desert in California, in the northeast portion of the range in Utah, and in extreme northern Arizona suggested that populations had experienced notable declines well into the 1980s. There was also speculation that juveniles were declining in the remainder of the eastern Mojave Desert; however, the data were insufficient to support this conclusion (USFWS 1990). The threats identified in the original listing rule continue to affect the species today, with invasive species, wildfire, and renewable energy development coming to the forefront as important factors in habitat loss and conversion. The potential effects of global climate change have also become an important consideration in future recovery planning and implementation. Overall, human-induced impacts that cause mortality and widespread habitat loss and fragmentation, such as urbanization, proliferation of roads and highways, off-highway vehicle activity, grazing, and habitat invasion by non-native invasive species still play an important role in the conservation status of the desert tortoise (Berry *et al.* 1996; Boarman and Sazaki 2006; Avery 1997; Jennings 1997; Boarman 2002). Since the time the 1994 Recovery Plan was drafted, no significant changes in the distribution of the species have been documented despite a decline in local populations.

Despite the substantial body of data that has been collected from long-term study plots and other survey efforts over the years, plot placement is generally regarded as a factor limiting demographic and trend conclusions only to those specific areas; hence, historic estimates of desert tortoise density or abundance do not exist at the range-wide or regional level for use as a baseline. However, the data do provide insight into the range-wide status of the species and show appreciable declines at the local level in many areas, which coupled with other survey results, suggest that declines may have occurred more broadly (Luke *et al.* 1991; Berry 2003; Tracy *et al.* 2004). Additionally, while it is clear that the identified threats impact individual tortoises, there are few data available to evaluate or quantify the magnitude of these threats, or their relative importance, on desert tortoise populations (Boarman 2002; GAO 2002; Tracy *et al.* 2004; Boarman and Kristan 2006). Finally, the biological constraints that were identified in the 1994 Recovery Plan (*i.e.*, life history and reproductive characteristics and maintenance of genetic and ecological variability) remain important considerations in current and future recovery planning and implementation. Desert tortoises possess a combination of life history and reproductive characteristics that affect the ability of populations to survive external threats. For instance, this long-lived species requires 13 to 20 years to reach sexual maturity and has low reproductive rates during a long period of reproductive potential (Turner *et al.* 1984; Bury 1987; Germano 1994). These factors make recovery of the desert tortoise challenging and complicate our ability to elucidate and quantify the contribution and magnitude of each of the identified threats and efficacy of recovery actions at the range-wide population level.

The long-term monitoring program for the desert tortoise has been refined to include annual range-wide population monitoring using line distance transects that began in 2001 (1999 in the Upper Virgin River Recovery Unit; McLuckie *et al*. 2002) and is the first comprehensive effort undertaken to estimate densities across the range of the species (USFWS 2006a). The monitoring program is expected to detect long-term population trends and gather information on baseline densities and annual and regional (between recovery unit) variability. The baseline information can subsequently be used to refine the monitoring design because it includes estimates for transect-to-transect variability in tortoise counts as well as regional variability in detection functions (USFWS 2006a). Continuing to improve the monitoring program will enable us to more adequately assess long-term population trends throughout the range of the species.

Meanwhile, numerous important recovery actions have been implemented, including establishment of DWMAs across the range of the species, and in many areas improved grazing management, mining withdrawal, route designation, habitat acquisition, increased fire management, increased raven management, and environmental education. In addition, the need to address the probability that multiple threats may simultaneously suppress tortoise populations at any given location within the species' range and to gain a better understanding of the relative contribution of multiple threats on demographic factors (*i.e.*, birth rate, survivorship, fecundity, and death rate; Tracy *et al.* 2004) is being incorporated into the Revised Recovery Plan (USFWS 2008). The draft revised recovery plan has identified strategies that would promote a more cohesive, scientifically powerful recovery strategy through applied research, effectiveness monitoring, and adaptive management.

We anticipate that implementation of the Revised Recovery Plan will resolve key uncertainties about threats and management, thereby improving recovery potential. Until then, we believe the Mojave population of the desert tortoise still meets the definition of threatened and recommend no status change at this time.

V. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (indicate reason for delisting according to 50 CFR 424.11):
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
_X_ No Change

New Recovery Priority Number and Brief Rationale: No change.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

Critical to recovery of the Mojave population of the desert tortoise will be the implementation of the Recovery Plan, after the draft revision is finalized. As noted previously, the recommended actions in the 1994 Recovery Plan formed a logical basis for recovery (GAO 2002), little information since 1994 contradicts these recommendations (Boarman and Kristan 2006), and insufficient time has elapsed over which detectable increases in desert tortoise populations or natural recovery of habitat could be realistically expected. Therefore, specific recommendations contained in the draft Revised Recovery Plan are being adapted from the 1994 Recovery Plan. Yet, the final plan revision will place a greater emphasis on solidifying partnerships across jurisdictional boundaries to maintain focus on implementing the recommended actions and conducting applied research, modeling, and effectiveness monitoring to evaluate actions in a formal adaptive management context.

Below are brief descriptions of the recovery actions that are considered the highest priorities over the next 5 years. Implementation of these specific actions is necessary in order for the Service to improve understanding and mitigation of threats, change the species' recovery priority number, maintain baseline population numbers, and prioritize additional actions for most efficient and effective progress toward recovery of the species. Recovery of the desert tortoise is a multi-agency effort under direction of the Desert Tortoise Recovery Office (DTRO) and future, regional recovery implementation teams (RITs). Agencies expected to participate on the RITs include the USFWS, State wildlife agencies, U.S. Geological Survey-Biological Resources Discipline, BLM, National Park Service, Department of Defense, local governments, academic institutions, and other interested parties. Various agencies are the primary coordinators and/or funding sources for some of these actions.

1) Establish regional, inter-organizational RITs to prioritize and coordinate implementation of recovery actions. This action (1.1 in the draft revised recovery plan) addresses all threats and listing factors in that RITs will encourage cross-jurisdictional, landscape-level action that will be tracked, monitored, and evaluated. This action is a necessary prerequisite to action number 3, as well as successful completion of action number 2.

2) Work with partners to revise and continue development of a recovery decision support system. This action (6.1 in the draft revised recovery plan) addresses all threats and listing factors because the recovery decision support system will incorporate a range-wide, geospatial database of current management activities, threats, and tortoise populations, providing managers a better framework for recognizing and implementing successful recovery actions. Through the use of conceptual models and research and monitoring results (action 4, below), the decision support system will provide an explicit, well-documented process for making decisions while clarifying key uncertainties about the relationship of threats and management to desert tortoise population status.

3) Work with partners to develop/revise recovery action plans. This is action 6.2 in the draft revised recovery plan. RITs should use the decision support system to tier off the recovery plan by developing 5-year action plans and budget needs with priorities for management scaled down to local or jurisdictional levels. Five-year action plans should be coordinated with the Management Oversight Group and developed within the first year of publication of the revised recovery plan. On-the-ground recovery actions, addressing multiple threats and listing factors, will be implemented by appropriate parties according to the RIT five-year action plans and during the term of this plan. Initial application of the decision support system for prioritizing actions at the local or regional level will vary among recovery units according to the timeline for updating the system, as described above.

4) Work with partners to monitor desert tortoise population growth and distribution. Through regular monitoring, this action (4.1 and 4.2 in the draft revised recovery plan) addresses all threats and listing factors by feeding information into the recovery decision support system described in action 2.

5) Work with partners to develop protocols and guidelines for a population augmentation program. This is action 3.1 in the draft revised recovery plan. Population augmentation in conjunction with threats management and restoration activities prioritized by the RITs, as well as research designed to investigate the effectiveness of these actions, is a means to gain insights into causes of declines (*i.e.*, addressing all threats and listing factors) and to increase the rate at which depleted populations could be revived. Specific guidelines and protocols will be developed by the DTRO in conjunction with the Science Advisory Committee, topical experts, and representatives from

pertinent regulatory and land management agencies. Within the first year after publication of the revised recovery plan, draft guidelines and protocols for the strategic population augmentation program will be developed (action 3.1 in the revised recovery plan). Subsequent actions entail identifying sites at which to implement strategic population augmentation efforts (action 3.2), securing facilities and obtaining tortoises for use in augmentation efforts (action 3.3), and implementing translocations in target areas to augment populations using a scientifically rigorous, research-based approach (action 3.4). Recovery plan actions 3.2 and 3.3 may be conducted at least partially concurrent with 3.1.

6) Work with partners to develop the Desert Tortoise Conservation Center into a regional recovery facility. The Desert Tortoise Conservation Center (DTCC) in Las Vegas, Nevada, has great potential to function as a center for scientific research, training, and education. In support of these functions, facility upgrades will be required. The DTCC should also be renovated to house head-starting facilities in a secure location in support of action number 5, above. Minimally, this action entails completing a needs assessment for the DTCC, identifying any new partners, and identifying potential funding sources within the next 5 years. This action is related to actions 2.3, 2.9, 2.11, 3.3, and various actions under strategic element 5 in the draft revised recovery plan.

7) Minimize effects of livestock grazing. This action addresses recovery plan action 2.16 by inventorying, analyzing, and resolving trespass cattle issues in the Northeastern Mojave Recovery Unit, as well as continuing to remove all grazing with desert tortoise Critical Habitat Units.

8) Minimize excessive predation on desert tortoises. This action addresses draft recovery plan action 2.14 through the implementation of the *Environmental Assessment to Implement a Desert Tortoise Recovery Plan Task: Reduce Common Raven Predation on the Desert Tortoise*. This action will reduce raven predation on desert tortoises through direct removal of ravens and by implementing cultural and mechanical methods to reduce human subsidies to ravens.

As noted previously, the actions described above are components of the overall recovery program, and those that are not brought forward in this 5-year review are no less important to the long-term recovery of the Mojave population of the desert tortoise. Please refer to the 2008 draft Revised Recovery Plan for a comprehensive description of the recovery strategy.

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U.S. FISH AND WILDLIFE USFWS
5-YEAR REVIEW

Mojave Population of the Desert Tortoise (*Gopherus agassizii*)

Current Classification: Threatened

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X__ No change needed

Appropriate Listing/Reclassification Priority Number: 12C

Review Conducted By: Nevada Fish and Wildlife Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service, Nevada Fish and Wildlife Office

Approve Robert D. Williams Date 9/7/10

REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 8

Approve [signature] Date 9/30/10

Cooperating Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

_____Concur _____ Do Not Concur

Signature____ Date_______

Cooperating Regional Director, U.S. Fish and Wildlife Service, Region 6

_____Concur _____ Do Not Concur

Signature____ Date_______

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Review Conducted By: Nevada Fish and Wildlife Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service, Nevada Fish and Wildlife Office

Approve ______________________________ Date ________

REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 8

Approve ______________________________ Date ________

Cooperating Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

_X_ Concur _____ Do Not Concur

Actin Signature ______________________________ Date 9-23-2010

Cooperating Regional Director, U.S. Fish and Wildlife Service, Region 6

_____ Concur _____ Do Not Concur

Signature ______________________________ Date ______

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Review Conducted By: Nevada Fish and Wildlife Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service, Nevada Fish and Wildlife Office

Approve ____ Date _________

REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 8

Approve ____ Date _________

Cooperating Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

_____Concur _____ Do Not Concur

Signature____ Date_______

Cooperating Regional Director, U.S. Fish and Wildlife Service, Region 6

_X_Concur _____ Do Not Concur

Signature [signature] Date 9/24/10