

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

# California Endangered Species Act



## Status Review for Mojave Desert Tortoise (*Gopherus agassizii*)

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Report to the Fish and Game Commission

February 2024



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**LIST OF ABBREVIATIONS, ACRONYMS, AND TERMS**

- BLM – Bureau of Land Management
- CEQA – California Environmental Quality Act
- CESA – California Endangered Species Act
- CHU – Critical Habitat Unit
- CNDDDB – California Natural Diversity Database
- Commission – California Fish and Game Commission
- Department – California Department of Fish and Wildlife
- DoD – Department of Defense
- ESA – Endangered Species Act
- et al. – “and others”
- ITP – Incidental Take Permit
- MCAGCC – Marine Corps Air Ground Combat Center Twentynine Palms
- NEPA – National Environmental Policy Act
- NPS – National Park Service
- RU – Recovery Unit
- TCA – Tortoise Conservation Area
- USFWS – United States Fish and Wildlife Service

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## **EXECUTIVE SUMMARY**

This status review contains the most current information available on the Mojave Desert Tortoise (*Gopherus agassizii*) and serves as the basis for the California Department of Fish and Wildlife's (Department) recommendation to the California Fish and Game Commission (Commission) on whether to change the status (i.e., uplist) of the species from threatened to endangered under the California Endangered Species Act (CESA).

The Mojave Desert Tortoise was designated a threatened species under CESA in 1989 and designated as threatened under the federal Endangered Species Act (ESA) in 1990. On March 23, 2020, Defenders of Wildlife, Desert Tortoise Council, and Desert Tortoise Preserve Committee submitted a petition to the Commission to change the status of the Mojave Desert Tortoise from threatened to endangered. At its public meeting on October 14, 2020, the Commission considered the petition, and based in part on the Department's petition evaluation and recommendation, found sufficient information exists to indicate the petitioned action may be warranted and accepted the petition for consideration. The Commission's decision initiated this status review to inform the Commission's decision on whether the change in status is warranted. The Department's recommendation is that uplisting the Mojave Desert Tortoise is warranted.

### **Species Description, Biology, and Ecology**

The Mojave Desert Tortoise is a long-lived, desert-dwelling reptile that uses behavioral and physiological adaptations to avoid extreme temperatures and dehydration, and to budget stored energy. Mojave Desert Tortoises primarily regulate their temperature by using underground burrows where the air is cooler and higher in humidity in summer, and warmer in winter. They can spend more than 90% of their lives underground.

Females become sexually mature at 12–20 years old and typically lay one or two clutches of eggs (about 6 eggs per clutch) per year. Nest predation is common, with 12–47% of nests lost to predators annually. Incubation time in the wild varies from 67 to 104 days and incubation temperatures determine the sex of the hatchlings, with hotter temperatures producing female-skewed clutches.

In California, the range of the Mojave Desert Tortoise includes the Mojave Desert and portions of the Sonoran and Great Basin deserts. Desert tortoise habitat typically consists of alluvial fans and plains that facilitate the digging of burrows. Tortoises need sufficient forage plants as well as larger shrubs and bushes for shade and protection of burrows. Tortoises feed on annual forbs, annual and perennial grasses, herbaceous perennial plants, and some cacti. Tortoises occur in very low densities or are absent where shrub cover is sparse, precipitation is low, and annual food plants are available only intermittently (e.g., lower elevations of Death Valley). They also occur at low densities in areas that are moderately to severely disturbed by human activity.

## **Status and Trends**

The most robust estimates of densities come from annual systematic surveys done in the USFWS-designated Tortoise Conservation Areas (TCAs) which are grouped into Recovery Units. These surveys began in 2001 and cover large areas of the best habitat for tortoises. The 1994 USFWS Recovery Plan for desert tortoise identified 3.9 adult tortoises/km<sup>2</sup> as the minimum density necessary for population viability. Only two of the ten TCAs in California had mean densities above that threshold in 2001, and all the TCAs were below the threshold in 2020. Between 2001 and 2020, densities declined an average of about 1% per year in the Colorado Desert and Eastern Mojave Recovery Units (17% decline over 19 years), and about 4% per year in the Western Mojave Recovery Unit (54% decline over 19 years). In 2001, the Western Mojave was the area with the highest densities of tortoises, but experienced the steepest decline in abundance, losing >50% of adults from 2001 to 2020. However, there is still a large amount of available habitat in California and there were estimated to be more than 90,000 adult tortoises in the Western Mojave Recovery Unit in 2020.

The available population data indicate that there were widespread sharp drops in density before the tortoise was listed as threatened, and those losses have continued to the point where most surveyed areas no longer support viable tortoise populations. Despite 30 years of state and federal protection as a threatened species, tortoise populations do not show consistent signs of recovery.

The slow maturation and low reproductive rates of tortoises means that if past and current management is successful at addressing threats and stemming the decline of tortoise populations, it would still take at least 25 years of positive population growth to reach the USFWS Recovery Criteria. For example, the USFWS 1994 Recovery Plan estimates that when adult survivorship is 98%, population growth would be less than 0.5% per year, and would take 140 years to double in size. Annual survival rates for both adults and juveniles are much lower than 98% in most areas, and since the late 1970s, the number of juveniles detected on surveys has also fallen sharply, to the point that in some recent surveys in the western Mojave Desert almost no juveniles were found.

## **Threats**

The declines of Mojave Desert Tortoise populations are likely due to extensive and interconnected threats. The important threats fall into two categories, those that directly kill adults and juveniles, and those that cause longer-term changes to habitat availability and quality.

In long-lived species that are slow to reproduce, decreased survival has long lasting impacts on population viability and can alter demographic rates for decades. Predation pressure from ravens and coyotes reduces the survival of juvenile and adult tortoises. Development within the tortoise range often creates or increases traffic on paved roads, and extensive networks of unpaved roads and trails for off highway vehicles occur on public land. Tortoises are killed by vehicles on paved and unpaved roads and trails. Moreover, road infrastructure increases the



amount of roadkill and garbage available, creating food subsidies for ravens and coyotes which encourages their presence near tortoises. Well-designed fences and culverts can help prevent tortoises and other wildlife from being killed by vehicles along major roads, but little fencing has been built in California tortoise habitat since 2011.

Habitat modification, fragmentation, and destruction reduces the amount of habitat that can support tortoises in the long-term and reduces the size of remaining habitat patches. Although a large proportion of desert tortoise range is under federal control, renewable energy, housing, offroad vehicle use, and other types of development reduce the amount of habitat available. Concerningly, predators like the raven and coyote that receive food subsidies in fragmented and disturbed habitats can also occur at higher densities in nearby “undisturbed” habitats.

Additional factors have direct and indirect impacts on tortoises and their habitat. Climate change is likely to cause hotter and periodically drier conditions in the desert tortoise range that will increase their physiological stress and change activity patterns. The nutritious native vegetation tortoises feed on is being outcompeted by nutritionally poor invasive grasses, which can lower tortoise survival rates. Fires fueled by invasive grasses decrease the amount of native vegetation available for tortoises to feed on and remove other important vegetation components of tortoise habitat. In combination, the impacts of climate change will likely result in less available suitable habitat.

Some threats appear to be declining since the species was listed. Upper respiratory tract diseases were a major concern when tortoises were listed as threatened. Encouragingly, the prevalence of diseased tortoises is lower than in previous decades, and these diseases do not currently appear to be an acute threat to wild populations. The prevalence of gunshot deaths has also decreased in the past several decades.

Historical and current conservation and management efforts such as the prohibition on take, creation of land use plans, required mitigation, and translocation and head-starting efforts have not proven sufficient to halt the population declines of desert tortoise. Given that there are multiple interacting threats that are reducing the amount and quality of viable habitat and lowering survival rates of adults and juveniles, the available information suggests that tortoise populations will continue to decline for the foreseeable future. However, several of the major threats like raven predation on juveniles and the lack of tortoise exclusion fencing on highways are issues that can be addressed with appropriate resources and policy changes. Implementing these actions where appropriate to improve survival in the short term is critical to give desert tortoise populations the resilience to weather longer term habitat and climactic effects.

Several recommended management actions are described in this status review. Improved coordination and communication between the Department and other state and federal agencies would help the implementation of these actions. We also point to several needs for increasing capacity at the Department to better track the impact of threats and conservation actions on tortoise populations.

**Recommendation**—In consideration of the scientific information contained herein, the Department has determined that listing the Mojave Desert Tortoise as endangered under CESA is warranted at this time.

## **1. REGULATORY SETTING**

### **1.1 Petition Evaluation Process**

On March 23, 2020, the Commission received a petition from Defenders of Wildlife, the Desert Tortoise Council, and the Desert Tortoise Preserve Committee to change the status of Mojave Desert Tortoise from threatened to endangered. On April 13, 2020, the Commission referred the petition to the Department for evaluation pursuant to Fish and Game Code section 2073 and published a formal notice of receipt of the petition (Cal. Reg. Notice Register 2020, No. 18-Z, p. 693). At its meeting on April 16, 2020, the Commission officially received the petition.

A petition to list, delist, or change the status of a species under CESA must include “information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and any other factors that the petitioner deems relevant” (Fish & G. Code, § 2072.3).

The Department’s charge and focus in its advisory capacity to the Commission is scientific, and it evaluates petitions based on the best scientific information available regarding potential listing factors including those listed above. At its meeting on August 20, 2020, the Commission received the Department’s petition evaluation report, which is intended to assist the Commission in making a determination as to whether the petitioned action may be warranted based on the sufficiency of scientific information (Fish & G. Code, §§ 2073.5 & 2074.2; Cal. Code Regs., tit. 14, § 670.1, subds. (d) & l). Focusing on the information available to the Department relating to each of the required information categories listed above, the Department recommended to the Commission that the petition be accepted.

At its public meeting on October 14, 2020, the Commission considered the petition, the Department’s petition evaluation and recommendation, and comments received. The Commission found that sufficient information existed to indicate the petitioned action may be warranted and accepted the petition for consideration. Upon publication of the Commission’s notice of its findings, the Mojave Desert Tortoise was designated a candidate species on October 19, 2020 (Cal. Reg. Notice Register 2020, No. 44-Z, p. 1445).

The Commission’s decision to designate the Mojave Desert Tortoise as a candidate species triggered the Department’s process for conducting a 12-month status review to inform the Commission’s decision on whether the change in status is warranted (Fish & G. Code, § 2074.6

and Cal. Code of Regs., title 14, § 670.1). At its meeting on October 14, 2021, the Commission granted the Department a six-month extension to complete the status review and facilitate external peer review.

## **1.2 Status Review Overview**

This status review is based upon the best scientific information available to the Department and serves as the basis for the Department's recommendation to the Commission on whether the petitioned action to list the Mojave Desert Tortoise as endangered is warranted. It is not intended to be an exhaustive review of all published scientific literature on Mojave Desert Tortoise; rather it is intended to summarize key points relevant to the status of the species and address regulatory report requirements.

All of the required elements in Fish and Game Code sections 2072.3 and 2074.6, as well as in California Code of Regulations Title 14 section 670.1, are included and addressed in this status review. These elements include “information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map” (Fish & G. Code, § 2072.3; see also Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1)). Sections are named and organized according to each of the required petition components and the listing factors that the Commission must consider in making its determination. However, in some instances, the Department has renamed and grouped similar elements to create a more cohesive and readable report.

A species shall be listed as endangered or threatened “if the Commission determines its continued existence is in serious danger or is threatened by any one or any combination of the following factors: present or threatened modification or destruction of its habitat, overexploitation, predation, competition, disease, or other natural occurrences or human-related activities” (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

An endangered species under CESA is one “which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease” (Fish & G. Code, § 2062). A threatened species under CESA is one that “although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by [CESA]” (id., § 2067).

Receipt of this report is to be placed on the agenda for the next available meeting of the Commission after delivery. At that time, the report will be made available to the public for a 30-day public comment period prior to the Commission taking any action on the petition.

## **2. BIOLOGY**

### **2.1 Taxonomy**

Desert tortoises are members of the order Testudines, family Testudinidae, genus *Gopherus*. When the Commission listed Desert Tortoise as threatened in 1989, *Gopherus agassizii* was understood to range from southeastern California, across southern Nevada, through western Arizona, and south into Sonora and Sinaloa, Mexico. In 2011, studies of tortoise genetics, morphometrics, and ecology led experts to conclude that the species complex formerly known as “Desert Tortoise” in fact consists of two separate species, Mojave Desert Tortoise and Sonoran Desert Tortoise (*Gopherus morafkai*) (Murphy et al. 2011, Iverson et al. 2017). Mojave Desert Tortoise, also known as Agassiz’s Desert Tortoise or Mohave Desert Tortoise, retains the binomial *G. agassizii*, and ranges across the deserts of southeastern California, southern Nevada, and small areas of Arizona and Utah north of the Colorado River as well as southwestern Utah. There is an “anomalous” population of *G. agassizii* east of the Colorado River in the Black Mountains of Arizona (Edwards et al. 2015). Apart from that population, desert tortoises east of the Colorado River in Arizona and in northern Mexico are now classified as Sonoran Desert Tortoise, also known as Morafka’s Desert Tortoise. More recent work by Edwards et al. (2016) separates desert tortoises living in the thorn scrub and tropical deciduous forests of southern Mexico into another species, *Gopherus evgoodei*. Only the Mojave Desert Tortoise occurs in California. This status review uses the common name Mojave Desert Tortoise when referring to *G. agassizii* as the species is currently understood. Any reference to Agassiz’s or Mohave Desert Tortoise in this document should be considered synonymous with Mojave Desert Tortoise.

### **2.2 Species Description and Life History**

Much of the information in this section is summarized from a Berry and Murphy (2019) monograph on *Gopherus agassizii*. The Mojave Desert Tortoise is a long-lived, desert-dwelling reptile. The upper shell or carapace of adults ranges in size from 178mm to over 370mm in length. Shell color varies from light yellow to dark charcoal in hatchling tortoises and from light to dark brown in adults (Berry and Murphy 2019). Generally, males are larger than females (Ernst and Lovich 1994) but the largest measured wild individual was a female in 1986 whose carapace length was 374 mm (Berry and Murphy 2019). The largest male measured in the wild had a 330 mm carapace length (Berry and Murphy 2019).



**Figure 1.** Mojave Desert Tortoise. Pictures by Dana Wilson BLM (left) and Roy Averill-Murray USFWS (right).

Desert tortoises make extensive use of underground burrows to regulate body temperature and as protection from predators. Temperatures in burrows can be up to 20°C (36°F) cooler than summer air temperatures, especially very deep in the burrows (Berry and Murphy 2019). Home range size depends on sex, age, and environmental conditions. Over a 2-year study in the western Mojave Desert, male home range size was 39–47 ha and female home range size was 14–17 ha (Harless et al. 2009). Home ranges of individuals can overlap (O’Connor et al. 1994) and in the western Mojave Desert Harless et al. (2009) found that males overlap more with other tortoises than do females. They also found that the overlap of an individual’s home range from one year to the next was about 35% and did not vary significantly by sex. Individuals tend to have fidelity to home ranges and activity centers, even after a fire (Drake et al. 2015, Lovich et al. 2018).

Tortoises are long-lived and females are thought to become sexually mature at 12–20 years old (mean 18.8; Medica et al. 2012), depending on locality (Woodbury and Hardy 1948, Turner et al. 1986, Curtin et al. 2009). Generation time is estimated to be around 25 years (U. S. Fish and Wildlife Service 1994). Mating occurs in late summer and fall, and females can mate with multiple males (Davy et al. 2011). Female tortoises store sperm/delay implantation so that nesting and egg laying occurs in April–July depending on the region (Berry and Murphy 2019). Females typically lay one or two clutches of eggs (about 6 eggs per clutch) per year; however, some females have been documented to lay more than two clutches (Ennen et al. 2012, Mitchell et al. 2021). Tortoise nests are typically placed near entrance to the burrow or within suitable soil (Ennen et al. 2012), and there is no parental care once eggs have hatched (Berry and Murphy 2019). Reported incubation time in the wild varies from 67–104 days (McLuckie and Fridell 2002) and incubation temperatures determine the sex of the hatchlings. Sex ratios were 1:1 at an incubation temperature of 31.3°C (88.3°F), while eggs incubated at under 30°C (86°F) produced only male hatchlings and those incubated at over 32.5° (90.5°F) produced only females (Rostal et al. 2002). Nest predation is common, with 12–47% of nests destroyed by predators annually (Bjurlin and Bissonette 2004, Ennen et al. 2012). When nests are not depredated, hatchling success is about 80% (Bjurlin and Bissonette 2004). Newly hatched tortoises are about 4–5 cm in length (Bjurlin and Bissonette 2004) and their shells do not fully ossify until they are 5–7 years old.

Tortoises feed on annual and perennial forbs, grasses, and will consume cacti during droughts (Berry and Murphy 2019). Much of the range of the desert tortoise is highly invaded by nonnative plants, including grasses like red brome (*Bromus rubens*) and cheatgrass (*Bromus tectorum*). Experimental studies found that grass diets that included no forbs were detrimental to tortoises, leading to weight loss, poor body condition, or even death (Hazard et al. 2009, Drake et al. 2016). This was the case even when the diet included native grasses (Drake et al. 2016). In addition, the seeds of *B. rubens* can cause injury to the oral mucosa of juveniles (Drake et al. 2016). According to Berry and Murphy (2019), tortoises “favored species of forbs or herbaceous perennials from several plant families: Asteraceae, Boraginaceae, Cactaceae, Fabaceae, Malvaceae, Nyctaginaceae, Onagraceae, and Plantaginaceae (Burge and Bradley 1976; Avery and Neibergs 1997; Jennings and Berry 2015).”

Tortoises are ectotherms whose body temperature is closely linked to the temperature in the environment around them. Mojave Desert Tortoises live in places that can fluctuate up to 40°C (104°F) seasonally and they primarily regulate their temperature by using underground burrows or rock shelters (Cummings et al. 2020) where the air is cooler and moister than the outside air in summer and warmer in winter (Ernst and Lovich 1994). Depending on the type, length, and depth of burrow, average temperatures inside vary from 33.7–36.6°C (92.6–97.8°F) in the summer and 8.9–13.5°C (48–56.3°F) in the winter (Mack et al. 2015). Berry and Murphy (2019) reported that desert tortoises spend >90% of their lives underground. Tortoises are active when their body temperatures are between 19.0°C and 37.8°C (66.2–100°F), they retreat to shade when body temperatures are 35–38°C (95–100.4°F), and body temperatures of 43°C (109.4°F) are deadly (Brattstrom 1965, Zimmerman et al. 1994). However, tortoises can be active above ground at any time of year, especially if it has rained and they can drink, or if they need to move between shelters (Ernst and Lovich 1994). They generally are underground or in rock shelters in late fall and winter, and in late spring through the hot summer. In early spring and fall they are more active above ground, feeding, travelling, and interacting with other tortoises (Berry and Murphy 2019). In the cooler late winter and spring, they are active late morning to mid-afternoon. In the hotter summer and fall, if activity occurs, it tends to be in the cool of the morning and late evening. Smaller juvenile tortoises can be active at cooler temperatures than larger tortoises so tend to be active more days per year (Berry and Murphy 2019). Available water and forage have an impact on activity and movement. Tortoises moved less, used fewer burrows, and had smaller home ranges during drought years as compared to wet years in the mid-1990s (Duda et al. 1999). However, at a different site in the late 1990s, the relationships between precipitation and activity area, rate of movement, and burrows used were less clear (Ennen et al. 2012), suggesting that there are many interacting forces that determine tortoise activity and movement levels.

Tortoises also have additional behavioral and physiological strategies to deal with extremes of temperature and resource availability. During droughts, tortoises can lose up to 40% of their body mass. They can resorb water from their bladders and store sodium, chloride, and urea in their blood and in the bladder. When it rains, they drink, void their bladders, and rapidly increase their body weight (Ernst and Lovich 1994, Peterson 1996, Berry and Murphy 2019).

## 2.3 Habitat Associations



**Figure 2.** Mojave Desert Tortoise in the Mojave Desert. Photo by Rachel London via USFWS

Mojave Desert Tortoises in California can be found in part of the southern Great Basin, Mojave, and western Sonoran deserts in southeastern California (Berry and Murphy 2019, Figure 2). Due to their dependence on burrows, they require soils, topography, geological features, and vegetation that facilitate the creation of burrows or dens (Andersen et al. 2000). Therefore, desert tortoise habitat typically consists of alluvial fans and plains, but they can be found on rocky hillsides (Germano et al. 1994). Tortoises also need appropriate vegetation communities for forage and shelter. Most burrows are found beneath shrubs, though they can also be dug into the sides of ephemeral streams.

The vegetation types that tortoises use vary across their range and by altitude. As Berry and Murphy (2019) put it:

“Within the Mojave Desert ecosystem, tortoises occur in several vegetation associations. At lower elevations or adjacent to dry lake beds, saltbush associations (*Atriplex* spp.) and other members of the Chenopodiaceae provide habitat. The most common associations contain creosote bush (*Larrea tridentata*), usually with white bur-sage (*Ambrosia dumosa*) or cheesebush (*A. salsola*) and several other species of shrubs, cacti, and perennial grasses. With increasing elevation, multiple species of woody shrubs and tree yuccas (Joshua tree, *Yucca brevifolia*, and Mojave yucca, *Y.*

*schidigera*) become more common, with blackbrush (*Coleogyne ramosissima*) associations present in higher elevations.

The western Sonoran Desert is a warmer, hotter desert with a higher proportion of precipitation occurring in summer. This desert is also characterized by creosote bushes, but a major difference is the presence of microphyll woodlands of blue palo verde (*Parkinsonia florida*), smoke tree (*Psoralea argemone*), and ironwood (*Olneya tesota*) in ephemeral stream channels separated by desert pavements or open desert with ocotillo (*Fouquieria splendens*) mixed with creosote bush, other shrubs, and cacti (Berry 1984).

Tortoises occur in very low densities or are absent where shrub cover is sparse, precipitation is low and timing erratic, and annual food plants are available only intermittently (e.g., the lower elevations in Death Valley). They are also in low densities in moderately to severely disturbed areas, regardless of desert or region (e.g., Bury and Luckenbach 2002; Keith et al. 2008; Berry et al. 2013)."

## 2.4 Range and Distribution

Range is the general geographical area in which a species occurs. For purposes of CESA and this status review, we are describing and evaluating the tortoise's range in California. Distribution describes the sites where individuals and populations of the species occur, and the spatial arrangement of individuals within the species' range.

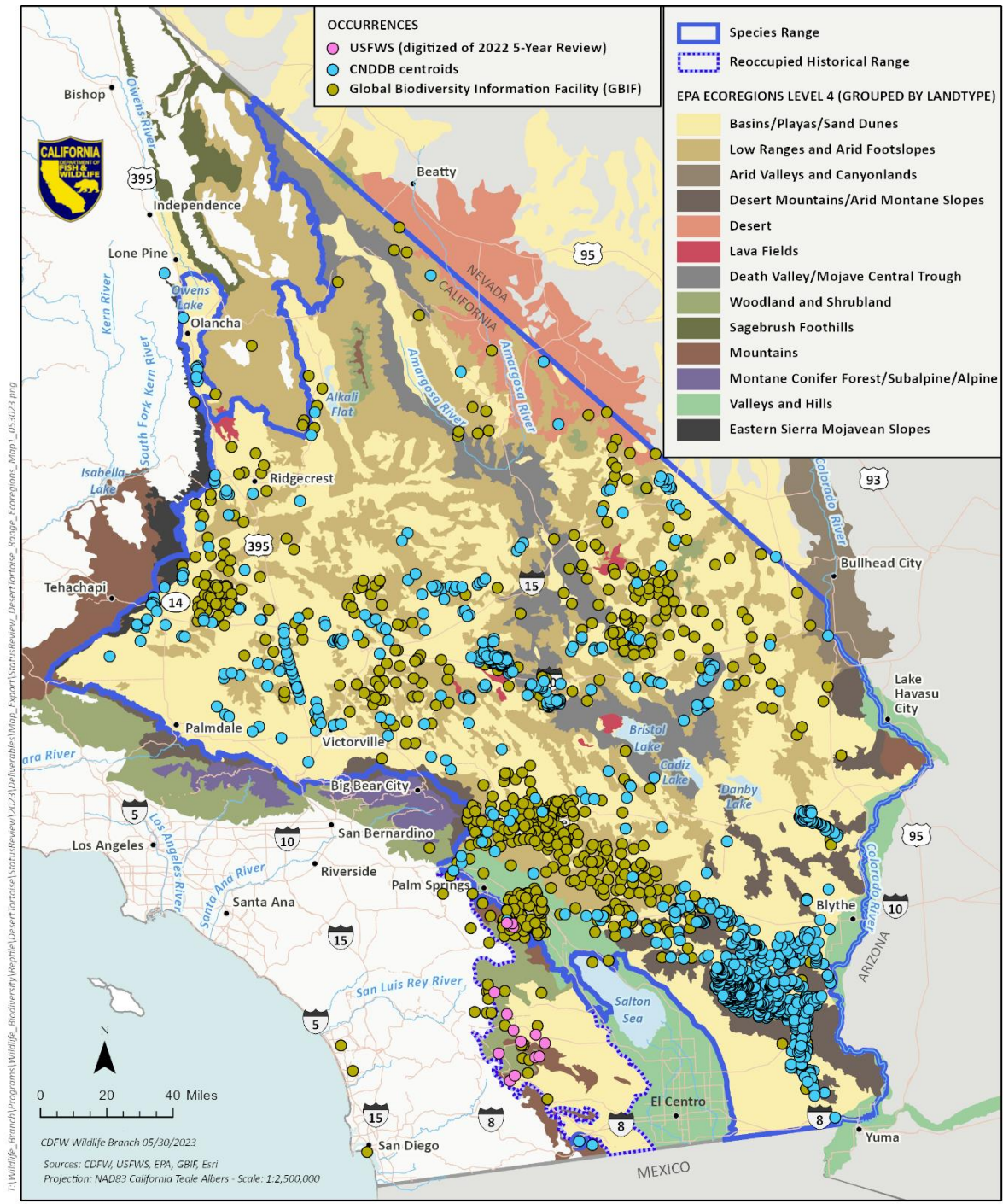
In California, the range of the Mojave Desert Tortoise includes the Mojave Desert and portions of the Colorado subunit of the Sonoran and Great Basin Deserts from the southern end of the Owens Valley south of the town of Lone Pine in Inyo County to the Mexican border near the southeastern corner of the state, and from the Colorado River in the east to the lower slopes of the Sierra Nevada, Transverse, and Peninsular mountains in the west (Berry and Murphy 2019).

The distribution of desert tortoises within California is uneven, and portions of the range no longer provide suitable tortoise habitat due to agriculture, development, and military activity. Data on tortoise occurrences from the California Natural Diversity Database (CNDDDB) and the Global Biodiversity Information Facility (GBIF) were used to plot the distribution of observations in California (Figure 3). These datasets do not represent exhaustive and comprehensive inventories of desert tortoises in California and are largely presence-only datasets. While caution should be used in using these types of data, there appear to be fewer occurrences in the northern part of the range and in the Death Valley/Mojave Central Trough (see grey area on Figure 3), and few occur in low areas near the Salton Sea (Lovich et al. 2020).

Desert Tortoise distribution has been dynamic due to the release of captive tortoises and potential immigration into areas from which they were previously extirpated. For example, tortoises were largely extirpated from the area of Anza Borrego Desert State Park by the 1940s (Manning 2018). In the early 1970s, taking tortoises from the wild became illegal, and people began turning in their captive tortoises to the Department. Between 1970 and 1972 the



Department released about 65 previously captive tortoises into the park. There were occasional sightings in the decades since, with more sightings since 2010. The tortoises there today could be descendants of released tortoises, however natural immigration to the park may also have occurred as there is a tenuous corridor of suitable habitat that connects the park to habitat occupied by tortoises to the north. In 2016, park staff began surveying for tortoises and formally collecting incidental observation data, and subsequent genetic analysis of tortoise blood and scat suggested “evidence of a naturally reproducing Mojave desert tortoise population in Anza Borrego Desert State Park” (Manning 2018). These tortoises extend “the distribution of reproducing Mojave Desert Tortoises greater than 60 km south of Palm Springs and beyond the southern edge of the Colorado Desert Recovery Unit boundary depicted in the recovery plan (Service 2011a)” (USFWS 2022a). We show this reoccupation of historical range in Figure 3, delineated using suitable ecoregion boundaries.



Disclaimer: Information presented on this map is for visual reference only. Consult primary data sources to ascertain the usability of this information for any use other than visual reference.

**Figure 3.** Map of the California range of the Mojave Desert Tortoise, occurrence locations, and Ecoregions. CNDDDB data are sightings from 1935 to 2011. The GBIF occurrences are from 1978 to 2022, and only include sightings that are confirmed by a photograph. The pink dots are the locations of tortoises in the reoccupied historical range as reported in USFWS (2022a). Range boundary is from the California Wildlife Habitat Relationship System (CDFW 2014).

## 2.5 Population Genetic Structure

For imperiled species, understanding the genetic structuring of their populations is important for effective management. Head-starting and translocation are two actions used in desert tortoise conservation (see section 9.1 for more details), and the efficacy of both depends on knowledge of genetic boundaries to avoid the potentially negative impacts of artificially mixing individuals from different genetic populations (Sánchez-Ramírez et al. 2018).

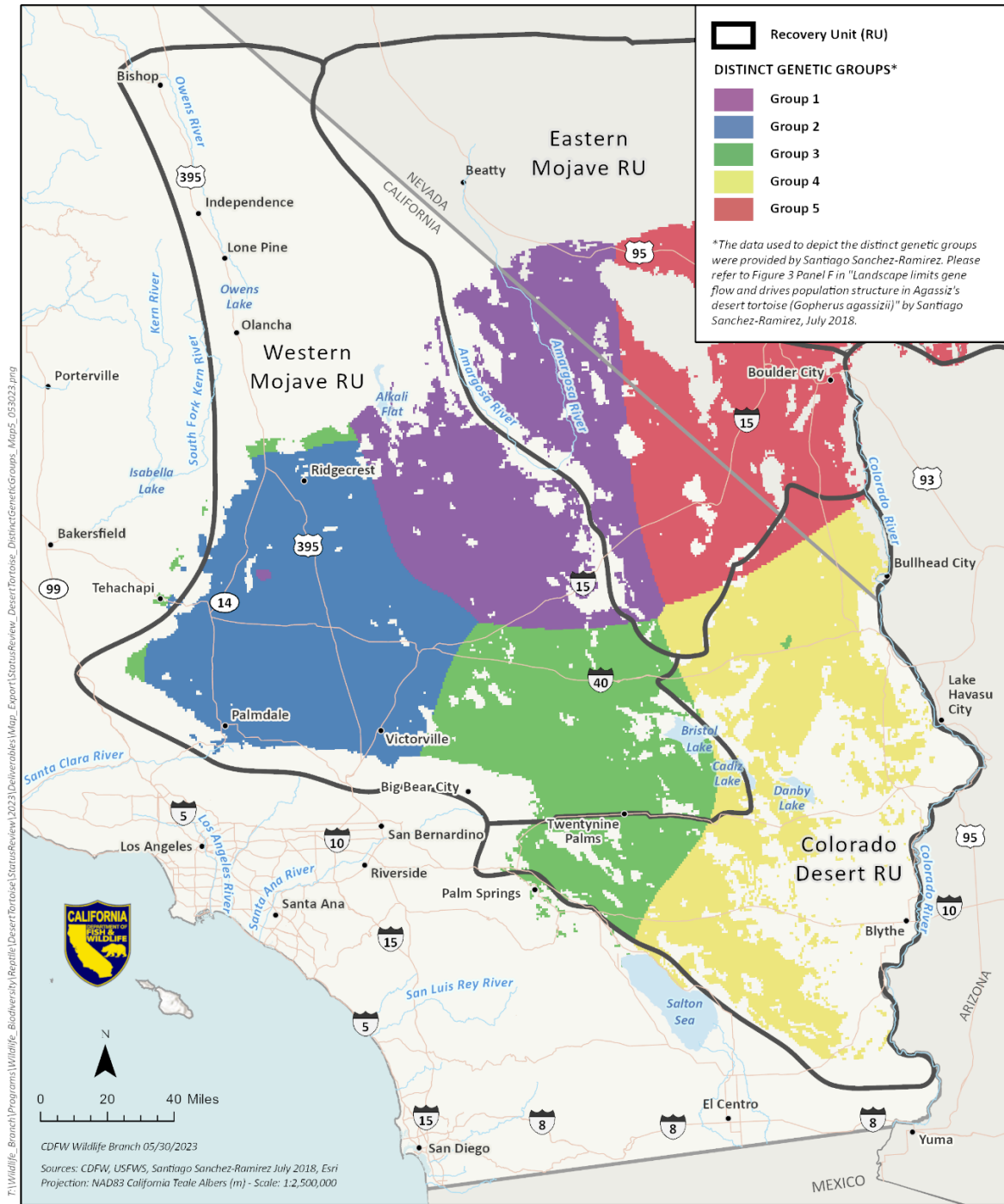
The 1994 U.S. Fish and Wildlife Service (USFWS) Recovery Plan outlined recovery units consisting of “evolutionarily distinct” populations, with three recovery units occurring in California: Western Mojave, Eastern Mojave, and Colorado Desert Recovery Units (see section 3.1 for details). However, a recent study found that the best supported number of genetic clusters in California was five, with the Western Mojave Recovery Unit in the northern and western part of the tortoise range in California containing three genetic groups (Sánchez-Ramírez et al. 2018) (Figure 4). This differs from the earlier work of Hagerty and Tracy (2010) which found the Western Mojave Recovery Unit to be one genetic group. This means that populations within 200–300 km of each other which were previously considered genetically similar and a single genetic unit for management purposes may actually be several genetically identifiable populations. Outbreeding depression has not been well studied in *G. agassizii*; however, the potential negative impacts of outbreeding are expected to occur at long time scales (~600 years; Averill-Murray and Hagerty 2014). This suggests that habitat quality and predator numbers are more important than outbreeding depression when evaluating suitable recipient sites for translocation. Despite this, Sánchez-Ramírez et al. (2018) advise caution when moving tortoises long distances for translocation or population augmentation. For more details about translocations see section 5.2.

## 3. STATUS AND POPULATION TRENDS IN CALIFORNIA

### 3.1 Administrative Status

The Mojave Desert Tortoise has been protected as a threatened species under the California Endangered Species Act (CESA) (Title 14, §670.5) since 1989 and under the federal Endangered Species Act (ESA) since 1990. Unauthorized “take” of threatened and endangered species is prohibited. “Take” is defined under CESA as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill (*Id.*, § 86).

The 1994 USFWS Desert Tortoise Recovery Plan designated six federal recovery units that cover desert tortoise range in California, Arizona, Nevada, and Utah. The recovery units were based on genetics, morphology, behavior, ecology, and habitat use, and each was considered an “evolutionarily distinct” population. These recovery units were revised in the 2011 Recovery Plan with better information and mapping tools. Of the six, all the Western Mojave, the majority of the Colorado Desert, and the western portion of the Eastern Mojave (formerly the Northeastern Mojave) Recovery Units are within California (Figure 4).



**Figure 4.** Map of genetic groups of the Mojave Desert Tortoise. Superimposition of the boundaries of the Recovery Units over Figure 3 panel F in Sánchez-Ramírez et al. (2018). The base map is the “spatial interpolation of ancestry coefficients of Agassiz’s desert tortoises using Krig modeling...combines areas of maximal ancestry proportion for each of the five genetic groups”.

The Western Mojave Recovery Unit is differentiated from the other recovery units by rainfall and vegetation (USFWS 2011). Summers are warm and winters are cold, with most rainfall occurring in fall and winter. Tortoises in the Western Mojave Recovery Unit dig deep burrows (usually located under shrubs on bajadas) for winter hibernation and summer estivation. Above-ground activity occurs primarily in spring when winter annuals provide food (USFWS 2011).

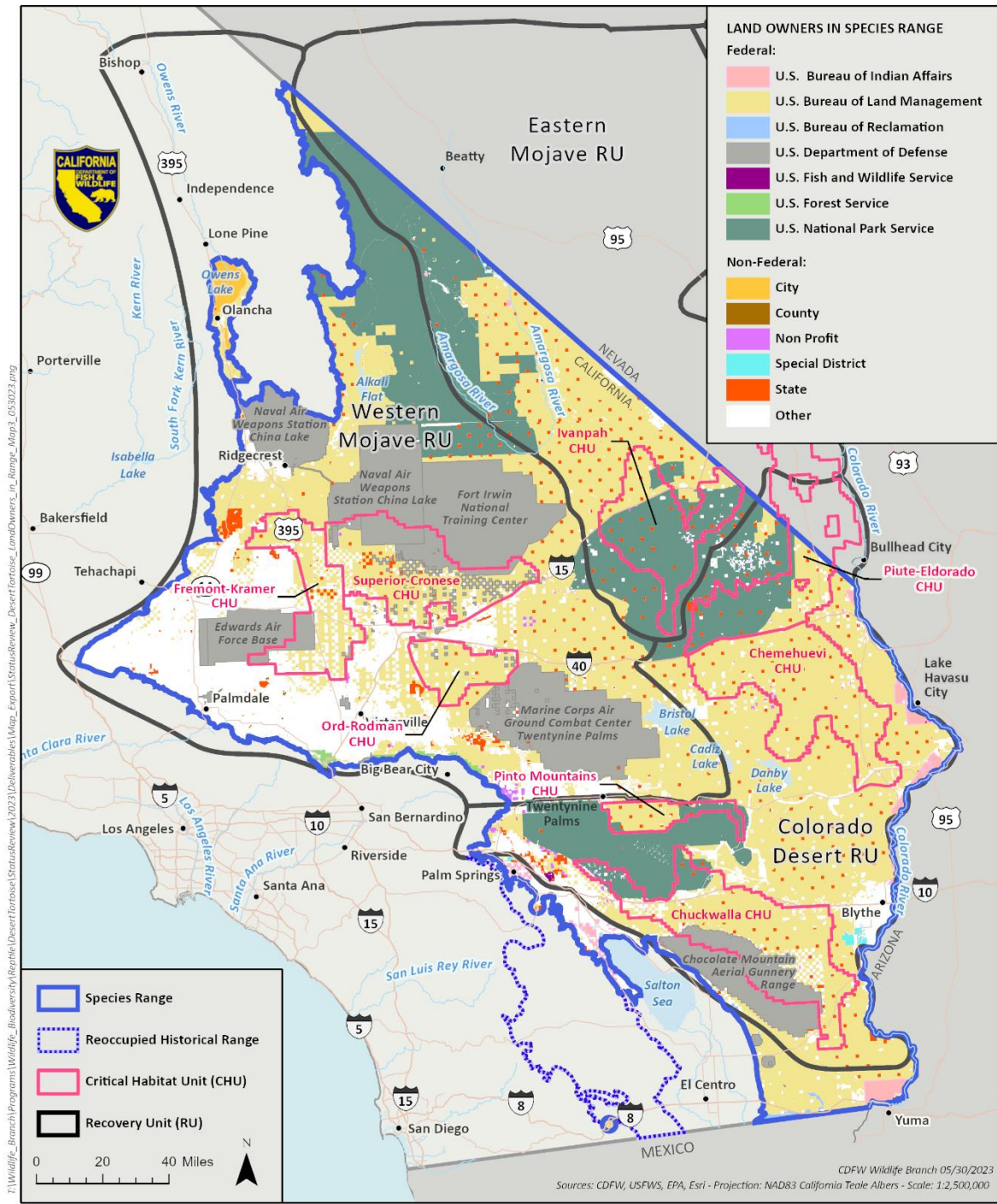
The Colorado Desert Recovery Unit receives about 1/3 of its annual rainfall in summer and supports distinct summer and winter annual plants that tortoises feed on. The climate is somewhat warmer than in other recovery units, with very few freezing days per year. Tortoises are found in the valleys, on bajadas, desert pavements, rocky slopes, and in the broad, well-developed washes (USFWS 2011).

The Eastern Mojave Recovery Unit is separated from the Western Mojave Recovery Unit by a mostly inhospitable barrier created by the Saline Valley, Death Valley, and Silurian Valley. Desert tortoises in the Eastern Mojave Recovery Unit are generally found in creosote bush scrub communities of flats, valley bottoms, alluvial fans, and bajadas. They are often active in spring, late summer, and early fall, as this region receives up to about 40% of its annual rainfall in summer and there are two distinct annual floras on which tortoises can feed (USFWS 2011).

Each recovery unit contains one or more Critical Habitat Units (CHUs). Under section 4 of the ESA, the Department of the Interior is directed to designate the specific areas supporting those physical and biological features that are essential for the conservation of the species. The Department of Interior designated critical habitat areas for the Mojave Desert Tortoise in early 1994 (59 FR 5820) that encompass over 24,281 km<sup>2</sup> in the Mojave and Colorado deserts (USFWS 2011). The critical habitat units are administrative areas managed to give reserve-level protection to desert tortoise populations while maintaining and protecting other sensitive species and ecosystem functions (USFWS 1994). According to USFWS (2019a):

“The specific physical and biological features of desert tortoise critical habitat are (1) sufficient space to support viable populations within each of the six recovery units and to provide for movement, dispersal, and gene flow; sufficient quality and quantity of forage species and the proper soil conditions to provide for the growth of these species; (2) suitable substrates for burrowing, nesting, and overwintering; (3) burrows, caliche caves, and other shelter sites; (4) sufficient vegetation for shelter from temperature extremes and predators; and (5) habitat protected from disturbance and human-caused mortality.”

In California, federal critical habitat designation totals 19,239 km<sup>2</sup>. Of this, 13,465 km<sup>2</sup> are Bureau of Land Management (BLM) land, 980 km<sup>2</sup> are military land, 538 km<sup>2</sup> are state land, and 4,255 km<sup>2</sup> are private land (USFWS 1994) (Figure 5).



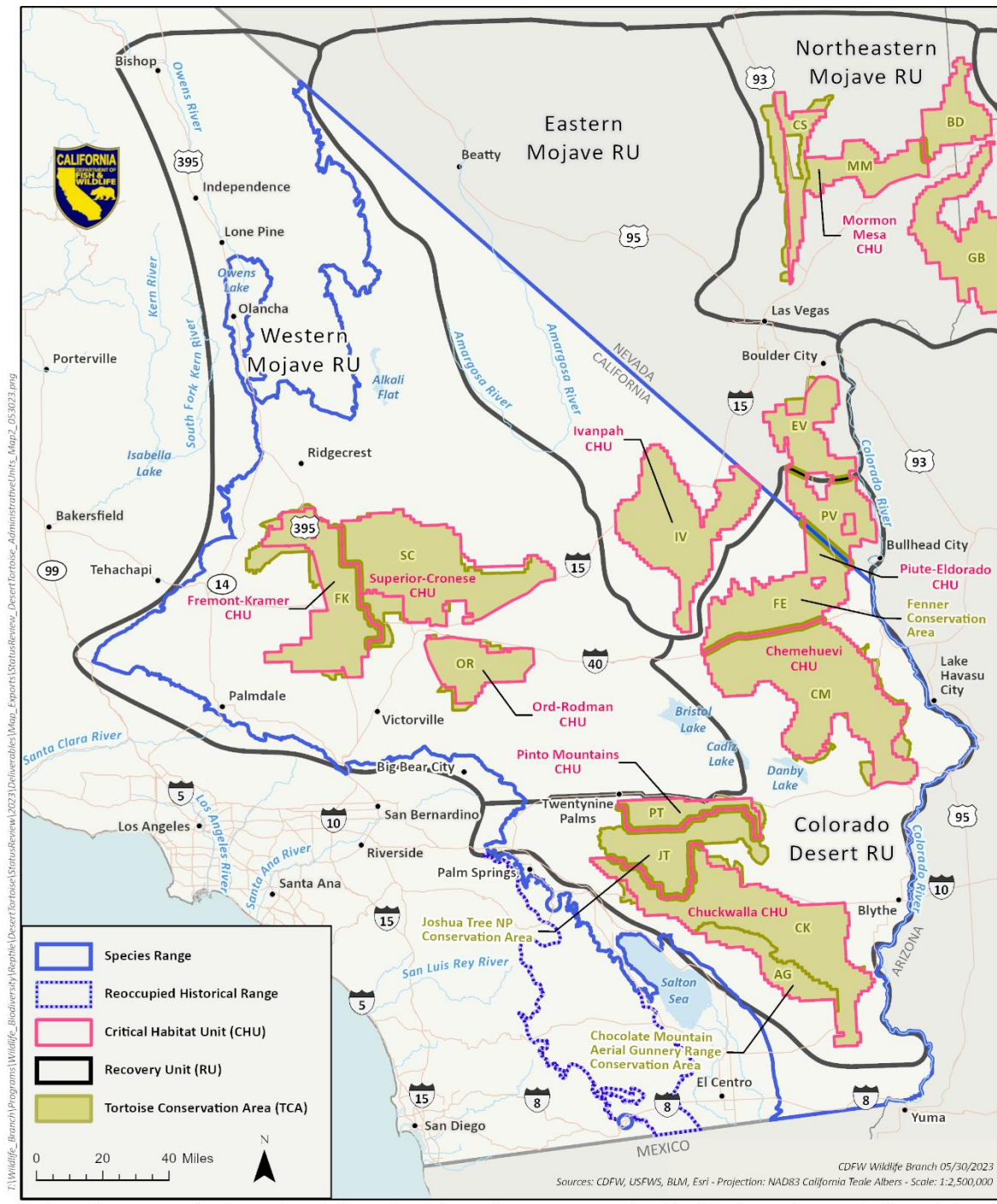
**Figure 5.** Landownership, RUs, and CHUs in the Mojave Desert Tortoise range in California.

Tortoise Conservation Areas (TCAs) are areas that mostly align with CHUs that the USFWS has designated for surveys to evaluate tortoise population status and recovery (see Figures 5, 6 and Table 1). They include “designated critical habitat as well as contiguous areas with potential tortoise habitat and compatible management” (USFWS 2019b). The TCAs have the same name as the CHU they encompass, with a few exceptions where there are multiple TCAs within a CHU

(USFWS 2015). Additionally, the Joshua Tree TCA is not within a CHU. See Figure 6 for boundaries of CHUs and TCAs, and Table 1 for overall size and amount of habitat within the CHUs and size of TCAs.

**Table 1.** Area of modeled desert tortoise habitat within California CHUs, and size of associated TCAs (USFWS 2019a). Note that there are two TCAs within the Chuckwalla CHU. Modeled habitat is suitable desert tortoise habitat per Nussear et al. (2009).

<b>Recovery Unit</b>	<b>Critical Habitat Unit</b>	<b>Size (km<sup>2</sup>)</b>	<b>Modeled Habitat (km<sup>2</sup>)</b>	<b>Tortoise Conservation Area</b>	<b>Size (km<sup>2</sup>)</b>
Western Mojave	Fremont-Kramer	2,096	2,028	Fremont-Kramer	2,417
Western Mojave	Ord-Rodman	1,025	745	Ord-Rodman	1,124
Western Mojave	Superior-Cronese	3,104	2,934	Superior-Cronese	3,332
Eastern Mojave	Ivanpah	2,559	2,067	Ivanpah	2,567
Colorado Desert	Chuckwalla	4,130	3,275	Chocolate Mountain Gunnery Range	755
Colorado Desert	Chuckwalla	4,130	3,275	Chuckwalla	3,509
Colorado Desert	Chemehuevi	3,794	3,701	Chemehuevi	4,038
Colorado Desert	Piute-El Dorado	3,928	3,764	Fenner	1,841
Colorado Desert	Pinto Mountains	695	583	Pinto Mountains	751
Colorado Desert	NA	NA	NA	Joshua Tree	1,567



**Figure 6.** Mojave Desert Tortoise range, RUs, CHUs, and TCAs.

### 3.2 Trends in Density and Abundance

Tortoises are long lived, reach sexual maturity late, and may have decades of reproductive life. These life history characteristics make it difficult to assess trends in tortoise populations. For such species, short- and medium-term studies (1–10 years) may not be long enough to



adequately understand population trends (Tracy et al. 2004). Also, studies that cover only very small, localized portions of the tortoise's range have limited value in assessing the overall population status. This makes long-term studies with consistent methodology that cover large portions of the range in California key to understanding the extent to which tortoise populations are declining or recovering over time.

Since the species was listed as threatened under CESA in 1989, the most robust estimates of density over time come from long-term surveys of TCAs within each CHU using line distance sampling. In 2001–2003, two person teams surveyed TCAs using line transect surveys. Transects were searched out to 8–10 m from the centerline. The shape and length of the transect changed year to year (USFWS 2006). Starting in 2004, square transects with 3 km sides were set up to provide good coverage of each TCA, and a random selection of these transects are surveyed each year. Two surveyors walk line transects along the boundary of the square or as close to it as is feasible. The lead surveyor walks in a straight line on a specified compass bearing, trailing 25 m of cord, and the second crew member follows at the end of the cord. They record the distance and bearing from the survey line to all tortoises seen and live tortoises are measured and sexed. In addition, data from tortoises carrying radio transmitters are used to estimate the proportion of tortoises that are above ground and detectable during the transects. Transects are scheduled in mid-March to May to maximize the chance tortoises will be active and above ground. Standard models are used to calculate density for the TCA from the line transect data in each sampling stratum. Funding for these efforts has varied, but in most years from 2001 to 2021 the USFWS has coordinated the distance sampling monitoring program for desert tortoises in the three recovery units that cover tortoise range in California (USFWS 2015, 2019b, 2020a, 2022a, b). The estimated densities in each TCA from 2004 to 2021 are presented in Appendix A.

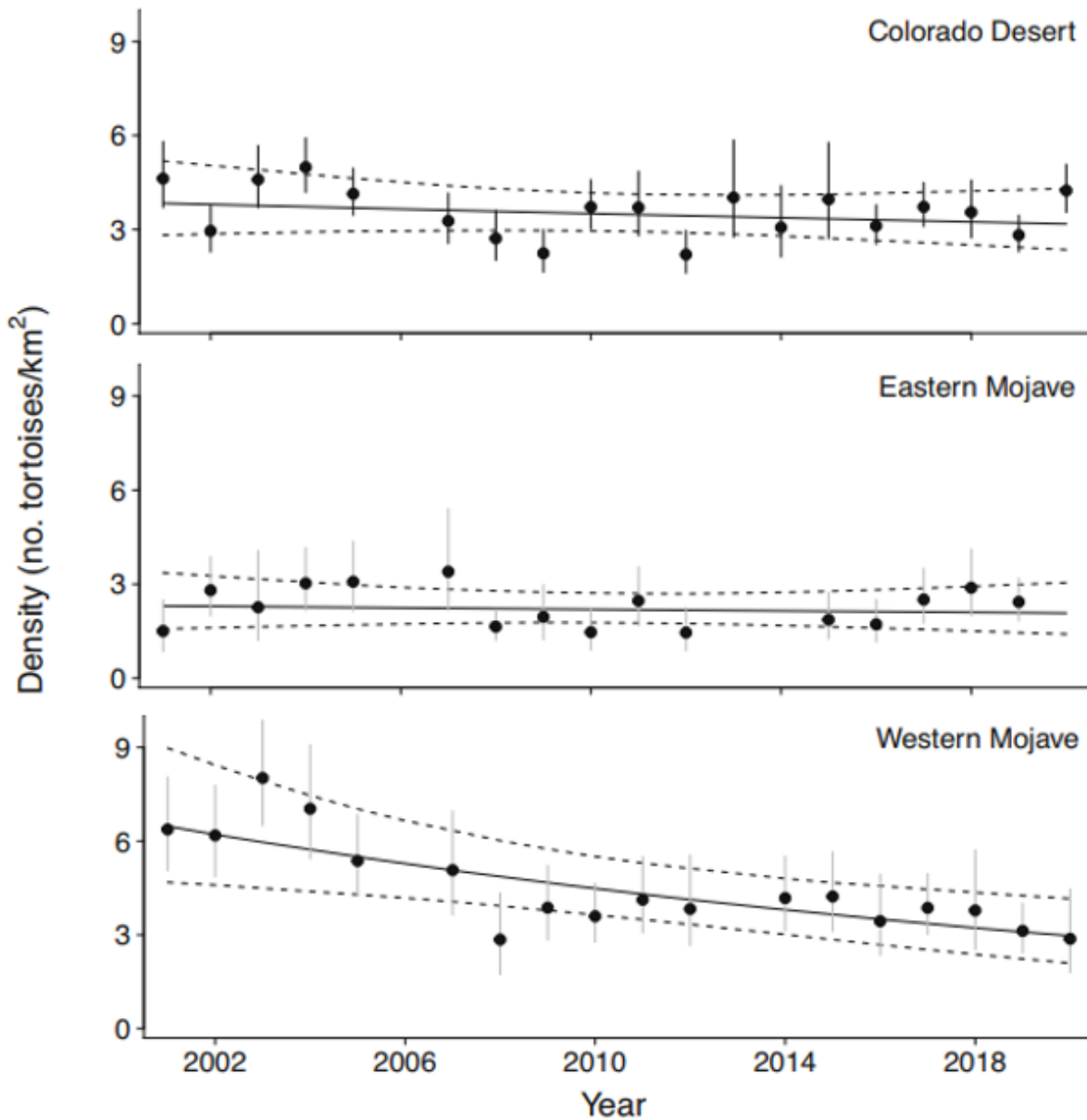
Creating reliable estimates of density for desert tortoise is challenging not only due to their life history traits but also because “spatial variation in environmental features influences both population densities and the ability of observers to detect individuals” (Zylstra et al. 2023). Until recently, the best estimates of density and trends in density were the yearly estimates generated by USFWS and Allison and McLuckie (2018). However, the most up to date modelling comes from Zylstra et al. (2023) who used the line transect data to generate spatially explicit estimates of density and regional trends for desert tortoises in the three recovery units from 2001 to 2020. Their results differ from the earlier ones because their modelling framework is better able to account for sources of uncertainty in the estimates, and we use their results in the discussion below.

Despite the protections afforded through the federal ESA and CESA, tortoise populations have declined in recent decades. The 1994 USFWS Recovery Plan for desert tortoise identified 3.9 adult tortoises/km<sup>2</sup> as the minimum density necessary for population viability (U. S. Fish and Wildlife Service 1994, USFWS 2011). Only two of the ten TCAs in California had mean densities above that threshold in 2001, both of which were in the Western Mojave RU (Zylstra et al. 2023; Table 2). Despite the low densities in 2001, the estimated densities continued to decline across all California TCAs through 2020. Over this period, densities declined about 1% per year

in the Colorado Desert and Eastern Mojave RUs, and about 4% per year in the Western Mojave RU (Zylstra et al. 2023; Figure 7). These rates of decline correspond to decreases in population density of 17% and 54% over 19 years, respectively. By 2020, all TCAs had densities that were below the population viability threshold.

**Table 2.** Predicted density of Mojave Desert Tortoises (number of adults/km<sup>2</sup>) in each of the Tortoise Conservation Areas (TCAs) in the recovery units in California in 2001 and 2020. Total estimated area excludes impervious surfaces (which increased by <25 km<sup>2</sup> between 2001 and 2019 across all TCAs). Modified from Zylstra et al. (2023).

Recovery Unit	TCA	Area (km <sup>2</sup> )	Mean Density 2001	Min Density 2001	Max Density 2001	Mean Density 2020	Min Density 2020	Max Density 2020
Colorado Desert	Chocolate Mountain Aerial Gunnery Range	866	3.74	2.18	5.52	3.1	1.81	4.58
Colorado Desert	Chuckwalla	3768	2.84	0.12	7.39	2.37	0.1	6.15
Colorado Desert	Chemehuevi	4281	2.7	1.01	4.9	2.24	0.84	4.1
Colorado Desert	Fenner	2009	3.56	0.47	4.77	2.95	0.39	3.96
Colorado Desert	Joshua Tree	1714	3.07	0.11	7.07	2.55	0.09	5.82
Colorado Desert	Pinto Mountains	848	3.59	0.61	5.35	2.99	0.52	4.47
Eastern Mojave	Ivanpah Valley	2755	1.75	0.16	2.94	1.59	0.15	2.68
Western Mojave	Fremont-Kramer	2590	7.29	0.51	12.4	3.33	0.23	5.24
Western Mojave	Ord-Rodman	1223	3.8	0.05	8.7	1.74	0.02	3.97
Western Mojave	Superior Cronese	3508	5.45	0.53	9.44	2.5	0.24	3.99



**Figure 7.** Estimates of density for adult Mojave Desert Tortoises (posterior medians [circles] and 95% credible intervals [CIs]) in each year a recovery unit was surveyed, with fitted log-linear trends (solid line) and 95% CIs for trends (dashed lines) in each recovery unit relevant for California. Modified from Zylstra et al 2023.

In 2001, the Western Mojave RU had the highest densities in California, but it has experienced the steepest decline in abundance since then, losing >50% from 2001 to 2020 (Zylstra et al. 2023; Table 3). The losses in abundance in the Colorado Desert and Eastern Mojave RUs were not as steep (with declines of about 17% and 9%, respectively), but overall, the three recovery units lost an estimated 130,000 tortoises over 19 years (Table 3). The Colorado Desert and

Eastern Mojave RUs each have one TCA outside of California, so the abundance estimates in Table 3 are likely an over-estimate for California.

**Table 3.** Predicted abundance (with associated standard error in parentheses) of adult Mojave Desert Tortoises in 2001 and 2020, and the difference between the two years, in the three California recovery units. For reference, the estimated areas within each recovery unit in 2001 and 2020 are included. The change in area between years is due to exclusion of areas with >40% impermeable surfaces. Modified from Zylstra et al. 2023.

Recovery Unit	Area (km <sup>2</sup> ) 2001	Abundance (2001)	Area (km <sup>2</sup> ) 2020	Abundance (2020)	Difference in Abundance
Colorado Desert	30,815	75,918 (12,458)	30,723	62,820 (9,862)	-12,782 (17,774)
Eastern Mojave	39,778	53,564 (10,784)	39,567	48,692 (9886)	-5,081 (16,925)
Western Mojave	50,623	206,540 (35,443)	50,444	94,433 (16,737)	-112,020 (42,490)

Predictions are based on a model that allowed for independent log-linear trends in each of the four recovery units. Differences in abundance between 2001 and 2020 were computed for each Markov chain Monte Carlo iteration and then summarized. Thus, calculated differences in the rightmost column do not equal the differences between summarized values in the Abundance columns.

Allison and McLuckie (2018) used different methods to estimate densities and declines in abundance from 2004 to 2014. Their density and abundance estimates were higher than those in Zylstra et al. (2023) but they also estimated a decline in abundance of about 50% in the Western Mojave RU in 2004–2014. Regardless, both techniques indicate broad scale, long-term declines in density and abundance for desert tortoise across their range in California. Currently all TCAs are estimated to be below the density necessary for population viability and have suffered declines for decades. These declines in the TCAs occurred despite state and federal listing and most of the land falling under federal land management agency ownership (Figure 5).

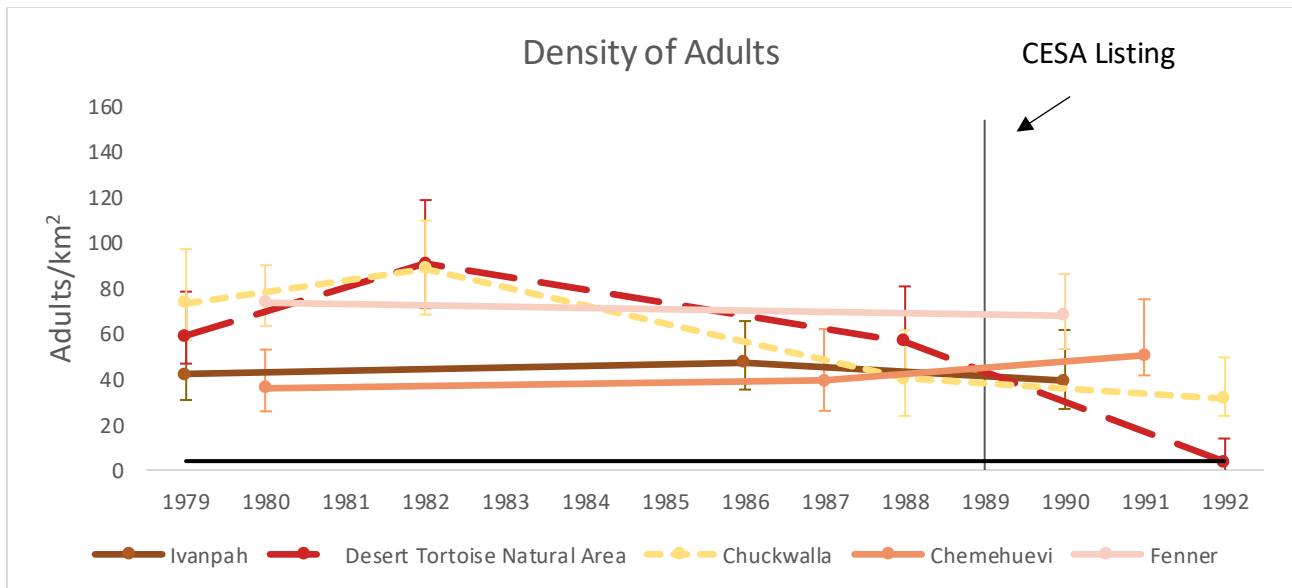
The long-term surveys in the TCAs provide robust data on declines in density since 2001. However, tortoise populations had been in decline for decades previously, and estimates of densities from before the species was listed under CESA in 1989 are important for understanding the scale of longer-term decline. While there were no large scale or frequent systematic population monitoring programs in the 20<sup>th</sup> century, multiple regional or short-term surveys gave snapshots of density in certain areas pre and post listing. These early monitoring programs sometimes relied on tortoise sign (tracks, scats, burrows, or carcasses) as well as observations of live tortoises, or employed mark-recapture methods to obtain estimates of abundance or density. It should be noted that survey methods that rely on sign to estimate numbers of live tortoises are not reliable. In addition, mark recapture methods contain several assumptions that are violated in surveys of tortoises (Corn 1994), and the lack of spatial information in conventional mark recapture analysis leads to inflated estimates of density (Mitchell et al. 2021b). Therefore, estimates of density before 2001 must be approached with

caution and direct comparisons between density estimates from mark recapture and line transect density methods are not advised. However, we can use these studies to give a rough picture of the state of tortoise populations in the late 20<sup>th</sup> century.

Broad estimates of tortoise densities in California before the species was listed under CESA can be found in Berry (1986a):

“Berry and Nicholson (1984a) developed a more detailed map of relative tortoise abundance throughout an area of over 100,000 km<sup>2</sup> using data from 1,808 strip transects. Transects, which were 2.4 km by 9.1 m, provided counts of tortoise signs (live individuals, carcasses, scats, cover sites, tracks, drinking sites, and courtship rings). Counts of signs were calibrated against counts along transects in areas where tortoise densities had been estimated by repeated censuses. The map prepared by this method showed five relative density classes: 0–8, 9–19, 20–39, 40–97, and >97 tortoises/km<sup>2</sup>. Four major tortoise population centers or crucial habitats with densities of >77 tortoises/km<sup>2</sup> were identified: (1) Fremont-Stoddard in the western Mojave Desert (4,864 km<sup>2</sup>), (2) Ivanpah in the eastern Mojave Desert (918 km<sup>2</sup>), (3) Fenner-Chemehuevi in the eastern Mojave and northeastern Colorado deserts (3,881 km<sup>2</sup>), and (4) Chuckwalla (1,333 km<sup>2</sup>) in the southern Colorado Desert.”

In addition, in the 1970s the BLM established 27 2.6 km<sup>2</sup> (1 mile<sup>2</sup>) survey sites in California (Berry and Turner 1986). Using mark recapture methods, researchers surveyed the plots over 60-day periods in the spring every 2–10 years (Berry and Medica 1995). Berry (1986a) reported that of those 27 sites, “eight had estimated densities of  $\leq 8$  tortoises/km<sup>2</sup>, six had 8–39 tortoises/km<sup>2</sup>, and 13 sites supported 42–184 tortoises/km<sup>2</sup>”, though the years those estimates come from are not reported. Several of these sites are located within the current Ivanpah, Chuckwalla, Fenner, and Chemehuevi TCAs. The Desert Tortoise Natural Area overlaps with the northern border of the Fremont-Kramer TCA. Comparing the density estimates in Berry and Medica (1995) to the USFWS estimates in 2001–2021 is not appropriate due to the differences in methodology described above. However, comparing the mark recapture density estimates between 1979 and 1992 can give us a sense of the general scale of decline even if the estimates themselves are biased high (Berry and Medica 1995, Mitchell et al. 2021b). Estimates of densities in 1979–1980 vary from 36 adults/km<sup>2</sup> in Chemehuevi to a high of 73 adults/km<sup>2</sup> in Fenner and Chuckwalla (Figure 8). By the early 1990s, densities of adults had not fallen particularly dramatically except in Chuckwalla which had a 57% decline from about 73 adults/km<sup>2</sup> to about 31 adults/km<sup>2</sup>, and the Desert Tortoise Natural Area which saw a 93% decline to 3.7 adults/km<sup>2</sup> (Figure 8).



**Figure 8.** Estimated densities of adults/km<sup>2</sup> in plots surveyed 1979–1992 using mark recapture methods. Each dot represents the midpoint of the density estimate for a given year, bars are 95% confidence intervals. Black horizontal line represents 3.9 adults/km<sup>2</sup>, the estimated minimum density needed for population viability. Redrawn from figures in Berry and Medica (1995).

Berry et al. (2020b) continued the work of surveying tortoises at Desert Tortoise Research Natural Area in the western Mojave Desert for decades. Part of the site was fenced to keep out sheep, vehicles, and humans but allow movement of tortoises, and surveys were done both inside and outside the fence. In 1979 when they started the surveys, estimated densities of tortoises were 103/km<sup>2</sup> inside the fence and 79/km<sup>2</sup> outside the fence. In 2002, densities had declined to 10.2/km<sup>2</sup> inside the fence and 4.17/km<sup>2</sup> outside the fence. By 2012, densities had increased to 15.6/km<sup>2</sup> inside the fence, and to 4.9/km<sup>2</sup> outside the fence. Counts of tortoises (from which densities were estimated) followed an estimated overall linear decline of 9.1% per year over the 30+ years of the study.

Other studies give rough estimates of historical density in other parts of the range. In the Pinto Basin of Joshua Tree National Park in 1991–1996, Freilich et al. (2000) used mark recapture methods to resurvey a 1 mi<sup>2</sup> (2.59 km<sup>2</sup>) plot that had been surveyed in the 1970s. Their methods were designed to estimate abundance rather than density; however, their estimate for the early 1990s was 42 adults/km<sup>2</sup>. They reported that the density estimates were 29–31 adults and juveniles/km<sup>2</sup> in the 1970s. However, Lovich et al. (2014) reported that surveys in the Pinto Basin in 1987–1988 provided density estimates as high as 77 tortoises/km<sup>2</sup>.

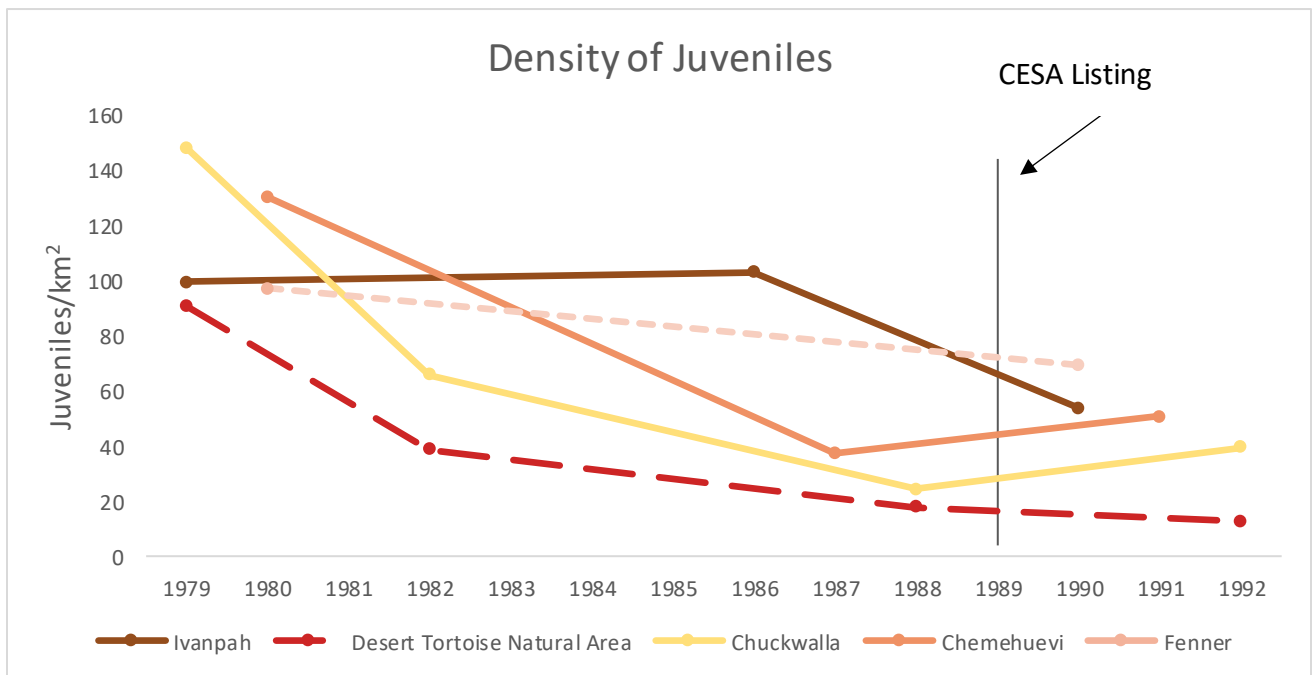
Medium-term tracking of densities occurred in four study sites in California at various times between 1977 and 1985 (Berry et al. 1986). At one site in the western Mojave Desert, Fremont Peak, sampling occurred three times (1977, 1980, and 1985) and the population density declined from 27/km<sup>2</sup> in 1980 to 15/km<sup>2</sup> in 1985 (Berry et al. 1986). However, at three other

sites there were no significant changes in density during those years. At the Kramer Hills site in the Western Mojave Desert there were an estimated 42 adults/km<sup>2</sup> in 1980 and 44 adults/km<sup>2</sup> in 1982. The Chemehuevi Wash site in the Colorado Desert was surveyed in 1979 and 1982 and saw a nonsignificant increase from 18 adults/km<sup>2</sup> to 22 adults/km<sup>2</sup>. The Chuckwalla Bench study site in the Colorado Desert had a non-significant increase in density from 75 adults/km<sup>2</sup> in 1979 to 87 adults/km<sup>2</sup> in 1982 (Berry et al. 1986); see Figure 8.

Although the density estimates from mark recapture surveys in the 1970s and 1980s only cover small areas and are biased high (Mitchell et al. 2021b), they provide a general picture of long-term decline and give context for more recent density estimates.

### Juveniles

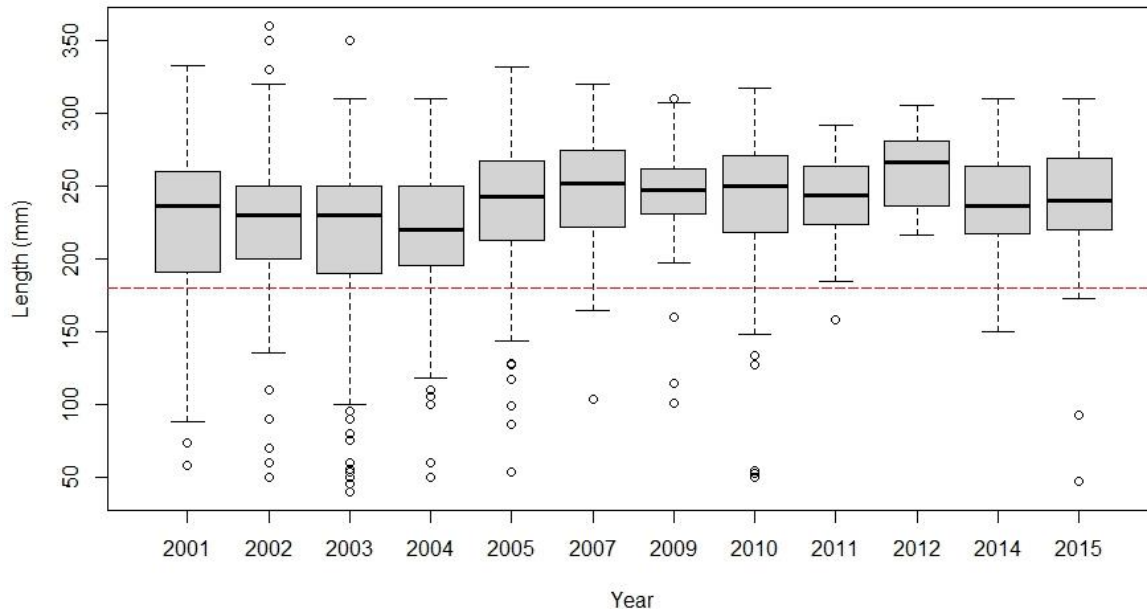
Juvenile tortoises are easier to overlook during surveys than adults, and the U.S. Fish and Wildlife Service does not include densities of juveniles in their yearly reports on density in the TCAs (but see Figure 10). However, Berry and Medica (1995) report on the density of adults and of all tortoises (including juveniles) using mark recapture surveys in BLM plots from 1979 to 1992. From those survey results, we can roughly calculate historical density of juveniles (density of all tortoises minus density of adult tortoises) in those specific plots to determine broad patterns of decline through 1992 (Figure 9).



**Figure 9.** Density of juvenile tortoises in plots in California from 1979 to 1992. Juvenile density was calculated by subtracting density of adults from density of all tortoises presented in Berry and Medica (1995).

Between the late 1970s and early 1990s, the density of juveniles declined roughly 46% in Ivanpah, 86% in the Desert Tortoise Natural Area, 73% in Chuckwalla, 62% in Chemehuevi, and 29% in Fenner (Figure 9). While juvenile tortoises are expected to have low survival rates, this

long-term loss of juveniles from the landscape is concerning, and there is evidence that it is continuing into recent years. In 2014 in the Western Mojave RU, the density of adult tortoises was 49% of what it had been in 2004, and the proportion of juveniles in the population declined by 9% (Allison and McLuckie 2018). In the yearly transect surveys done in the TCAs, the median midline carapace length did not change significantly between 2001 and 2015 (Figure 10). However, fewer juveniles small enough to be classified as outliers (the small circles below the lower ‘whisker’ in the box and whisker plot of Figure 10) were found in 2007–2015 compared to 2001–2005. In 2011, only one juvenile (midline carapace length <180 mm) was found, and in 2012 none were found. In some areas, the youngest tortoises found in recent years were at least 30 years old (Holcomb 2022a). Despite a steady median carapace length across 2001–2015, the range of carapace lengths decreased, with most of that change due to fewer smaller individuals found. Even with thousands of adults in a population, if sufficient juvenile tortoises are not surviving to breeding age, the population will decline without interventions like head-starting, although that decline may take decades to manifest (Lovich et al. 2018).



**Figure 10.** Midline carapace length of tortoises surveyed within the Western Mojave Recovery Unit Tortoise Conservation Areas, showing a reduction in observations of tortoises smaller than 180mm after about 2005. Described in Alison and McLuckie (2018), and figure made with USFWS unpublished data provided by K. Holcomb and used with permission. The horizontal dashed line at 180 mm represents the size over which tortoises are considered to be adults.

### 3.3 Mortality and Survival Rates

Adult and juvenile survival rates are important demographic factors that can affect whether a population is increasing, stable, or declining. Desert tortoises generally have low survival rates (i.e., high mortality rates) as hatchlings and juveniles, and relatively high adult survival rates (Berry and Murphy 2019). The adult survival rate needed for population stability depends on a



number of factors, including population reproduction and/or recruitment rates, but the USFWS 1994 Recovery Plan estimated that an adult survival rate of 98% per year is needed for population growth of 0.5% per year. A more recent estimate that incorporated current adult densities and juvenile survival rates found that an adult survival rate of 93% per year was necessary for desert tortoise population stability (no growth or decline) (Holcomb 2022a). Estimates of survival/mortality rates come from a variety of studies within California, most of which were quite limited in geographic scale. When comparing survival rates to mortality/death rates, a broad rule of thumb is that mortality or death rate  $\approx 1 - (\text{survival rate})$ .

Adult tortoises are much easier to survey than juveniles and consequently most of the information about survival and mortality in the wild relates to adults. In the late 1970s and early 1980s, a study from four sites provided some limited information on annual mortality rates in stable and declining populations (Berry et al. 1986). At Fremont Peak in an area that later became the Fremont-Kramer TCA, densities of adults and subadults declined significantly between 1973 and 1985, and the estimated annual mortality rate of adults and subadults was 4.8% per year. In contrast, three other sites surveyed during that period that did not see significant declines in density had annual mortality rates of 2.2–2.9% (Berry et al. 1986). Berry et al. (2020b) estimated survival rates (1979–2012) of adults and juvenile tortoises inside and outside of the fenced portion of the Desert Tortoise Research Natural Area in the Western Mojave. As mentioned previously, in 1979 the estimated density of all tortoises was 103/km<sup>2</sup> inside the fence and 79/km<sup>2</sup> outside the fence. By 2012 densities had decreased to 15.6/km<sup>2</sup> inside the fence and to 4.9/km<sup>2</sup> outside the fence. During those years the population suffered an estimated 87.6% decline. Median annual survival probability (converted into percentages for ease of comparison) for adults inside and outside of the fenced area ranged from 79%–83% in 1979–1989, 71%–78% in 1989–2002, and 94%–96% in 2002–2012. These estimates are all well below the necessary survival rate identified in the USFWS 1994 Recovery Plan to achieve modest population growth. Juveniles had lower survival - their estimated median annual survival probability was 66%–73% in 1979–1989, 57%–65% in 1989–2002, and 90%–93% in 2002–2012.

In Eastern Joshua Tree National Park, tortoises were surveyed intermittently from 1978 to 2012 (Lovich et al. 2014). The authors tested the impact of rainfall on survival, and the best model of survival was based on the average estimated winter precipitation over the preceding three winters. They estimated a mean annual (apparent) survival rate of 0.87 (87%). Values below the mean occurred in 1991, 1997–2004 and 2008, which were years of lower rainfall (Lovich et al. 2014). Estimated survival was above the mean in 2010–2011. It should be noted that other factors that impact survival, such as predation, roadkill, and disease were not tested independently.

Between 2002 and 2004, Berry and Keith (2008) evaluated the status of desert tortoise populations in Red Rock Canyon State Park in Kern County. In the 1970s the population density had been estimated to be <8 tortoises/km<sup>2</sup>. They estimated that 67% of the adult and subadult tortoise alive in 2000 were dead in 2004, and densities were between 2.7 and 3.6 tortoises/km<sup>2</sup>.

In 2007–2008, Berry et al. (2020c) evaluated the status of a population of tortoises in the El Paso Mountains close to the Fremont-Kramer Critical Habitat Unit. Estimated density of adults was 4.8/km<sup>2</sup> and the annual death rate of adults in 2003–2008 was 6.9% (Berry et al. 2020c). The top causes of known death were mammalian and avian predators, gunshots, and vehicles. The authors concluded that “the high death rate of adults, low population density, high human visitor use, and ongoing decline in the adjacent critical habitat unit indicate that a viable population is unlikely to persist in the study area” (Berry et al. 2020c).

Esque et al. (2010) tracked several hundred adult tortoises before and after translocations from Fort Irwin National Training Center to neighboring public land in the Superior-Cronese Critical Habitat Unit. They monitored translocated tortoises, tortoises resident at the release sites, and control tortoises in nearby areas that were not affected by the translocations. In the first year (2008), 19% of control tortoises, 20% of resident tortoises, and 25% of translocated tortoises died. Most of the mortalities were thought to be due to coyote (*Canis latrans*) predation. As a comparison, at a different reference site in the Superior-Cronese Critical Habitat Unit, 8.3% of tracked tortoises died in 2008. At reference sites in other critical habitat units in California, percent mortality in 2008 ranged from 0% in Ivanpah and Ord-Rodman to 28–30% in Chemehuevi and Chuckwalla. Esque et al. (2010) also showed that mortality can vary greatly year to year in the same site. For example, at Soda Mountain outside of the Superior-Cronese Critical Habitat Unit, in 2006 there was no mortality, in 2007 mortality was 17%, and in 2010 mortality was 43%.

In 2009, Berry et al. (2020a) surveyed about 93 km<sup>2</sup> of BLM land within the eastern Chemehuevi Valley, adjacent to the Chemehuevi Critical Habitat Unit. Based on the number of live and dead tortoises found and the estimated age of the carcasses, they concluded that the density of adults was 2.0/km<sup>2</sup> (+/- 1.0), and that the annual death rate in the four years prior to the survey was 13.1%/year. These data led them to conclude that the population was probably nonviable (Berry et al. 2020a).

Collectively, these data suggest that adult survival rates in most recently surveyed areas are too low to support stable populations and have been below the thresholds established by the USFWS 1994 Recovery Plan and by Holcomb (2022a) for some time (Table 4). Although survival rates have not been estimated systematically across the tortoise’s range in California, rates appear to be particularly low outside of CHUs.

**Table 4.** Survival and mortality rates of adult and subadult tortoises in various studies.

Life stage	Survival vs Mortality	Rate	Location	Time scale	Reference
Adults	Median annual survival probability	79%-83%	Desert Tortoise Research Natural Area	1979-1989	Berry et al. 2020b
Adults	Median annual survival probability	71%-78%	Desert Tortoise Research Natural Area	1989-2002	Berry et al. 2020b
Adults	Median annual survival probability	94%-96%	Desert Tortoise Research Natural Area	2002-2012	Berry et al. 2020b
All	Mean annual survival	87%	Eastern Joshua Tree National Park	1978-2012	Lovich et al. 2014
Adults & subadults	Annual mortality	4.5%	Fremont -Kramer TCA	1977-1985	Berry et al. 1986
Adults & subadults	Annual mortality	2.2%-2.9%	Kramer Hills, Chemehuevi, Chuckwalla	1977-1985	Berry et al. 1986
Adults & subadults	Death rate over 4 years	67%	Red Rock Canyon State Park	2002-2004	Berry and Keith 2008
Adults	Annual death rate	6.9%	El Paso Mountains near Fremont-Kramer CHU	2003-2008	Berry et al. 2020c
Adults	Annual mortality	13%	Chemehuevi Valley	2005-2009	Berry et al. 2020a
Adults	Annual mortality	0%	Ivanpah	2006-2008	Esque et al. 2010
Adults	Annual mortality	0%	Ord-Rodman	2006-2008	Esque et al. 2010
Adults	Annual mortality	0%-31%	Chemehuevi	2006-2008	Esque et al. 2010
Adults	Annual mortality	9%-29%	Chuckwalla	2006-2008	Esque et al. 2010
Adults	Annual mortality	0%-44%	Soda Mountain	2006-2008	Esque et al. 2010
Adults	Annual mortality	6.3%-8%	Superior-Cronese	2007-2008	Esque et al. 2010

### *Juvenile Survival*

In long-lived species like the tortoise, if adult survivorship drops, reproductive rates or juvenile survival would have to increase dramatically to keep populations stable. Analysis by the USFWS (1994) estimated that “a 10% increase in adult mortality can require a 300% increase in juvenile survivorship” to maintain a stable population. Many of the threats to adult survival also affect juveniles, making it unlikely that juvenile survivorship can naturally increase to the levels needed to compensate for the decreasing adult survival documented above.

Several factors limit the number of hatchlings that are produced in the wild each year. Temperature, precipitation, and body size influence the number eggs females lay (Henen 2002, Mitchell et al. 2021a), with the maximum being 12-18 eggs a year (J. Lovich Pers comm 2023). Incubation success depends on temperature, and nest predation is common (see section 2.2 for more detail) (Berry and Murphy 2019). In the Ivanpah Valley between 2011 and 2014, Tuberville et al. (2019) compared survival and growth of free ranging hatchlings to those reared in pens under different rainfall scenarios. Both groups were hatched from eggs laid by wild females and brought into captivity for the study. Free ranging hatchlings were released into the wild between 0 and 18 months old. Estimated annual survival rates for the free ranging hatchlings was 48%–49% compared to 94% of those reared in pens.

We have little information on historical juvenile survival rates, but the impact of recent low survival rates can be seen in demographic information. As mentioned previously, in the yearly surveys performed in the Western Mojave TCAs, many fewer tortoises with midline carapace length <180 mm were found in 2007–2015 compared to 2001–2005 (Figure 10). One factor influencing juvenile mortality is raven (*Corvus corax*) predation. Holcomb et al. (2021) estimated that annual survival rates for 1–10-year-old tortoises in 5 CHUs averaged 63% when within 500 m of a raven’s nest, and ~76% when the median distance to a nest was 1.72 km. See section 4.4 for more detail on predation.

One strategy to improve juvenile survival is to raise tortoises in captivity and then release them once they reach a certain size (referred to as head-starting; for more details see section 5.2). A study at the Fort Irwin National Training Center on head-started juvenile tortoises (Nagy et al. 2015b) found that in the two years after release, survivorship was 76–79%, but in the third-year survivorship dropped to 53%, resulting in an overall three year survival rate of 32%. Survival was generally higher amongst tortoises with a carapace length of at least 100 mm (9 years old). Another study on head-starting found no significant difference in the survival rate of hatchlings released vs. those reared indoors for 7 months vs. those reared in outdoor pens for 7 months (Daly et al. 2019). Although the head-started tortoises grew quickly, the combined annual survival of the three groups was 44%, with the odds of survival increasing 51% for every 100 m away from a raven nest. They predicted that survival would be near 100% if the nearest nest was more than 1.6 km away (Daly et al. 2019).

Even with head-starting, juvenile survival rates can be lower than the 59% average annual juvenile survival rate estimated by Holcomb (2022a) to be necessary for population stability if adult annual survival rates are 93% (Table 5; see Table 4 for adult annual survival rates). The available information suggests that low juvenile survival is a likely contributor to widespread declines in density.

**Table 5.** Survival rates of juvenile tortoises in various studies.

Life stage	Survival rate estimated	Rate	Location	Time scale	Reference
Juveniles	Median annual survival probability	66%-73%	Desert Tortoise Research Natural Area	1979-1989	Berry et al. 2020b
Juveniles	Median annual survival probability	57%-65%	Desert Tortoise Research Natural Area	1989-2002	Berry et al. 2020b
Juveniles	Median annual survival probability	90%-93%	Desert Tortoise Research Natural Area	2002-2012	Berry et al. 2020b
Head started juveniles	Survivorship after 2 years	76-79%	Fort Irwin	2005-2007	Nagy et al. 2015
Head started juveniles	Survivorship after 3 years	53%	Fort Irwin	2005-2008	Nagy et al. 2015
Wild Hatchlings	Survival rate	48%-49%	Ivanpah Valley	2011-2014	Tuberville et al 2019
Head started juveniles	Annual survival after release	44%	Mojave National Preserve	2015	Daly et al. 2019
Juveniles	Annual survival close to ravens' nest	63%	Mojave Desert	2020	Holcomb et al. 2021
Juveniles	Annual survival far from a raven nest	76%	Mojave Desert	2020	Holcomb et al. 2021

For species like tortoise with slow growth, delayed maturation, and low reproduction rates (Shine 2005), factors that lower adult survival rates can have long-term negative impacts on abundance/density. Snapping turtles have similar life history traits as desert tortoises, and in a population in Ontario Canada, river otters killed about 50% of the adults over three years in the late 1980s (Keevil et al. 2018). Female annual survival rates fell from 94% to 76–86% during those years, and the population was reduced by about 40% (Keevil et al. 2018). Twenty-three years later, survival rates had returned to early 1980s level, but abundance did not rebound. This suggests that even if threats are removed, and survival rates increase, for a long-lived species like the desert tortoise, populations may not recover for several decades. The problem is magnified if juvenile survival is very low as occurs in multiple survey areas in California. Having breeding adults on the landscape is vital for population viability, and low rates of juvenile recruitment create an unstable demographic structure that will make it less likely for populations to recover and makes them vulnerable to any additional sources of mortality (Holcomb 2022b).

#### 4. FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE

This section considers the factors affecting the ability of the population to survive and reproduce, and the degree and immediacy of threat (Fish & G. Code, § 2072.3; see also Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1)). In addition, this section addresses the six listing factors identified in title 14 of the California Code of Regulations section 670.1, subdivision (d)(1): present or threatened modification or destruction of habitat, overexploitation, predation, competition, disease, or other natural occurrences or human-related activities. This

section reviews the best available scientific information regarding each of these factors and assesses the degree of threat of each.

Desert tortoise life history traits, including delayed reproductive maturity, relatively low annual fecundity, and low survival rates of juvenile tortoises cause populations to be vulnerable to a multitude of threats (Berry et al. 2020b). Their vulnerability is increased because many of the threats are interactive and amplify each other. This document focuses on individual threats, but also recognizes that many of them are fundamentally intertwined. Many of the threats described in the initial desert tortoise status review and the USFWS Recovery Plans (U. S. Fish and Wildlife Service 1994, USFWS 2011) continue to affect the species.

#### **4.1 Habitat Modification and Destruction**

The Mojave Desert Tortoise range in California includes a variety of public and private land jurisdictions, the top three being BLM (39,251 km<sup>2</sup>), National Park Service (NPS) (17,035 km<sup>2</sup>), and Department of Defense (DoD) (13,018 km<sup>2</sup>). Habitat management and allowable modification varies by jurisdiction. BLM land can be officially designated as Wilderness where mechanical transport is not allowed and there are many restrictions on use. In other areas BLM land is managed for a wide range of uses and stakeholders, and permitted activities that may impact tortoises include off-highway driving, mining, and renewable energy projects. On NPS land off-highway driving, mining, and renewable energy projects are not allowed. DoD land is not generally open to the public and uses range from extremely low impact to high impact live artillery use. See Figure 5 for more details on land ownership.

In the large majority of tortoise habitat, at least some alteration is allowed which can impact tortoises. Across all states, an estimated 66% of Mojave Desert Tortoise habitat has some development within 1 km, where development is defined as “urban development, cultivated agriculture, energy development (e.g., oil and gas well pads, solar energy facilities), surface mines and quarries, pipelines and transmission lines, and transportation (e.g., roads and railroads)” (Carter et al. 2020). The direct impacts of development include removal of soil and vegetation, destruction of burrows, and creation of roads and other infrastructure that can kill tortoises or hinder their movements (Boarman and Sasaki 1996, 2006). An important indirect impact of development is subsidization of predators (see section 4.4) (Boarman et al. 2006).

Tortoises are less likely to occur in areas that have even a low level of development. Carter et al. (2020) found that “encounter rates of both live and dead Mojave Desert Tortoises combined decreased significantly with development levels” and that when “10% of the area within 1 km of that location has been altered by development” (10% development), it was rare to find live or dead tortoises at a location. The authors estimated that encounter rates for both live and dead Mojave Desert Tortoises decreased an average of 4% for every 1% increase in the development index (Carter et al. 2020).

While there is some development within 1 km of the majority of desert tortoise habitat range-wide, the three Recovery Units partially or wholly within California generally include little development. In the Western Mojave Recovery Unit (which is wholly within California) 47% of

tortoise habitat has almost no development (<1% within 1 km), and 5% of habitat has >10% development (USFWS 2022a). For the Eastern Mojave Recovery Unit, the proportion of habitat with <1% development within 1 km is 58%, and 5% is at 10% development. In the Colorado Desert Recovery Unit, it is 65% and 4% respectively (USFWS 2022a). However, those two units extend outside of California (see Figure 6), and it is unclear whether those percentages are representative of the range in California. In their 2022 5-year review, the USFWS concluded that “space does not appear to be a limiting factor to tortoise recovery”. However, these categories of development used above do not include unpaved roads and tracks for off-highway vehicles (OHVs) which are allowed on BLM land (see section 4.2). And given continued desert development, the conclusions may be less applicable in the future.

The human population in the inland deserts of California has increased significantly in the past 30 years. Between 1990 and 2022, the number of housing units increased 58% in Imperial County, 79% in Riverside County, and 37% in San Bernardino County (numbers calculated from State of California Department of Finance 2023). Not all of this growth happened in the desert portions of the counties, and the more urbanized areas tend to be in western parts of the counties that contain less desert habitat. Urban or suburban development typically expands along the edges of previously impacted habitats which generally contain few tortoises. Therefore, we focus discussion on other types of projects that are more likely to have large-scale impacts on areas with desert tortoise populations.

#### *Department of Defense*

The Department of Defense is a major landholder in the desert tortoise range. Military bases in California deserts include Fort Irwin, Naval Air Weapons Station China Lake, Edwards Air Force Base, George Air Force Base, Chocolate Mountain Aerial Gunnery Range, Marine Corps Air Ground Combat Center Twentynine Palms (MCAGCC), and Marine Corps Logistics Base Barstow. In total, these bases encompass over 3 million acres (14.78% of the total tortoise range in California, see Figure 5). A wide variety of land uses occur on DoD property, and some of those uses are compatible with desert tortoises while others are not. For example, MCAGCC has Restricted Use Areas, at least one of which (Sandhills TA) is 11,801 acres and “protects the installations water supply, archeological resources, and the desert tortoise” (Marine Air Ground Task Force Training Command and Center 2018). In contrast, active training areas are generally high impact and tortoises in those areas are translocated to other sites. For example, according to the USFWS (2022a), the “Department of the Army (Army) expanded training onto 18,197 acres (73.6 km<sup>2</sup>) of designated critical habitat on the southern area of Fort Irwin that had previously been off-limits to training, thus requiring the translocation of approximately 650 adult desert tortoises. In addition, the Army plans to expand activities onto and displace tortoises from up to 62,045 acres (~250 km<sup>2</sup>) of its western training area in the near future, which is designated critical habitat and currently off limits to training. The Department of the Navy (Navy) expanded training for the Marine Corps Air Ground Combat Center (MCAGCC) at Twentynine Palms into approximately 167,982 acres (680 km<sup>2</sup>) of public and private land, which required translocating approximately 1,000 adult tortoises.” Around 700 of the tortoises from Twentynine Palms were translocated into the Ord-Rodman TCA (see section 5.2 on Translocation).

Along with translocation of tortoises, other strategies used by the DoD to offset the impact of converting large areas of habitat into training grounds include acquiring land within a CHU (making it federal), buying out grazing allotments, increased law enforcement in tortoise habitat, predator monitoring and targeted control within translocation sites, rehabilitation of closed routes, installation of off-highway vehicle barriers and desert tortoise exclusion fencing, and constructing perimeter fences to prevent public trespass into tortoise habitat (USFWS 2022a). For more discussion of efforts to conserve tortoises, see section 5.2 Current Management Actions.

Given the relatively large amount of DoD land with land use practices that require translocation of tortoises, it is of interest whether and how quickly habitats might become suitable again for tortoises if they are no longer used for training. Recovery from disturbance can take a long time in desert ecosystems (Lovich and Bainbridge 1999). This has been documented in soils and vegetation of the Desert Training Center which spans parts of southern California, southern Nevada, and western Arizona. This area was used for military training exercises in the 1940s and 1960s, and 40–60 years later the soil in tank tracks remained compacted and rain infiltration rates were low (Prose and Wilshire 2000). These soil differences led to increased plant density in the tracks, but those plants had restricted growth. In addition, grass species with shallow fibrous root systems increased in density in the tracks while species with long tap roots had reduced density and cover (Prose and Wilshire 2000). USFWS (1994) estimated that areas where camps, roads, and parking lots were built would take “decades or centuries to recover.”

Other documented direct negative impacts to tortoises on military property include “vandalism, predation, mycoplasmosis, and shell diseases” with “significantly more tortoises with shell disease...found on plots with current and recent military use than on plots with no history of military use” (Berry et al. 2006). For more detail on shell disease see section 4.7.

In the past 10 years, approximately 150,000 acres of the ~3,000,000 acres (~607 km<sup>2</sup> of ~12,140 km<sup>2</sup>) of viable desert tortoise habitat under DoD jurisdiction in California have been eliminated (USFWS 2022a).

#### *Renewable Energy Projects*

Renewable energy projects, including solar farms and wind energy facilities, are a major source of development in desert tortoise habitat. These facilities are regarded as key to reducing CO<sub>2</sub> emissions, and their development has been prioritized on public land (e.g., American Reinvestment and Recovery Act 2008; National Energy Policy Act 2005, Infrastructure Investment and Jobs Act 2021, Inflation Reduction Act 2022). Unlike urban or suburban development, energy projects tend to be sited in mostly undeveloped public land, thus leading to the potential degradation and fragmentation of relatively high-quality tortoise habitat (Lovich and Ennen 2011).

Development of a wind power project results in a variety of disturbances that are classified as temporary or permanent. Permanent impacts include land occupied by wind turbine pads, access roads, substations, and transmission lines. Temporary direct impacts include temporary



roads, staging areas, and substation/transmission construction (Denholm et al. 2009). However, in desert ecosystems, ‘temporary’ disturbances may have decades-long impacts if sites are not actively rehabilitated. Denholm et al. (2009) collated data on the size of several wind projects in California including total size (land associated with the complete wind plant project) and area of direct (permanent and temporary) impact. Of the four projects with complete data, direct impacts accounted for 1.5–7% of the total area of the project.

Data specifically evaluating the impacts of wind energy facilities on desert tortoises remains limited, however two studies suggest that tortoise survival rates on project sites are relatively high. A study near Palm Springs in Riverside County estimated tortoise survival rate within a wind energy facility (WEF) and a nearby wilderness area (NWA) using data from 1997–2000 and 2009–2014 (Agha et al. 2015). They found “long-term tortoise survivorship within the WEF (96.7%) was significantly higher than in the nearby NWA (92.1%)” (Agha et al. 2015). This counter intuitive result may have been due to tortoises at the WEF benefiting from “edge enhancement of vegetation (food resources), turbine pads (artificial rain catchments), reduced subsidized predators and low traffic.” (Agha et al. 2015). Lovich et al. (2011) tracked tortoises at a wind energy facility near Palm Springs for six field seasons (1997–2000 and 2009–2010). The facility contained turbines, electrical transformers, and an extensive network of roads. Their estimated annual survivorship rate of 91.6% (confidence interval 90.5–93.5%) was based only on adult females, which is a much higher survival rate than has been reported in many areas across the range in California (see section 3.3). The authors suggested a few characteristics of the site that might have led to high survival rates including very restricted public access and fewer ravens. However, they cautioned that without before-and-after studies of the impact of wind energy facilities, of which there are very few, it is hard to draw conclusions about the long-term impacts of wind energy facilities on desert tortoise. A study in southern California compared windfarms with nearby areas and found that species richness, evenness, and diversity was lower on the farm sites for reptiles, birds, mammals, arachnids, and plants (Keehn and Feldman 2018). Renewable energy facilities are not sited within tortoise CHUs, however they can be close enough that the impacts listed above spill over into critical habitat (K. Berry USGS, pers. comm 2022).

Solar power plants have a different design and land use than windfarms. However, similar types of impact classifications occur. Direct impacts occur where land is cleared and occupied by solar arrays, access roads, substations, service buildings, and other infrastructure (Ong et al. 2013). Three types of solar power plants were evaluated in one study, and the percentage of total land that was directly impacted was between 38% and 100% of the project site (N=12 projects) (Ong et al. 2013). The impact of infrastructure to wildlife extends beyond the habitat that is directly modified, including fragmentation and barriers to gene flow, effects due to noise, vibration, and shadow flicker, electromagnetic field generation, macro- and micro-climate change, predator attraction, dust and dust suppressants, and increased fire risk (Lovich and Ennen 2011, 2013).

Renewable energy projects that could potentially cause ‘take’ of desert tortoises must apply for incidental take permits (ITPs) from the Department or from the USFWS depending on jurisdiction (see section 5.1 for more detail). Between 2010 and 2021, the Department issued

ITPs for desert tortoise for 49 renewable energy projects, the majority of which are solar farms. In 2022, the Department completed ITP permitting for six renewable energy projects within San Bernardino and Riverside counties that would have a total footprint of about 10,600 acres (43 km<sup>2</sup>). As of October 2022, the Department was in the process of reviewing or issuing ITPs for 14 more renewable energy projects in Riverside and San Bernardino counties that could potentially have footprints of up to 20,750 acres (84 km<sup>2</sup>). For solar farms in particular, CDFW assumes these sites will lose all of their biological resources. Not all of these projects are necessarily sited within the recovery units or will end up receiving permits from the Department. However, it does show that there is increasing demand to use land within the Mojave Desert for renewable energy projects, specifically high impact solar farms (for more information about ITPs, see Section 5.2).

### *Cannabis Operations*

Illegal cannabis farms are an emerging threat to tortoises and their habitat in California's deserts. Habitat is destroyed to put up greenhouses, and there are potential associated spillover effects like chemical leakage into stream beds, trash dumps, and other land disturbances beyond the footprint of the greenhouses. In addition, water and trash may attract and increase densities of predators like coyotes and ravens, and guard dogs (*Canis familiaris*) are thought to kill tortoises (Holcomb 2022a, USFWS 2022a). In the Department's Region 6, which includes the majority of desert tortoise range, as of 2022 there had been 3,065 acres (~12 km<sup>2</sup>) of illegal cannabis cultivation visited by law enforcement. However, the Department acknowledges that there are vastly more illegal sites within tortoise range for which a law enforcement response has not been possible, therefore these numbers likely underestimate the true impacts. The presence of illegal cannabis farms can have additional indirect impacts on tortoise conservation. For example, according to USFWS (2022a), "illegal cannabis farms have already led to the cessation of raven monitoring and management efforts in the Fremont-Kramer Critical Habitat Unit in 2021, with the likelihood that tortoise monitoring in the same unit scheduled for 2022 will be cancelled due to safety concerns for field workers."

Legal cannabis cultivation also occurs within the desert tortoise range. Currently in Region 6 there are 2,394 acres (~9.5 km<sup>2</sup>) of legal cannabis cultivation that have Streambed Alteration Agreements. The Department evaluates each development project individually for the purposes of the California Environmental Quality Act, and there has not been a robust analysis of the cumulative impacts to the species resulting from cannabis development in the area. Due to the newness of the threat, the overall impact on tortoises from illegal and legal cultivation has not been quantified. However, it is a matter of increasing concern, and the current tools of permitting and law enforcement resources may not be sufficient to lessen the negative impacts on tortoises.

### *Summary*

While the long-term impact of habitat modification and destruction resulting from the land uses described above, along with any associated mitigation measures, is not fully known, the USFWS (2019a) states the impacts of large-scale land use conversions are "unlikely to be positive, despite the numerous conservation measures that have been (or will be) implemented

as part of the actions.” Although there are multiple science-based measures enacted to manage and mitigate threats, USFWS (2019a) warns that they “have been unable, to date, to determine whether the expected benefits of the measures have yet been realized, at least in part because of the low reproductive capacity of the desert tortoise. Therefore, the conversion of habitat into areas that are unsuitable for this species continues the trend of constricting the desert tortoise into a smaller portion of its range”.

Across the entire species range, it has been estimated that 7.4% of modelled tortoise habitat is now unsuitable for tortoise survival due to development and recent fire (Holcomb 2022a). Additionally, habitat is degraded in many additional areas by factors such as off-highway vehicle use, wildfire, invasive plant species, and increased temperature due to climate change. Therefore, focusing solely on the proportion of direct habitat loss in the desert tortoise range may be misleading and create an overly optimistic picture. With more than 90% of historical habitat still accessible, tortoise populations have declined severely in the past two decades.

#### **4.2 Vehicle Strikes, Roads, and Fencing**

Development of all types creates roads and other transport corridors that impact tortoises directly through vehicle strikes and as barriers to movement. Indirect impacts of transport corridors include habitat degradation including the spread of invasive species (Boarman et al. 1997, Brooks and Lair 2005).

Tortoises are often attracted to roads within their home ranges because the rain runoff collects and appropriate forage plants often grow along their edges (Boarman et al. 1997). However, impacts from direct mortality and increased access for predators near roads can result in the creation of reduced occupancy zones of variable width along roads (Boarman et al. 1997). Two-lane paved roads in Mojave National Preserve had reduced occupancy up to 400 m away from the road (Hughson and Darby 2013). Boarman and Sazaki (1996) studied Highway 58 in California and found reduced occupancy up to 800 m away. If the roads occur at a sufficient density, these zones could impact enough habitat to affect tortoise density across large scales. Although these results are only correlative, the TCAs that have road densities above 0.75 km/km<sup>2</sup> all had declines in tortoise densities between 2004 and 2014, while TCAs with less dense roads had both increases and declines in tortoise density (USFWS 2022a).

Desert tortoises are particularly susceptible to being killed on roads due to their slow rate of travel. Human behavior also plays a role. Boarman et al. (1997) anecdotally reported drivers intentionally swerving to hit turtles and tortoises. Even if most drivers are not intentionally hitting tortoises, speeding on all types of roads can lead to deadly strikes on tortoises (A. Ellsworth pers. comm. Nov 2022). Boarman and Sazaki (1996) estimated a kill rate of one tortoise per 2.4 km of road per year on Highway 58 in the western Mojave Desert, but warned their estimate was likely low because carcasses disappear quickly in the desert (likely due to scavenging). Juvenile dispersing tortoises are more likely to be killed on roads compared to adults (Boarman and Sazaki 1996). Anecdotal evidence from the Mojave Desert Preserve indicates an average of 5.3 tortoises per year are found dead on the 216 km of paved road in

the Preserve. Using 2008–2010 data from the Preserve, Hughson and Darby (2013) estimated that the loss of ~60 tortoises per year (on top of the low rates of natural adult mortality for such a long-lived species) would be unsustainable. They concluded that road mortalities could account for ~9% of this excess mortality per year.

Keeping tortoises off roads is a conservation priority (USFWS 2022a). Well-constructed fencing designed to stop tortoises from accessing roads can lead to 93% fewer tortoise carcasses along highways as well as reducing road kills of other small vertebrates (Boarman and Sazaki 1996). Properly designed culverts under roads facilitate tortoise movements and help prevent fences from fragmenting tortoise populations (Boarman and Sazaki 1996). However, proper design is key, as culverts can become death traps for tortoises if not properly designed and implemented (Lovich et al. 2011).

While fences are an important conservation measure, the pace of construction has slowed in recent years. According to the USFWS (2022a):

“Through 2011 approximately 1,660 km of highway roadside (including both sides of roads for those fenced on each side) had tortoise exclusion fencing installed to prevent road mortalities. Unfortunately, only approximately 43 km of roadside have been fenced in the decade since 2011. Almost 500 km of roadside have been identified as priorities for fencing based on our current understanding of road-effect zone area, relative habitat potential, and locations of extant populations (Holcomb 2019).”

Considerations that can slow or prevent fence building include cost, maintenance, visual disruption of the landscape, and loss of habitat during construction. At the October 2022 Desert Tortoise Management Oversight Group Meeting, the BLM reported that 3.5 miles of I-40 in the Ord-Rodman CHU will be fenced and 5 miles of fence will be built in Mojave National Preserve. Other strategies to reduce tortoise mortalities on roads such as lowering speed limits, installing warning signs, and driver education have not been shown to be particularly effective (Hughson and Darby 2013).

#### *Off-highway vehicles*

Off-roading is a popular pastime in California’s deserts. According to the BLM, in 2008 there were four times the number of off-highway vehicles in western states than in 1998 (Bisson 2008). In Desert Wildlife Management Areas and CHUs, OHVs are legally required to stay on established roads and trails, while on the remainder of BLM land they can travel cross-country, although local BLM offices can enact further restrictions. OHVs and their associated unpaved trails lead to habitat degradation, but the impacts are thought to be generally less severe than paved roads.

OHV trails are typically <4 m wide with a dirt surface, and are unimproved (i.e., they have never been bladed or filled) (Brooks and Lair 2005). When the trails are created, soils and vegetation are altered, and some types of wildlife may potentially be killed. Tortoises can be struck by OHVs on and off these trails. OHVs can crush burrows, depriving tortoises of refuge from

extreme temperatures and drought. In areas of very frequent OHV use, multiple routes may merge into broad areas devoid of perennial vegetation 10–100 m or more across. These extremely high impact areas are rare, however there are large networks of OHV trails across the Mojave Desert which collectively can significantly change local habitat and soils (Brooks and Lair 2005). OHV trails change water runoff patterns (especially on slopes) and can lead to greater erosion (Brooks and Lair 2005). In addition, roads of all kinds can serve as pathways for invasive species. Inholdings of private parcels within BLM land are often set aside for conservation, and OHV trails formally stop and restart at the boundaries. However, drivers often trespass across those private parcels, creating negative impacts for the tortoises even in areas that are designated as protected (A. Ellsworth, CDFW pers. comm. Oct 2022). The ecosystem or landscape-wide impact of OHV use can be hard to tease out in areas like the Mojave Desert that have multiple land uses, and Brooks et al. (2005) warned that “dispersed landscape effects ... should be generalized very cautiously”.

The extent of OHV trails in desert tortoise habitat is hard to quantify, however the recent expansion of the Spangler, El Mirage, and Johnson Valley off-highway vehicle recreation areas under the 2019 John D. Dingell, Jr. Conservation, Management, and Recreation Act opened up an additional 60,000 acres (~242 km<sup>2</sup>) of public land to OHV use (USFWS 2022a).

Closing and restoring illegal OHV routes can improve habitat for tortoises. At the October 2022 Desert Tortoise Management Oversight Group Meeting, the BLM reported that there is a multi-year restoration project in Fremont-Kramer CHU to monitor and restore OHV routes.

### **4.3 Impacts from Invasive and Non-Native Species**

Like many of the processes threatening desert tortoise, the impacts of invasive species are often tied to and synergistic with other factors such as livestock grazing, drought, and wildfire. Invasive Mediterranean grasses have spread through much of the Mojave Desert. These grasses create fuel for wildfires (Drake et al. 2015) and outcompete native annual plants (DeFalco et al. 2003). In 1995, 34 plots in the Mojave Desert near Barstow had frequencies of occurrence of 17% for *Bromus* and 38% for *Schismus* (both invasive grasses) (Brooks 1999). A more recent study sampled 718 plots across the Mojave Desert in 2009–2013 to investigate invasive grasses (*Bromus* spp. and *Schismus* spp.) and an invasive forb (*Erodium cicutarium*). At least one of the invasive taxa occurred in 91% of the plots with herbaceous cover, and two or more of the species co-occurred in 77% (Underwood et al. 2019). Berry et al. (2020b) summarized the impacts of invasive grasses on desert tortoise:

“Grasses are high in fiber, contain less digestible energy, and little protein (Hazard et al. 2009), causing juveniles to lose phosphorus and potentially shell volume (Hazard et al. 2010). Because of numerous human activities, invasive, non-native, and fire-prone grasses became established in tortoise habitat and now contribute substantially to the biomass of annual plants in late winter and spring, the principal feeding time for the tortoise (Brooks and Berry 2006, Brooks and Matchett 2006, Brooks et al. 2006, Minnich 2008). These grasses compete with native forbs for nutrients (Brooks 2000a). A diet of grasses is insufficient in

nutrients and leads to water loss during digestion (Hazard et al. 2009, 2010). In experimental studies, 32–37% of neonates and yearlings did not survive on a diet of grasses, whereas individuals in these size groups fed native forbs or a mix of native forbs and grasses had better body condition, immune functions, growth, and survival rates exceeding 95% (Drake et al. 2016).”

In contrast to grasses, the alien forb *Erodium* provided sufficient nitrogen and is of similar nutritional quality as a native forb (Nagy et al. 1998), allowing juvenile tortoises fed on forbs to gain weight (Hazard et al. 2009).

#### **4.4 Competition**

Grazing by livestock is a major part of the recent history of the desert. While grazing on BLM lands was historically permitted in tortoise range (Berry et al. 2014) after federal listing in 1990 it was halted in the CHUs. However, grazing is allowed on private inholdings within the CHUs, which are often unfenced. The documented impacts of livestock on tortoises include competition for food, trampling to death, and causing the collapse of burrows (see Berry and Murphy (2019)). Livestock also degrade habitat by creating or expanding trails which reduces annual plant cover and can (but does not always) promote wind erosion and compaction (Webb and Stielstra 1979, Lovich and Bainbridge 1999). Livestock increase browsing pressure on the trees and shrubs that tortoises require for shade and for establishing burrows (Berry et al. 2020a). Artificial watering sites concentrate activity of wild and domesticated large herbivores, potentially modifying soil nutrients, compaction, seedbanks, and density of invasive species nearby. In a grazing allotment on BLM land in the west central Mojave Desert, cover of native plants decreased with increasing proximity to a water site, while cover of alien (but not necessarily invasive) species increased (Brooks et al. 2006). This change in plant composition was observed up to 800 m away from the watering site. Ninety-six percent of the alien plant cover was made up of three species, including the forb *Erodium cicutarium* and the alien grass *Schismus* spp. (Brooks et al. 2006).

#### **4.5 Predation**

Desert tortoises are preyed upon by several native species, with different predators targeting different tortoise age classes. The number and distribution of certain predators in tortoise habitats have increased in tandem with human development.

The best studied tortoise predators in California are ravens and coyotes. These species are generalist predators which utilize a variety of habitats including those modified by humans. Human residence and activity in tortoise habitat provide food resources such as unsecured trash, water, and road-killed carcasses, and buildings and other structures provide shelter (Boarman et al. 2006, Kristan and Boarman 2007). These ‘resources bonanzas’ (Kristan and Boarman 2007) allow predator populations to flourish, potentially increasing predation pressure on native prey.

Raven populations have drastically increased in the Mojave Desert in the past 50–100 years and ravens have become a major predator of juvenile tortoises. This contrasts with population trends for many other bird species. Between the early 20<sup>th</sup> century and 2013–16, survey sites in the Mojave Desert lost 43% of their bird species on average (Iknayan and Beissinger 2018). Ravens were the only bird species to substantially increase across survey sites. The probability that ravens would be detected at a survey site was on average 35% in the first half of the 20<sup>th</sup> century and 76% in 2013–2016 (Iknayan and Beissinger 2018). Between 1970 and 2020, the index of abundance of ravens inside Mojave Desert Tortoise range increased by a factor of 6 (Harju et al. 2021). In 2020, surveys in Fenner, Ivanpah, Fremont-Kramer, Ord-Rodman, and Superior-Cronese CHUs found average densities of 0.63 ravens/km<sup>2</sup> in Fenner in the east to 2.44 ravens/km<sup>2</sup> in Fremont-Kramer in the west (Holcomb et al. 2021). This expansion of raven presence in extent and abundance is due at least in part to increased anthropogenic subsidies (Boarman and Berry 1995). Ravens spend time near these subsidies (Boarman and Berry 1995, Boarman et al. 1995, 2006), which is one of the factors that leads to higher mortality for tortoises near human infrastructure than in open desert (Berry et al. 2006, Esque et al. 2010). As human infrastructure has increased in the Mojave Desert, the impact of raven predation on desert tortoise populations has likely increased.

Ravens are more likely to target juvenile tortoises rather than adults. Nagy et al. (2015b) released 53 tortoises on Fort Irwin National Training Center in 2005, and 78% of the mortality of smaller tortoises (carapace 45–80 mm) was due to ravens, while coyotes were a major source of mortality for larger (111–175 mm) tortoises. High levels of raven predation on juveniles are thought to have led to far fewer juveniles being observed in the annual TCA surveys. In an area with a raven density of 2.4/km<sup>2</sup>, the USFWS estimated survival of 0–12-year-old tortoises at 51%, which is much lower than in areas without ravens (Holcomb 2022b). Distance to the nearest raven nest impacts the survival rates of 0–10-year-old tortoises. Using decoy tortoises, Holcomb et al. (2021) found that juvenile tortoises had an average annual survival rate of 63% at 500 m from a raven nest, while juvenile tortoises 1.72 km from a nest had an annual survival rate of about 76%. They estimated that in areas where there were more than 0.89 ravens/km<sup>2</sup>, and tortoises were less than 1.72 km from a nest, high rates of juvenile mortality would lead to population decline. If these criteria were applied to the Fremont-Kramer CHU, raven predation alone would likely have caused “inadequate” recruitment of juvenile tortoises across the majority of the CHUs over the past 20 years (Holcomb et al. 2021).

Predation pressure by ravens is not even across the tortoise range. In a study in the El Paso Mountains east of Bakersfield between 2008 and 2009, avian predators (mostly ravens) accounted for only 2.5% (on plot) and 3.7% (off plot) of observed mortalities (Berry et al. 2020c). Ivanpah and Fenner CHUs are in the eastern part of the range and have fewer anthropogenic subsidies for ravens and therefore lower raven densities. However, the densities in those CHUs are high enough that predation pressure combined with drought, road mortality, and invasive species together permit sustained recruitment of juvenile tortoises only in a few places (Holcomb et al. 2021).

Coyotes are thought to be a major predator of adult tortoises. In a study of translocated tortoises in the Superior-Cronese CHU, between 2008 and 2018 an estimated 60% were killed by predators, likely coyotes based on nearby tracks and scat (Esque et al. 2010, Mack and Berry 2023). In an examination of the dead tortoises found in the El Paso Mountains east of Bakersfield between 2008 and 2009, 20% of the carcasses found on the survey plots and about 52% of those found off plots were killed by mammalian predators including coyote, kit fox (*Vulpes macrotis arsipus*), and badger (*Taxidea taxus*) (Berry et al. 2020c). Lovich et al. (2014) surveyed tortoises in a plot in Joshua Tree National Park, and in 2012, about 30% of tortoise carcasses had signs of predation or scavenging, likely by coyotes or kit foxes.

There is some evidence that canid predators focus more on females than males. In the Superior-Cronese CHU in 2008, Esque et al. (2010) found that females were more likely to be predated than males. They also looked at reference sites across the Mojave Desert and found that coyote predation on tortoises was strongly associated with the size of nearby human populations (Esque et al. 2010). Like ravens, coyotes receive food subsidies from human populations, and according to scat surveys, are widespread in some areas (Cypher et al. 2014). However, there is not much data on coyote population trends in the Western Mojave (Cypher et al. 2014) so it is unclear if their numbers have increased in the past few decades or were particularly high in years of high tortoise mortality like 2008.

During periods of suppressed rodent and prey populations following dry years, it has been suggested that coyotes will switch to preying on tortoises (Esque et al. 2010). This may help explain the widespread high mortality rates due to predation in 2008 (Esque et al. 2010). However, work by Cypher et al. (2018) did not necessarily support that hypothesis. In a study following the 2008 translocation of tortoises to an area south of Fort Irwin, they collected data on the relative abundance of rodents and rabbits, as well as the contents of coyote scats in 2009–2014. The years 2011–2014 were very dry compared to the wetter years of 2009–2010. While the frequency of occurrence of rodents in scat was lower in dry years (24.3%–46.3%) than in the wet years (53%–65%), the frequency of tortoises in scat was also lower in dry years (2.4%–2.6%) compared to wet years (5.6%–5.8%). These results suggest that it is unlikely coyotes switched to tortoise prey because of lack of rodents. Instead, as coyotes ate fewer rodents in the dry years, their amount of anthropogenic food sources increased (Cypher et al. 2018). While 2008 may have been an anomalous widespread pulse in predation pressure (Esque et al. 2010), there is a lack of rigorous evidence that coyotes regularly prey switch to tortoises when rodent or lagomorph populations are low because of drought.

Badgers are thought to be partially responsible for high levels of mortality of tortoises in 2012–2013 on and near Ft. Irwin, and may be important predators in certain locales (Emblidge et al. 2015). Other predators of tortoises include fire ants, white-tailed antelope squirrels (*Ammospermophilus leucurus*), bobcats (*Lynx rufus*) (Nagy et al. 2015a, b), red-tailed hawks (*Buteo jamaicensis*) (Anderson and Berry 2019), rattlesnakes (*Crotalus* spp.) (Berry et al. 2016), and domestic dogs (Berry and Murphy 2019).



### *Summary*

Predation, especially by ravens and coyotes, is a significant factor in desert tortoise population decline. Ravens (and to a lesser extent coyotes) are subsidized by the infrastructure, water, and food around human development, and raven populations have dramatically increased in recent decades. Ravens preferentially target juvenile tortoises, and since clutch sizes are low and tortoises can take 12–20 years to become sexually mature, decreased juvenile survival is likely an important factor in many areas with declining tortoise densities. Given the slow life history traits of tortoises, lower juvenile survival will be a long-term issue for the population, impacting populations for decades. Coyotes can kill older tortoises, and in some areas are a significant cause of death. Reducing raven and coyote predation is likely to be challenging and predation is likely to remain a significant challenge for rapid tortoise population recovery.

## **4.6 Climate Change and Drought**

Anthropogenic climate change has led to higher annual average air temperatures in general as well as increased volatility of California's climate. Extreme events like drought and heat waves are more frequent, rainfall is increasingly variable, and flow regimes of rivers are changing (Bedsworth et al. 2018). These changes have led to observable shifts in species distributions and timing of life history events (OEHHA 2018). In California, Mojave Desert Tortoises inhabit the relatively cooler high Mojave Desert, and the hotter low Sonoran Desert. The western part of the tortoise range in the Mojave Desert gets most of its precipitation in the winter with only about 15% from summer monsoons, whereas the monsoons account for about 30% of yearly precipitation in the eastern deserts (Hopkins 2018).

### *Impacts of Increased heat*

In the inland deserts of California, daily maximum temperatures warmed by 0.4–0.7°F (0.2–0.38°C) when 1976–2005 was compared to a historical base line of 1961–1990 (Hopkins 2018). Those temperatures are projected to see increases of up to 8–14°F (4.4–7.7°C) by 2070–2100, depending on the future emission levels of greenhouse gases (Hopkins 2018). It is projected that by 2070–2100 there will be up to 141 days a year in the Mojave Desert when the temperature exceeds 95°F (35°C), up from an average of 90 days per year in 1981–2000. Minimum daily temperatures are projected to rise 4–7°F (2.2–3.8°C) by 2070–2100 (Hopkins 2018).

Under warming scenarios described above, desert tortoises will have fewer areas where they can stay within their physiological limits. As habitat area shrinks, tortoises are already heading upslope in some areas to escape the heat of the valley bottoms (W. Campbell pers. comm. May 2022). This type of movement may become more difficult as temperatures increase and suitable upslope areas shrink. Sadoti et al. (2017) found that tortoises restrict their movements when it is hotter. While this is not necessarily surprising, if there are more days when it is too hot for tortoises to move, they might find it harder to move to avoid those hot temperatures and will have limited opportunities to disperse or find mates. However, the degree to which increased heat in the summer will shift mating season or impact reproductive success is unknown. Increased temperatures will make burrows as refugia from the heat more critical.

Since only certain types of soils and substrates allow for creation of adequately long tunnels, available tunnel sites may become a critical habitat concern in the future and should be taken into consideration in conservation efforts (Mack et al. 2015).

As mentioned in the section on life history, the sex of the hatchling is heavily influenced by incubation temperature. As temperatures rise and heat extremes become more common due to anthropogenic climate change, it is likely that sex ratios at hatching will skew to be more female dominated, however the degree to which this will impact adult sex ratios is unknown, especially if drought increases adult female mortality.

### *Impacts of drought*

Desert tortoises are adapted to drought and heat. However, increasing levels of both are likely to cause physiological stress and alter the availability of edible vegetation. Barrows (2011) lists some of the physiological and behavioral impacts of drought:

“Drought conditions result in reduced tortoise activity (Duda et al., 1999) and lower metabolic and reproductive rates (Peterson, 1996a; Henen, 1997; Henen et al., 1998) although some breeding activity occurs even during periods of water stress (Henen, 1997). Despite these behavioral and physiological adaptations, during droughts tortoises experience as much as 40% loss of body mass and a 60% loss of water volume relative to body mass as well as large variations in blood osmolarity (Peterson, 1996b) and can have higher levels of mortality (Turner et al., 1984).”

California has undergone extreme drought recently with the 2000–2021 span being the driest in the southwestern U.S. in the past 1,200 years (Williams et al. 2022). Although there is significant uncertainty regarding projected precipitation changes, current models show that winter precipitation is likely to increase in the inland deserts, but the summer monsoon precipitation could decrease up to 40% if atmospheric CO<sub>2</sub> concentrations double (Pascale et al. 2017). Precipitation events are likely to be more intense and at the same time soils are predicted to be drier, leading to more flash flooding (Hopkins 2018). The projected warmer and periodically drier conditions during the 21<sup>st</sup> century may increase the risk for more severe drought (Hopkins 2018).

Long-term drought has caused die offs of perennial plants in desert tortoise habitat, likely driven by lack of winter rain (McAuliffe and Hamerlynck 2010). Die offs were extensive but not homogenous, and soil conditions likely played a role (McAuliffe and Hamerlynck 2010). Tortoises are selective herbivores that will feed from a wide variety of available plants if necessary but primarily focus their observed foraging effort on a small set of species, many of which are relatively uncommon (Jennings and Berry 2015). Given predictions that winters may become wetter but summers drier (Hopkins 2018), the impacts of future droughts on the vegetation that tortoises rely on is unclear. Some invasive species of *Bromus* grasses are successful in disturbed habitats, and their presence in desert habitat has helped alter the fire cycle (Brooks 1999, Bradley et al. 2016). However, germination, growth, and reproduction are limited by temperature and rainfall which makes it difficult to predict the relative success of

invasive grasses vs. native forbs under predicted climate changes (Bradley et al. 2016). It is possible that tortoises will also face increased nutritional stress if preferred plants die off and more nutrient poor grasses like *Bromus* remain available.

Lovich et al. (2014) used intermittent surveys in Joshua Tree NP from 1979 to 2012 to estimate the impact of persistent and recurrent drought on tortoise survival. Estimated population size decreased dramatically from 1996 to 2012, with high survival in 1978–1996, and lower survival in 1997–2002. The lower survival rates were concurrent with persistent drought, and estimated survival rates were best explained by winter precipitation. Being in a national park, tortoises in Joshua Tree should be sheltered from many anthropogenic impacts including large scale habitat modification and degradation and direct killing by humans. In addition, in 2012, many of the dead tortoises showed signs consistent with death by dehydration and starvation. Therefore, the authors concluded the decline was likely the result of reduced survival rates due to drought (Lovich et al. 2014). Other populations of desert tortoises have also shown a negative impact of drought on survival and abundance. Populations in Arizona of *G. agassizii* and *G. morafkai* were surveyed multiple times between 1990 and 2017 and experienced very low survival (30% in the Black Mountains and 34% in the Hualapai Mountains) during a drought, which led to a drop in adult abundances of about 50% (USFWS 2022a).

There is some evidence that drought is affecting sex ratios of adult tortoises. Unequal sex ratios are thought to lower effective population size, which in small populations with limited connectivity could exacerbate inbreeding (Frankham 1995). In 2015–2016, Lovich et al. (2023) surveyed two sites in Shaver’s Valley about 70 km southeast of Palm Springs along the boundary of the Joshua Tree and Chuckwalla TCAs. At both sites there was a male bias in live tortoises. At the cooler, wetter site there was an even sex ratio in tortoises found dead, but in the hotter and drier Chuckwalla site, more females were found dead. It is possible that the energetic requirements required for reproduction make females less likely to survive long-term drought conditions (Lovich et al. 2023). However, there is limited evidence that there is a widespread and long-term skew in sex ratios. In a 2.6 km<sup>2</sup> (1 mi<sup>2</sup>) study plot in Joshua Tree NP, data from intermittent surveys from 1978–2012 showed that “sex ratios, defined as the number of live males divided by the number of females, ranged from unity, to male biased (5:1), to female biased (0.22:1) across years with no trend in any one direction” (Lovich et al. 2014). On a wind energy facility near Palm springs in 1997–2010, the “adult sex ratio was not significantly different from unity” (Lovich et al. 2011).

A major question is how much desert tortoise habitat will become unsuitable in the future due to heat and drought. Species have shifted altitude and/or latitude as climate has changed (VanDerWal et al. 2013, Wolf et al. 2016), but species that are not nimble dispersers may have trouble accessing new areas, and those areas may not contain the full suite of conditions necessary for survival. However, within current habitats, local refugia may persist in future climatic conditions and allow species to persist. Barrows et al. (2016) evaluated potential habitat refugia on MCAGCC and found that 33% of the study area (283,900 ha) supported desert tortoise habitat at the time. With a simulated 1°C (1.8°F) of warming, the amount of habitat shrunk by 25%, with remaining habitat occurring at higher elevation. Under a simulated

3°C warming, habitat area shrunk by 56% (to 127,650 ha). Of the remaining available habitat, 91% overlapped with current tortoise habitat, suggesting that climate refugia would be relatively easy for tortoises to access. However, it should be noted that while Barrows et al. (2016) considered 3°C (5.4°F) to be an end of century level of warming, California's 4<sup>th</sup> Climate Change Assessment from 2018 predicts that level of warming to occur in the inland deserts by 2039 (Bedsworth et al. 2018). In Joshua Tree National Park, desert tortoises are found in both the Mojave and Sonoran desert portions. Modelling by Barrows (2011) predicts that under 2°C (3.6°F) of warming with 50 mm decrease in precipitation, habitat area will decrease by about 88% in the Sonoran Desert portion and by about 66% in the Mojave Desert portion.

#### 4.7 Fire

Desert tortoise habitat historically experienced few fires due to low plant productivity and sparse fuel loads, and those that did occur tended to burn in a patchy mosaic pattern (Esque et al. 2003). Consequently, desert tortoises are not well adapted to fire, although use of burrows can prevent mass casualties in fires (Esque et al. 2003). The expansion of invasive plants (primarily grasses like *Bromus*) has increased fuel loads in the Mojave Desert (Brooks 1999), and fire frequency in the California portion of the Mojave Desert increased between 1980 and 1995 (Brooks and Esque 2002). However, longer term studies looking at fires from 1980–2004 (Brooks and Matchett 2006) and 1992–2011 (Hegeman et al. 2014) in the Mojave Desert show no clear increase in numbers of fires or acres burned per year. However, 2005 stood out as the amount of area burned in the Mojave Desert was 385,357 ha (952,238 acres) (M. Brooks unpublished data), representing 132% of the total area that burned during the previous 25 years (Brooks and Matchett 2006). In recent years large fires have burned in Mojave National Preserve including the 2020 Dome Fire (43,273 acres /175 km<sup>2</sup>) of higher elevation tortoise habitat) (USFWS 2022a), or the 2023 York Fire (93,078 acres/377 km<sup>2</sup>). Fire-caused tortoise death is summarized in Berry and Murphy (2019):

“Woodbury and Hardy (1948) reported deaths of about 14 tortoises from a fire covering ca. 5.2 km<sup>2</sup> on part of the Beaver Dam Slope south of Bunkerville in 1942. In a post-fire study, Lovich et al. (2011c) described a fire in the western Sonoran Desert that killed an adult female tortoise and injured five other adult tortoises. Nussear et al. (2012) reported that three of 30 tortoises died from fire during a comparative study of translocated and resident tortoises. In the Red Cliffs Desert Reserve and critical habitat in Utah, 687 tortoises died in 2005 in a fire that burned ca. 23% of the approximately 251 km<sup>2</sup> habitat (A. McLuckie, pers. comm.). Drake et al. (2012) described a tortoise recovering from burns three years post-fire.”

The effects of wildfire on vegetation can impact tortoises in several ways. A study in low elevation Mojave Desert shrubland found that invasive *Bromus* cover increased after one fire but did not continue increasing after additional fires (Brooks 2012). However, native vegetation cover decreased with multiple fires, with percentage cover dropping from about 25% to about 1% when fire frequency increased from one every ten years to three every ten years. Given the

poor nutritional content of *Bromus*, increasing fire frequency threatens tortoises' ability to find sufficient and adequate food. Tortoises tend to remain in same areas after fire (Lovich et al. 2018), and one study found that tortoises used burned and unburned areas nearly equally, starting the first year after the fire (Drake et al. 2015). Tortoises moved into the burned areas seasonally to forage for preferred annuals and herbaceous perennials (Drake et al. 2015). The use of burned habitats did not appear to affect their health or reproduction in the short term. However, the expansion of red brome grass in burned areas and the injuries that fire can cause tortoises remained concerns (Drake et al. 2015).

The effects of a changing climate on wildfire size and frequency in desert tortoise habitat are uncertain. Increased winter rain could promote biomass growth that dries out in the hotter summers and increases fuel load (Tagestad et al. 2016). Alternately, the predicted increase in drought like conditions may keep fuel loads low. Another variable is the cause of ignitions. In the past 40 years, human caused fires were more prevalent in areas with high visitation levels such as low to mid elevation and desert montane zones, while lightning caused fires were more common in the central and eastern areas that get summer monsoons (Brooks and Matchett 2006). There are widespread campaigns and regulations aimed at reducing the chances that visitors will cause fires in the desert, and the efficacy of these campaigns may influence fire frequency and spatial distribution in the future. Overall, Hopkins (2018) suggests that strong temporal and spatial variability in precipitation and fuel load across the desert makes long-term and widespread trends in fire regime hard to predict.

#### **4.8 Disease and Parasites**

Desert tortoises are susceptible to a variety of diseases, some of which are likely to have caused or contributed to population declines. Upper respiratory tract disease (URTD) has been cited as a cause of population declines in desert tortoise and was a reason for listing under the ESA in 1990 (USFWS 1990).

URTD can be caused by the bacteria *Mycoplasma agassizii* and *Mycoplasma testudineum*, while herpesviruses can cause similar symptoms (Johnson et al. 2005, Jacobson et al. 2014). The disease presents as lesions in the nasal cavity and inflammation of mucosa of the upper respiratory tract, mucooid discharge from the nares, damaged nasal scales due to chronic mucooid discharge, wheezing breath, swollen and watery eyes, and extreme lethargy (Jacobson et al. 1995, 2014, Johnson et al. 2005, Sandmeier et al. 2013). Tortoises that do not show clinical signs of infection can still serve as a reservoir for the disease and likely can transmit it to healthy tortoises (Jacobson et al. 1995). Transmission is most likely through direct contact that happens during courtship, mating, and fighting, and aerosol transmission is not likely (USFWS 1990, Jacobson et al. 2014). The disease both directly kills tortoises and can potentially interfere with their sense of smell and therefore their ability to forage for food and can potentially negatively affect their reproductive fitness (Germano et al. 2014, Jacobson et al. 2014). Sandmeier et al. (2013) found evidence that longer and colder winters correlated positively with the proportion of tortoises exhibiting URTD, possibly because time spent underground depresses the tortoise immune system or allows the bacteria to flourish.

A significant URTD outbreak occurred in the Desert Tortoise Natural Area in Kern County in 1989 when 627 dead tortoises were recovered during a survey, and 43% of 468 live tortoises had signs of the disease (Jacobson et al. 1991). The population declined by 90% between 1979 and 1992 (Berry and Medica 1995). In 1990–1995, Christopher et al. (2003) sampled tortoises at three sites in the Mojave Desert:

“Of 108 tortoises, 68.5% had clinical signs of upper respiratory tract disease consistent with mycoplasmosis at least once during the study period. In addition, 48.1% developed moderate to severe shell lesions consistent with cutaneous dyskeratosis. Ulcerated or plaque-like oral lesions were noted on single occasions in 23% of tortoises at Goffs and 6% of tortoises at Ivanpah. Tortoises with oral lesions were significantly more likely than tortoises without lesions to have positive nasal cultures for *Mycoplasma agassizii* ( $P=0.001$ ) and to be dehydrated ( $P=0.0007$ )”.

More recent studies have found much lower prevalence of URTD. In the central Mojave Desert in 2005–2008, Berry et al. (2015) found only 1.49% of sampled tortoises were antibody positive. It is thought that the high prevalence of the disease in wild populations in the 1970s–1990s was due in part to infected captive tortoises being released into the wild. Several factors are correlated with outbreaks of the disease, mainly factors that increase physiological stress in tortoises such as drought, heavy metal pollution, and human disturbance (Jacobson et al. 2014). Berry et al. (2015) pointed out that many of the stressors that increase tortoise vulnerability to URTD, especially drought and proximity to human populations, are increasing in desert tortoise range. However, there have not been any large outbreaks documented in California recently, and in the Desert Tortoise Natural Area the disease has “evolved from an acute, epizootic disease with high mortality to a chronic endemic disease with variable morbidity, low mortality” (Jacobson et al. 2014). Reflecting the decreased level of threat currently posed by the disease, in their 2022 5-year review the USFWS stated that “direct disease management of wild tortoise populations is less important (other than in translocations of tortoises between populations) than managing factors that affect their habitat and its capacity to support healthy tortoises” (USFWS 2022a).

Official handling protocols include strict guidelines to minimize human mediated transfer of pathogens and stress (USFWS 2020b). In addition, translocating sick individuals runs the risk of spreading URTD, so translocation protocols include health assessments and quarantine to minimize disease transfer between populations (USFWS 2020b). However, disease can be transferred by tortoises naturally dispersing, and reservoirs of the disease in populations outside of California should be considered in discussions of connectivity (Burgess et al. 2021).

Shell diseases like cutaneous dyskeratosis also affect tortoises and present as “abnormal conformation and loss of normal integrity of the horny layer (scute) of the shell and cutaneous scales. Deep shell defects may expose dermal bone” (Homer et al. 2001). Shell lesions were correlated with high mortality rates of desert tortoises in Chuckwalla Bench in 1982–1988 (Figures 8 and 9, Jacobson et al. 1994). In 1979, 56% of the tortoises surveyed had shell lesions.

The proportion of effected tortoises increased to 65% in 1982, to 90% in 1988, and remained high in 1990 at 87%. During those years the density of all tortoises (adults and juveniles) fell from 221/km<sup>2</sup> to 71/km<sup>2</sup>, a 68% decline (Berry and Medica 1995). While the declines in population cannot be definitively tied to shell lesions, they could be a sign of a deficiency disease or toxicosis (Jacobson et al. 1994). There has been very little reported on shell disease in wild tortoises in California since the mid-1990s.

#### **4.9 Overexploitation**

Under the California Fish and Game Code, desert tortoises have had some legal protection from take or collection since 1961 (Fish & G. Code, § 5000: *It is unlawful to sell, purchase, harm, take, possess, transport, or shoot a projectile at, a tortoise (Gopherus)*). However, vandalism (gunshots) and collecting for pets were listed as reasons for population declines in the USFWS's 1990 decision to list the desert tortoise as threatened (USFWS 1990). Before tortoises were listed, Berry (1986b) found that percentage of tortoise deaths from gunshots in California deserts (1972–1982) ranged from a low of 1.8% at Chuckwalla Bench to a high of 28.9% in the Fremont Valley. Overall, 14.3% of carcasses found had evidence of gunshots, with the areas with the highest percentage in the Western Mojave. In a 2008–2009 study in the El Paso Mountains in Kern County, 6 of 67 carcasses had evidence of gunshots (Berry et al. 2020c). Berry and Murphy (2019) reported gunshot deaths in Fort Irwin National Training Center (1997–2003), Red Rock State Park (2002–2004), and the Desert Research Natural Area (2011).

While the actual number of California tortoises collected from the wild is unknown, Berry et al. (1996) (reported in Berry and Murphy (2019)) estimated that more than 2,000 tortoises were removed from four study areas over a 10-year period from the mid-1980s to the mid-1990s. It is likely some tortoises are still being taken from the wild, with those near roads most vulnerable. A study in the Sonoran Desert of Arizona in 2008–2009 placed decoy tortoises on roads and found 1.4% of drivers stopped and tried to collect the decoy by placing it in their vehicle. Drivers were more likely to notice the tortoises on maintained gravel roads compared to paved roads or unmaintained gravel roads. However, road type did not influence the probability a driver would try to collect the tortoise (Grandmaison and Frary 2012).

#### **4.10 Other Human-related Activities**

##### *Mining and pollution*

Although Spanish colonizers panned for gold in the Chocolate Mountains in the late 1700s, commercial mining in California deserts began in the 1800s. Prospectors and miners dug shafts to extract gold, tungsten, silver, copper, and other valuable materials (Shumway et al. 1980). Some of these shafts remain open and unfenced, and tortoises can fall in and become trapped (Berry and Murphy 2019). Mining also leaves behind pollutants of various types including mercury, arsenic, and lead that impact soil and plants (including those favored by tortoises) up to 15 km from mining sites (Chaffee and Berry 2006). These pollutants can enter tortoises via breathing, ingestion of impacted plants, or absorption through skin, and there is some concern that exposure to these toxins may make tortoises more susceptible to disease (Berry et al. 2015, Berry and Murphy 2019). Tortoises collected from the Kelly Rand Mining District

northeast of California City and from Edwards Airforce Base had bioaccumulated arsenic in their shell plates compared to tortoises from areas with minimal land disturbance (Foster et al. 2009). However, Cohn et al. (2021) analyzed the blood of tortoises in the Ivanpah Valley and found that heavy metal levels in the blood were generally low (0%–7%), heavy metal levels in the soil did not exceed soil health guidelines, and there was no relationship between metal concentrations and body health or disease prevalence, suggesting that tortoises were not negatively impacted by mining pollution in that area.

### *Deliberate Releases*

Based on public comments received by the Department, well-meaning individuals may release captive tortoises, believing it will help wild populations. People may also release animals they no longer wish to keep as pets. The deliberate release of captive tortoises presents several issues. Captive tortoises can have high prevalence of respiratory diseases which could be passed on to wild tortoises if they are released (Berry et al. 2015). Releasing animals of unknown genetic origin, or even different species like *G. morafkai* or the Texas tortoise (*G. berlandieri*), could result in hybridization with wild *G. agassizii* (USFWS 1994). The release of diseased captive tortoises was a large enough concern to be mentioned as reason for population declines in the 1994 Recovery Plan (USFWS 1994), but we lack robust recent data on the current prevalence of releases and their effects. A public education campaign highlighting the downsides to freeing captive tortoises may help address this threat. Translocations of captive tortoises into the wild are also discussed in section 5.2.

## **5. EXISTING MANAGEMENT**

### **5.1 Regulatory Status and Legal Protections**

#### *Federal*

##### Federal Endangered Species Act

In August 1989, the USFWS listed the Mojave population of desert tortoise as endangered on an interim basis. Eight months later in April 1990, it issued a final rule to list it as threatened (USFWS 1990). In July 2002, the USFWS received a petition to reclassify the species from threatened to endangered. In 2017, the USFWS announced a 90-day finding that the petition did not present substantial scientific or commercial information indicating that reclassifying the Mojave population of the desert tortoise may be warranted, and no status review was initiated in response to the petition. The USFWS has published status reviews in 2010 and 2022, both recommending that the threatened status be retained (USFWS 2010, 2022a). The 2022 status review uses much of the same data presented here and acknowledges that “the status of the Mojave Desert Tortoise had not improved by 2014 and most threats to the species persist at or above 2010–2011 levels. These conditions portend further status deterioration in the absence of concerted efforts by land managers to meaningfully reduce predator subsidies, vehicle-caused tortoise mortalities, and invasive annual plants in important tortoise habitats” (USFWS 2022a). The recommendation to retain the threatened status was based on finding about a dozen *G. agassizii* in Arizona, east of the Colorado River making the “range of the species slightly larger than the currently listed entity”, recognition that the range-wide population of



tortoises is in the hundreds of thousands, and optimism that conservation actions will eventually result in population improvements (USFWS 2022a).

### National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to assess the environmental effects of their proposed actions prior to making certain decisions. Using the NEPA process, agencies evaluate the environmental and related social and economic effects of their proposed actions. Agencies also provide opportunities for public review and comment on those evaluations. Title I of NEPA contains a Declaration of National Environmental Policy. This policy requires the federal government to use all practicable means to create and maintain conditions under which man and nature can exist in productive harmony. Section 102 in Title I of the Act requires federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach. Specifically, all federal agencies are to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions significantly affecting the environment. These statements are commonly referred to as Environmental Impact Statements and Environmental Assessments.

### *State*

#### California Law/Fish and Game Code

California law has long included protections for Mojave Desert Tortoise. In 1939, California state law prohibited purchase or sale of the species. In 1961, an additional law was passed to prohibit “*to sell, purchase, harm, take, possess, transport, or shoot a projectile at, a tortoise*” (Fish & G. Code, § 5000). In 1972, the Fish and Game Code was amended to allow possession of tortoises as long as the tortoise was legally acquired (Fish & G. Code, § 5001).

#### California Endangered Species Act

On August 3, 1989, the Commission listed the desert tortoise as a threatened species under CESA. CESA prohibits the import, export, take, possession, purchase, or sale of Mojave Desert Tortoise, or any part or product of Mojave Desert Tortoise, except as otherwise provided by the Fish and Game Code, such as through a permit or agreement issued by the Department (Fish & G. Code, § 2080 *et seq.*). For example, the Department may issue permits that authorize the incidental take of listed and candidate species if the take is incidental to an otherwise lawful activity, the impacts of the authorized take are minimized and fully mitigated, the activity will not jeopardize the continued existence of the species, and other conditions are met (Fish & G. Code, § 2081, subd. (b).). The Department may also authorize incidental take through voluntary local programs and safe harbor agreements (Fish & G. Code, §§ 2086 and 2089.2 *et. Seq.*) and for scientific, educational, or management purposes (Fish & G. Code, § 2081, subd. (a).). If the species is listed under both the federal ESA and CESA, a project that has received a federal incidental take statement or incidental take permit that is consistent with CESA can receive a consistency determination (CD) from the Department (Fish & G. Code, § 2080.1).

Given the predominance of federal land in desert tortoise range, it should be noted that federal agencies undertaking federal projects on federal land are usually not subject to CESA and

instead must typically consult with the USFWS to “ensure that actions they fund, authorize, permit, or otherwise carry out will not jeopardize the continued existence of any listed species or adversely modify designated critical habitats” (USFWS 2022d). However, non-federal entities working on federal lands are subject to CESA. For example, timber companies with permission to harvest timber on U.S. Forest Service lands must comply with both federal and state wildlife laws.

In 2000 and 2005, the Department prepared summary reports pursuant to CESA describing the status of desert tortoise as declining (CDFW 2000, 2005). The 2005 report described the desert tortoise as severely threatened by population losses and further stated that tortoise populations were extremely low in some areas and may not have been viable (CDFW 2005).

#### California Environmental Quality Act

State and local agencies must conduct environmental review under the California Environmental Quality Act (CEQA) for discretionary projects proposed to be carried out or approved by the public agency unless the agency properly determines the project is exempt from CEQA (Pub. Resources Code, § 21080). If a project has the potential to substantially reduce the habitat, decrease the number, or restrict the range of any rare, threatened, or endangered species, the lead agency must make a finding that the project will have a significant effect on the environment and prepare an environmental impact report (EIR) or mitigated negative declaration as appropriate before proceeding with or approving the project (Cal. Code Regs., tit. 14, §§ 15065(a)(1), 15070, and 15380.). An agency cannot approve or carry out any project for which the EIR identifies one or more significant effects on the environment unless it makes one or more of the following findings: (1) changes have been required in or incorporated into the project that avoid the significant environmental effects or mitigate them to a less than significant level; (2) those changes are in the responsibility and jurisdiction of another agency and have been, or can and should be, adopted by that other agency; or (3) specific economic, legal, social, technological, or other considerations make infeasible the mitigation measures or alternatives identified in the EIR (Pub. Resources Code, § 21081; Cal. Code Regs., tit. 14, §§ 15091 and 15093.). For (3), the agency must adopt a statement of overriding considerations finding that the overriding benefits of the project outweigh the significant effects on the environment. CEQA establishes a duty for public agencies to avoid or minimize such significant negative effects where feasible (Cal. Code Regs., tit. 14, § 15021.). Impacts to Mojave Desert Tortoise, as a CESA-threatened species, must be identified, evaluated, disclosed, and mitigated or justified under the Biological Resources section of an environmental document prepared pursuant to CEQA.

#### *Nonregulatory Status*

##### Natural Heritage Program Ranking and IUCN Red List

Natural heritage ranking does not provide any regulatory protections but is often considered during the CEQA process (Hammerson et al. 2008). All Natural Heritage Programs, such as the CNDDDB, use the same ranking methodology originally developed by The Nature Conservancy and now maintained by NatureServe. This ranking methodology consists of a global rank describing the rank for a given taxon over its entire distribution, and a state rank describing the

rank for the taxon over its state distribution. Both global and state ranks reflect a combination of rarity, threat, and trend factors. The ranking methodology uses a standardized calculator that uses available information to assign a numeric score or range of scores to the taxon, with lower scores indicating that a taxon is more vulnerable to extinction, and higher scores indicating that a taxon is more stable (Faber-Langendoen et al. 2012). The rank calculation process begins with an initial rank score based on rarity and threats, with rarity (multiplied by 0.7) factored more heavily into the calculator than threats (multiplied by 0.3). The combined rarity and threat rank is then either raised or lowered based on trends. When there is a negative trend, the rank score is lowered, and when there is a positive trend the rank score is raised. Short-term trends are factored more heavily into the calculator than long-term trends. International Union for Conservation of Nature (IUCN) and NatureServe assess extinction risk for species using a time period of 10 years or 3 generations, whichever is longer, up to a maximum of 100 years (Faber-Langendoen et al. 2012).

The Mojave Desert Tortoise has been assigned a global rank of G3 indicating the species is “vulnerable and at moderate risk of extinction or collapse due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.” This species has been assigned a state rank of S2 indicating the species is locally imperiled and “at high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.” The factors cited for this rank include widespread habitat loss, degradation, and fragmentation, and human-associated factors that cause mortality (NatureServe 2022).

The IUCN Red List provided a global scope assessment of Mojave Desert Tortoise in October 2021 (Berry et al. 2021) resulting in a designation of critically endangered. This Red List category represents the highest risk of extinction and is assigned when a taxon has been evaluated against the ranking criteria and is not yet designated Extinct in the Wild, but qualifies above endangered, vulnerable, and near threatened. The species was originally assessed as vulnerable in 1996 and its designation has steadily increased in severity (Berry and Murphy 2019).

## **5.2 Management Efforts**

Due to its large range and the decades since it was formally protected under the ESA and CESA, a diverse suite of government and other entities are involved in land ownership and management within the range of Mojave Desert Tortoise (Table 7). The majority of land is managed by federal agencies, but the range also includes a substantial portion of private land. The BLM is responsible for managing nearly 11,000 km<sup>2</sup> of Mojave Desert Tortoise critical habitat and is the largest landowner within the species range. The NPS is responsible for the next largest portion of the range, most of which is congressionally designated Wilderness where motorized vehicles are prohibited. Private lands and DoD lands comprise most of the remaining land ownership within the species range.

**Table 6.** Land ownership within the entire range of Mojave Desert Tortoise and within designated critical habitat.

<b>Land Management Entity</b>	<b>Landownership in Species Range (Km<sup>2</sup>)</b>	<b>Percent of Landownership in Species Range (%)</b>	<b>Landownership in Critical Habitat (Km<sup>2</sup>)</b>	<b>Percent of Landownership in Critical Habitat (%)</b>
United States Bureau of Land Management	37,960	42.5	10,917	56.6
United States National Park Service	18,418	20.6	3,702	19.2
Private Lands	15,147	17	1,730	9.0
United States Department of Defense	13,018	14.6	2,270	11.8
State of California	2,018	2.3	485	2.5
Cities, Counties, Non-Profits, Special Districts	995	1.1	114	0.6
Other Public or Private Lands	391	0.4	30	0.2
Other Federal	79	0.1	19	0.1
United States Bureau of Indian Affairs	689	0.8	NA	NA
United States Forest Service	242	0.3	NA	NA
United States Bureau of Reclamation	181	0.2	NA	NA
United States Fish and Wildlife Service	89	0.1	NA	NA

### *Partnerships and Working Groups*

The Desert Tortoise Management Oversight Group (MOG), formed in 1994, is comprised of senior managers from USFWS, BLM, state transportation agencies, state wildlife agencies, county governments, and non-governmental organizations (NGOs) that work in the tortoise range in Arizona, Nevada, Utah, and California. This group identifies regional recovery priorities, addresses issues common to multiple agencies, and shares information and updates about tortoise status and their recovery activities.

The Recovery and Sustainment Partnership (RASP) is comprised of DoD and Department of Interior agencies and is intended to provide increased flexibility for the use of land for military operations (i.e., make it easier to conduct training in areas with tortoise populations) in return for developing recovery initiatives. Under this partnership, agencies fund recovery actions such as raven management in California. Pooled funding and the Memorandum of Understanding between RASP partners allows for increased flexibility and reduced regulatory hurdles for implementation of broad, regional scale recovery actions.

The California Desert Conservation Act (Fish & G. Code, § 1450 et seq.) became effective on January 1, 2022, and establishes a California Desert Conservation Program within the California Wildlife Conservation Board with the goals of protecting habitat in California’s Mojave and Colorado deserts by planning and implementing land acquisition and restoration projects. The California Desert Conservation Program could result in increased conservation or restoration of Mojave Desert Tortoise habitat in California.

### *United States Fish and Wildlife Service*

The USFWS has developed and revised range-wide Recovery Plans for Mojave Desert Tortoise that encourage collaboration, identify research priorities, and encourage management actions for the benefit of the species. In 1994, the USFWS published the first Recovery Plan and designated more than 25,000 km<sup>2</sup> of critical habitat, most of which is in California (USFWS 1994). The plan identified Desert Wildlife Management Areas and included management recommendations such as landscape-level management and monitoring, public education, and habitat protection (USFWS 1994). In 2011, the USFWS published revisions to the Revised Recovery Plan which identified research priorities and recovery actions, including facilitation of recovery partnerships, protection of existing populations and habitat, supplementing populations, and implementing adaptive management (USFWS 2011). In 2010, the USFWS published its first 5-year review for Mojave Desert Tortoise across its multi-state range, in which they assigned a recovery priority number indicating that the species faces a moderate degree of threat, has a low potential for recovery, and faces conflict with construction or other development projects or other forms of economic activity. The USFWS recommended no change in status from threatened to endangered, in part because implementation of the at-the-time draft Revised Recovery Plan was expected to resolve key uncertainties and improve recovery potential (USFWS 2010). In 2022, the USFWS published another 5-year review reporting the continuing declines in density in all the California Tortoise Conservation Areas (see Table 2), but also recommended no change in the listing status of the Mojave Desert Tortoise (USFWS 2022a). For more detail see section 5.1.

As part of the 2011 Revised Recovery Plan revision, Recovery Implementation Teams were developed, which are “composed of representatives from government agencies and non-profit organizations. Participants in these teams prepare proposals for recovery actions, seek funding to support the proposals, and assist with implementation when funding becomes available” (Berry and Murphy 2019). Recovery Implementation Teams have focused on restoration of habitat burned and/or denuded by livestock, trash management to mitigate predator subsidies, invasive plant control, roadway fencing, and other conservation and management actions (Berry and Murphy 2019).

### *Bureau of Land Management*

The 2016 Desert Renewable Energy and Conservation Plan (DRECP) Land Use Plan Amendment (LUPA) to the California Desert Conservation Act Plan of 1980 guides management of 10.8 million acres (43,706 km<sup>2</sup>) of BLM lands in California. The plan “identifies priority areas for renewable energy development while setting aside areas for conservation and recreation” (BLM 2022). Phase I of the DRECP focused on the BLM lands and was released as a LUPA. Phase II will focus on county-level planning designed to work in conjunction with the LUPA. Along with many other agencies and stakeholders, the Department provided input on the development of the DRECP.

Under the DRECP, 11,290 acres (~46 km<sup>2</sup>) of modeled desert tortoise habitat would eventually be developed for renewable energy, with a streamlined permit review process (BLM 2016). The LUPA contains numerous conservation and management actions, including establishment of a

cumulative limit (no more than 1%) on ground-disturbing activities within BLM-owned portions of TCAs and mapped linkages. The plan amendment further prohibits long-term habitat removal in high density tortoise areas (more than five tortoises at least 160 mm carapace length per square mile, or more than 35 individuals in total), but gives an exception for transmission projects. Although the LUPA allows some renewable energy project development in tortoise habitat, other lands will be managed “according to numerous conservation and management actions that are more protective of desert tortoises than direction contained in the previous land use plan “(USFWS 2022a).

### *National Park Service*

Management of the Mojave Desert Tortoise on NPS lands is guided by the NPS Organic Act of 1916, the ESA, the Wilderness Act of 1964, the 2006 NPS Management Policies, each unit’s General Management Plan (GMP) and Superintendent’s Compendium, and Resource Stewardship Strategies.

The NPS Organic Act of 1916 (39 Stat. 535, 16 U.S.C. 1, as amended), states that the NPS “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.”

In desert tortoise range, the NPS administers Joshua Tree National Park, Death Valley National Park, and Mojave National Preserve. The majority of lands across these three units are congressionally designated Wilderness, including nearly 50% of lands in Mojave National Preserve, approximately 85% of lands in Joshua Tree National Park, and roughly 93% of lands in Death Valley National Park. The Wilderness Act is intended to preserve places “where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain” (Wilderness Act section 2, subd. I). Use of offroad vehicles and motorized equipment is prohibited in Wilderness areas.

The NPS 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 other agencies and partners to implement management programs which inventory, monitor, restore, and maintain listed species habitats. The Mojave Desert Inventory & Monitoring Network of the NPS regularly implements monitoring programs at all three NPS units focused on desert spring riparian vegetation and water quality as well as upland vegetation and soil characteristics that might influence the survival of Mojave Desert Tortoise.

Broad conservation actions are outlined in GMPs and specific closures and updates to prohibited actions are contained in the Superintendent’s Compendium. Examples include prohibitions on use of Unmanned Aircraft Systems (drones), limits on use of artificial lights to view wildlife, requirements for food storage and trash management, and commitments for restoration of disturbed areas and/or mitigation of direct vegetation impacts.

### *United States Department of Defense*

The Sikes Act was established in 1960 to ensure conservation and protection of natural resources used by the DoD. The U.S. Congress amended the Sikes Act in 1997 requiring the DoD to develop and implement Integrated Natural Resources Management Plans (INRMPs). These plans outline how each military installation will manage its significant natural resources holistically while maintaining military readiness. Since these lands are often protected from access and use by the general public, they sometimes contain significant large tracts of plant and animal habitat and play important roles for species conservation and habitat connectivity.

Under the ESA, the DoD is responsible for managing and protecting the threatened and endangered species found on its installations. DoD is required to consult with the USFWS and National Oceanic and Atmospheric Association (NOAA) Fisheries to manage its threatened and endangered species efforts (Dalsimer 2016).

DoD facilities within the Mojave Desert Tortoise range include Naval Air Weapons Station China Lake, Edwards Air Force Base, Fort Irwin, Marine Air Ground Task Force Training Command and Marine Corps Air Ground Combat Center Twentynine Palms, Marine Corps Logistics Base Barstow, and the Chocolate Mountain Aerial Gunnery Range. DoD is an active collaborator in the MOG and RASP partnerships and contributes funding to many recovery actions. Unlike most other federal land, tortoise habitat under DoD jurisdiction is “subject to more dramatic changes in management or use than other federal lands depending on the changing national security situation” (USFWS 2011). This means that large tracts of desert tortoise habitat can relatively quickly be converted to uses that are incompatible with desert tortoise, requiring translocation of large number of tortoises (see section 4.1 for more details). To offset these losses of tortoise habitat, the DoD undertakes a variety of actions such as purchasing land in critical habitat units, increasing law enforcement, predator control and monitoring, rehabilitation of closed roads, and installation of fencing.

### *California Department of Fish and Wildlife*

CESA prohibits the unauthorized take of desert tortoise, but the Department may permit take that is incidental to otherwise lawful activities if the impacts of the take are minimized and fully mitigated. These permits are commonly called incidental take permits.

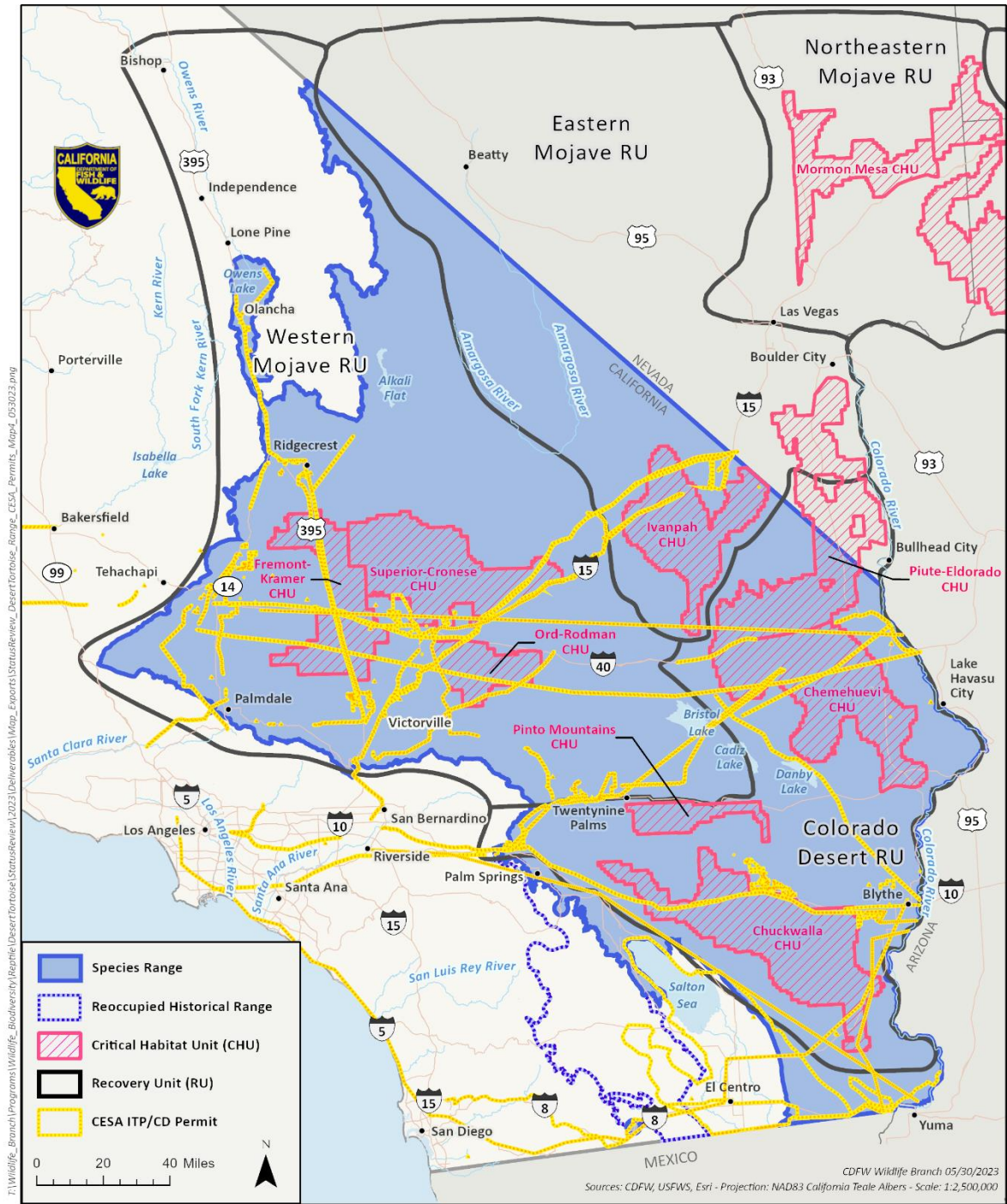
The Department is required to determine what qualifies as “full mitigation” for each permit on a case-by-case basis. As a practical matter, full mitigation has frequently required the perpetual protection and management of habitat mitigation lands. In addition, projects may have to implement a variety of measures to minimize take of tortoises including but not limited to surveying and monitoring for their presence, fencing to keep tortoises out of the project site, relocating nests to safe offsite locations, translocating tortoises from the project site, and managing ravens on the site.

Since 1989, the Department has issued 192 ITPs and 49 CDs covering incidental take of Mojave Desert Tortoise; the most common project types include renewable energy, transportation, and utility infrastructure (for locations of permitted projects see Figure 11). The Department’s records are not complete; however, at minimum these permits authorize 62,131 acres (~250

km<sup>2</sup>) of permanent impacts and 14,672 acres (~59 km<sup>2</sup>) of temporary impacts (based on data available on temporary acres from 36% of ITPs and on permanent impacts from 79% of ITPs). The ratio at which projects must protect and manage mitigation habitat varies on a project-by-project basis, however projects sited in federally designated critical habitat are generally mitigated at a 5:1 ratio and other habitats at around a 3:1 ratio, depending on quality. Permit holders have multiple options when choosing mitigation lands but must typically provide permanent protection and perpetual management of habitat for the listed species either on the project site or at another location approved by the Department. This requires transfer of fee - title and/or recordation of a conservation easement, to which the Department must be at least a third-party beneficiary, funding of short-term management practices and a long-term management endowment, and monitoring to ensure compliance with the conservation easement. Alternatively, permittees may purchase credits at conservation and mitigation banks.

The desert tortoise is addressed in several Natural Community Conservation Plans (NCCPs) and Habitat Conservation Plans (HCPs) in California, including the West Mojave Plan, the Coachella Valley Multi Species Habitat Conservation Plan (MSHCP), and the California Energy Commission's Habitat and Species Protection Research Project. The Coachella Valley MSHCP area supports a small but significant population of desert tortoises in Riverside County (CDFW 2005). This MSHCP includes all federally designated critical habitat within the plan area as part of the Desert Tortoise and Linkage Conservation Area.





**Figure 11.** Map of Incidental Take Permits (ITPs) and Consistency Determinations (CD) in the general area of Mojave Desert Tortoise range in California. The linear permit areas are for energy transmission lines, pipelines, fiber optic lines, and other linear features. Other types of projects are represented as polygons.

### *Population Augmentation*

Multiple agencies have coordinated on active management to augment and stabilize populations of desert tortoise. The two primary management strategies to increase the survival rates of individual tortoises are mitigation-driven translocation and release of head-started juveniles. Mitigation-driven translocation involves moving tortoises from a site where they would be harmed and into an appropriate recipient site. Head-starting is a strategy to reduce predation mortality on juvenile tortoises by hatching and rearing juveniles in captivity until they are large enough to avoid most predators.

### Translocation

Mitigation driven translocation happens when a proposed project could result in incidental take of tortoises. As part of the minimization measures set forth in an ITP issued by the Department pursuant to CESA or an ITP or Incidental Take Statement issued by the USFWS pursuant to the ESA, tortoises in the project area can be translocated to preapproved recipient sites. The main purpose of translocations is to remove tortoises from project areas where they would otherwise not survive; however, bolstering the population at the recipient site is also a goal. There are several factors that need to be considered when tortoises are translocated, such as the habitat suitability of potential translocation sites and disease prevalence of both tortoises being moved and at the recipient site. The specific guidelines used by the USFWS are laid out in the USFWS Plan Development Guidelines (USFWS 2020b).

The Department requires that ITP holders monitor any tortoises translocated, and has teams carefully examine recipient sites for soil and vegetation communities that are suitable for all life stages of the tortoise, evaluate the presence and abundance of predators, and make sure there are sufficient burrows of appropriate size so that translocated tortoises can quickly find shelter. Most of the tortoises translocated under ITPs granted by the Department are placed within 4 miles of the donor site (although distance is only one of many considerations when choosing a recipient site) and the number of tortoises translocated for any project is usually less than 50. It should be noted that these common ITP requirements do not necessarily fully overlap with those of the USFWS. Due to the consistent efforts to find suitable recipient sites, deaths from translocation via dehydration or predation are rare (CDFW unpublished data, W. Campbell pers comm Jan 2023). However, the longer-term survival of translocated tortoises is not known.

Larger scale translocations face the challenge of finding recipient sites that are suitable for larger numbers of tortoises. If donor sites are chosen where resident populations are depleted or have low densities, they may not have the capacity to maintain higher densities of tortoises in general and might not be able to support large numbers of translocated animals (USFWS 2011). For example, sites with a depleted population due to habitat modification or degradation may currently be at a low carrying capacity and not be able to support many transplants because the site lacks sufficient food or shelter to support more individuals, thermal conditions are suboptimal, or predation pressure is high.

An additional consideration is how far to translocate individuals. When tortoises must be translocated from large tracts of land such as military bases, translocating individuals close to their home ranges may not always be feasible. Long distance translocation involves potential mixing of genetic subunits and possible maladaptation to the environment, and investigations into the genetic makeup of the source and recipient populations can help managers make appropriate decisions (Weeks et al. 2011). Averill-Murray and Hagerty (2014) evaluated genetic variation of tortoises using microsatellite loci and concluded that “releasing tortoises at recipient sites within a straight-line distance of 200 km from the source population would most conservatively maintain historic genetic population structure.” However, more recent work by Sánchez-Ramírez et al. (2018) using Single Nucleotide Polymorphisms (SNPs) suggests that there are three genetic subunits within the Western Mojave Recovery Unit and translocating them at distances of 200 km away could mix individuals from different genetic units.

In the spring of 2008, 570 tortoises (184 females, 293 males, 93 juveniles) were translocated from the southern edge of Fort Irwin National Training Center to neighboring public land in the Superior-Cronese Critical Habitat Unit. Esque et al. (2010) tracked the survival of translocated tortoises, resident tortoises (from areas near the release sites), and control tortoises (from areas more distant from release sites). In the first year, 19% of control tortoise, 21% of resident tortoises and 25% of translocated tortoises were found dead, with the majority of deaths attributed to predation. Esque et al. (2010) also reported higher mortality rates of tortoises in 2008 compared to the previous two years at sites across California and Nevada. Looking at the same translocation event, Mulder et al. (2017) found that four years later, the translocated males that survived were not fathering hatchlings. Even though translocated males made up 46% of the males in the population, all hatchlings that could be assigned fathers were sired by resident males.

Mack and Berry (2023) monitored 158 of the adult tortoises translocated from Fort Irwin in 2008 for ten years. Thirty-nine percent died in the first year, more than 50% were dead by the end of the third year, and after 10 years about 66% were confirmed dead and another 15% missing. Most of the deaths were attributed to coyote predation. However, they did not report survival rates of resident or control tortoises, so it is unclear the role translocation played in these death rates.

In the Ivanpah Valley near the Nevada border, the probability of mortality of translocated, resident, and control tortoises after translocation from a solar energy facility into nearby sites did not differ significantly either three (Brand et al. 2016) or five years (Dickson et al. 2019) after translocation.

Beyond the survival of tortoises involved in large scale translocations, there have been many studies looking at how body condition and temperature (Brand et al. 2016), environmental conditions (Nafus et al. 2017, Dickson et al. 2019), physiological stress (Drake et al. 2012), proximity of anthropogenic resources (Esque et al. 2010), movement and space use (Nussear et al. 2012, Farnsworth et al. 2015, Hinderle et al. 2015), and water availability (Field et al. 2007)

affect the outcomes of translocations. These results are critical to improving and refining decision making around translocations.

### Head starting

Head-starting is a strategy to try to circumvent the high mortality of juvenile tortoises in the wild (see sections 3.3 Mortality and Survival Rates and 4.5 Predation). Population modeling suggests that increased juvenile survival can improve population growth rates. Eggs are hatched in captivity and juveniles are reared until they reach a certain size and then released. There is some evidence that this strategy is effective at least in the short term (Nagy et al. 2015*a,b*, Tuberville et al. 2019), however, mortality is high for juveniles smaller than 100 mm in length. When Daly et al. (2019) monitored head started tortoises after release in the Mojave National preserve, annual survival was 44% and short-term survival was better if tortoises were more than 1.6 km from a raven's nest. Nagy et al. (2015) recommends not releasing head-started tortoises until they are over 100 mm, which requires keeping them in captivity for about 9 years and is a considerable investment of time and resources.

There is currently a head-starting program at the Ivanpah Desert Tortoise Head-starting Facility in Mojave National Preserve, a joint project between the University of Georgia and UC Davis. They have produced more than 675 hatchlings, released 324 which have been radio-tracked following release, with another approximately 275 for upcoming releases (Tuberville 2022). Another head-start program is on Edwards Air Force Base and involves San Diego Zoo, the U.S. Geological Survey, Cadiz Inc., and the BLM (SDZWA 2018).

## **6. SUMMARY OF KEY FINDINGS**

CESA's implementing regulations identify key factors relevant to the Department's analyses and the Commission's decision on whether listing a species as threatened or endangered is warranted. A species will be listed as endangered or threatened if the Commission determines that the species' continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities (Cal. Code Regs., tit. 14, § 670.1, subd. (i)).

The preceding sections of this status review describe the best scientific information available to the Department, with respect to the key factors identified in the regulations. This section considers the significance of any threat to the continued existence of Mojave Desert Tortoise for each of the factors.

Historical and current conservation efforts have not proven sufficient to halt the population declines of desert tortoises. The most robust tortoise density estimates come from annual systematic surveys begun in 2001 in the Tortoise Conservation Areas, which include the critical habitat units and contiguous areas with potential tortoise habitat and compatible management. Taken as a whole, these surveys provide strong evidence that most tortoise populations in California have declined rapidly over the past decades. Estimated rates of annual decline in density in the Recovery Units from 2001 to 2020 were about 4% in the Western Mojave (54%

decline over 19 years) and about 1% in the Eastern Mojave and Colorado Desert Recovery Units (17% decline over 19 years). In 2001, 80% of the TCAs had estimated densities below 3.9 adult tortoises/km<sup>2</sup>, which is the density considered necessary for population viability. By 2020, all TCAs had estimated densities below that threshold. While we do not have estimates of density in all the TCAs prior to the desert tortoise being listed as threatened, densities in the early 1980s in select TCAs varied between 35 and 90 adults/km<sup>2</sup>, and between 35 and 70 adults/km<sup>2</sup> when they were listed as threatened under CESA in 1989. Since the late 1970s, the number of juveniles detected on surveys has fallen to the point that in recent surveys in the Western Mojave almost no juveniles were found. Overall, population data indicate that the Mojave Desert Tortoise has experienced long-term, large population declines throughout its range in California. Data from the last 20 years show that this decline is ongoing. Populations in the TCAs, which represent much of the best habitat, are no longer considered viable.

Due to the slow components of tortoise life history, if past and current management is successful at mitigating threats and adverse impacts to tortoises, it will still take at least 25 years of positive population growth to reach the USFWS Recovery Criteria (USFWS 2022a). For example, the USFWS 1994 Recovery Plan estimates that when adult survivorship is 98%, population growth would be less than 0.5% per year, and would take 140 years to double in size. Annual survival rates for both adults and juveniles in many areas are much lower than 98%, making population stability, let alone growth, unlikely. Collectively, the available data show that despite 30 years of state and federal protection, in the critical habitat units (which were established to encompass the best tortoise habitat), most tortoise populations have continued to decline and do not show consistent signs of recovery. In regularly surveyed areas, tortoise densities are below the thresholds considered to represent population viability.

The dramatic declines in Mojave Desert Tortoise populations have likely resulted from the extensive number and interconnected nature of the threats facing tortoises in California. The important threats fall in two categories, those that directly kill adults and juveniles, and habitat modifications that make it less likely to support healthy populations.

Particularly in long-lived species that are slow to reproduce, decreased survival has long lasting impacts on the population and can alter demographic patterns for decades. Human created subsidies can increase predator densities, and predation pressure from ravens and coyotes reduce the survival of juvenile and adult tortoises, respectively. Increasing development removes or reduces habitat suitability and creates roads and increased traffic that can directly kill tortoises. Well-designed fences and culverts can help prevent tortoises and other wildlife being killed by vehicles along major roads, but many primary roads remain unfenced and little fencing has been built since 2011. Extensive networks of trails for off-highway vehicles on public lands add to the risk of tortoise roadkill. Development in the desert will likely continue and possibly speed up given California's need for housing and renewable energy (Office of Governor Gavin Newsom 2021). Additional factors have direct and indirect impacts on tortoises and their habitat. Climate change is likely to make desert tortoise range hotter and drier and alter the vegetation communities. This will increase tortoise physiological stress, change activity patterns, and reduce and shift the locations of suitable tortoise habitat. Increased frequency or

severity of drought can further degrade habitat and increase stress on tortoise populations. The nutritious native plants tortoises preferably feed on are being outcompeted by nutritionally poor invasive grasses, which can lower tortoise survival rates.

Some threats appear to be declining. Upper respiratory tract diseases were a major concern when tortoises were listed as threatened. Encouragingly, the prevalence of diseased tortoises is lower than in previous decades, and it does not currently appear to be an acute threat to wild populations. The prevalence of gunshot deaths also decreased in the past several decades, but it is unclear if this is due to change in human behavior or simply reflects a lower tortoise encounter rate due to declining tortoise density.

Given that there are multiple interacting threats that are reducing the amount and quality of viable habitat and declining survival rates of adults and juveniles, available information suggests that tortoise populations will continue to decline for the foreseeable future. However, several major threats like raven predation on juveniles and the lack of fencing on highways can be minimized with the appropriate resources and policy changes. Implementing these actions where appropriate to improve survival in the short term is critical to give desert tortoises the resilience to be able to weather longer term habitat and climactic effects.

## **7. PROTECTION AFFORDED BY LISTING**

It is the policy of the state to conserve, protect, restore, and enhance any endangered or threatened species and its habitat (Fish & G. Code, § 2052). If listed as an endangered rather than a threatened species pursuant to CESA, unauthorized “take” of Mojave Desert Tortoise will remain prohibited and its conservation, protection, and enhancement will remain a statewide priority. As the Mojave Desert Tortoise is already listed as threatened, public agency environmental review is required under the California Environmental Quality Act (CEQA) and its federal counterpart, the National Environmental Policy Act (NEPA). There are no changes in legal protections under CESA for species uplisted from threatened to endangered.

However, if the status of the Mojave Desert Tortoise is changed to endangered under CESA, it may increase the likelihood that state and federal land and resource management agencies will prioritize and allocate more funds towards protection and recovery actions. The federal and state listings of the desert tortoise as threatened stimulated a great deal of interest and funding in addressing basic questions about the species, with expanded research into status and distribution of populations, ecology, genetics, and diseases, as well as collaborations to minimize conflict among the many users of desert tortoise habitats. It also triggered the creation of a USFWS Recovery Plan and the numerous conservation and management measures outlined in section 5 (Existing Management). However, funding for species recovery and management is limited, and there is a growing list of threatened and endangered species. Therefore, while a status change pursuant to CESA will highlight the urgency of tortoise conservation needs, the management effects of such a change are uncertain.

## **8. RECOMMENDATION FOR THE COMMISSION**

CESA requires the Department to prepare this status review regarding the status of Mojave Desert Tortoise in California based upon the best scientific information available to the Department (Fish & G. Code, § 2074.6). CESA also requires the Department to indicate in this status review whether the petitioned action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). Based on the criteria described above, the best scientific information available to the Department indicates that Mojave Desert Tortoise is in serious danger of becoming extinct in California due to one or more causes including present or threatened degradation and loss of habitat, predation, and other natural occurrences and human-related activities.

The Department recommends that the Commission find the petitioned action to change the status of Mojave Desert Tortoise from threatened to endangered to be warranted.

## **9. MANAGEMENT RECOMMENDATIONS**

CESA directs the Department to include in its status review recommended management activities and other recommendations for recovery of Mojave Desert Tortoise (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). The USFWS created a Recovery Plan for desert tortoise in 1994 which was revised in 2011. This is currently the most comprehensive framework of actions needed to recover the desert tortoise, and many of the recommendations are still very relevant. For our recommendations we borrow heavily from the framework in the 2011 revised Recovery Plan, include examples of recent progress, and point out specific areas where the Department could engage more.

### **9.1 Actions**

This document is not a Recovery Plan; however, it is useful to identify the conservation goals that the management recommendations are meant to achieve.

In brief, the USFWS Recovery Plan includes the following objectives:

1. Maintain self-sustaining populations of desert tortoises within each recovery unit into the future.
  - Criteria: Rates of population change for desert tortoises are increasing over at least 25 years (a single tortoise generation)
2. Maintain well-distributed populations of desert tortoises throughout each recovery unit.
  - Criteria: Distribution of desert tortoises throughout each tortoise conservation area is increasing over at least 25 years
3. Ensure that habitat within each recovery unit is protected and managed to support long-term viability of desert tortoise populations.

The major elements of the USFWS Recovery Plan strategy to achieve these objectives are:

1. Develop, support, and build partnerships to facilitate recovery.
2. Protect existing populations and habitat, instituting habitat restoration where necessary.
3. Augment depleted populations in a strategic manner.
4. Monitor progress toward recovery.
5. Conduct applied research and modeling in support of recovery efforts within a strategic framework.
6. Implement a formal adaptive management program.

For each element in the Recovery Plan strategy, the USFWS includes specific measures to contribute to the strategy. We do not list all these specific measures here, but instead discuss the elements and measures that are most relevant and important to recovery in California and highlight those which the Department may have a role in implementing.

*1. Develop, support, and build partnerships to facilitate recovery*

There are multiple existing partnerships to facilitate recovery of desert tortoise (see section 5.2 Management Efforts). The Department could become more active in the MOG, participate in Recovery Implementation Teams, and strengthen relationships with state and federal agencies to collaboratively address priorities such as highway fencing and translocation.

*2. Protect existing populations and habitat, instituting habitat restoration where necessary*

**a. Conserve intact desert tortoise habitat**

The majority of land (63.1%) in the tortoise range is under stewardship of the BLM or the NPS and receives some level of protection (see Table 7). Future habitat conservation efforts should consider how habitat suitability will change in the coming decades under predicted climate change and ways in which habitat can be restored and made more resilient and/or habitat degradation can be ameliorated.

**b. Secure lands/habitat for conservation**

Projects that will potentially result in incidental take of tortoises may apply for an ITP from the Department. As a condition of the ITP, the Department must require any impacts to the desert tortoise to be fully mitigated. This requirement is most often met through the perpetual protection and management of off-site habitat. The Department should continue to focus on securing high quality habitats through the ITP process and through other means (e.g., facilitating recovery land acquisitions through grants, facilitating conservation easements). The USFWS also issues take authorizations that ask for mitigation in the form of land protection. For more detail see section 5.2 Management Efforts.

Other agencies are actively involved in securing habitat. As mentioned previously, “the Army acquired approximately 100,000 acres (~405 km<sup>2</sup>) of nonfederal land within the Superior-Cronese Critical Habitat Unit for conservation management of desert tortoises. It also



purchased the base property of three cattle allotments on which the Bureau subsequently re-allotted the forage to wildlife” (USFWS 2022a).

#### c. Connect functional habitat

Low genetic differentiation among desert tortoise populations in California (Hagerty and Tracy 2010) suggests that historically there were few barriers to movements and mixing, aside from large mountain ranges and other significant climatic or vegetative barriers. However, this is effectively no longer the case, and habitat patches are separated by roads, housing, agriculture, industry, energy projects, and military activities.

The strategy outlined in the 1994 Recovery Plan suggests that habitat patches of at least 2,590 km<sup>2</sup> (1,000 mi<sup>2</sup>) are needed in each recovery unit to “contain a viable population of desert tortoises that is relatively resistant to extinction processes” (USFWS 1994). Multiple TCAs are smaller than 2,590 km<sup>2</sup>, therefore protecting corridors between TCAs so that tortoises can disperse is important for conservation. Tortoises within isolated patches are at higher risk of extirpation due to the usual risks to small populations—stochastic catastrophes like drought and fire, reduction in genetic variation, and potential associated losses of fitness (Boarman et al. 1997, Berry and Murphy 2019, USFWS 2022a). While many of the patches share the same threats, given the differences in land use and management across the desert tortoise’s range, individual patches should be managed to minimize the most severe threats for that patch. The USFWS (2019a) points out that the current fragmented nature of desert tortoise habitat (e.g., urban and agricultural development, highways, freeways, military training areas) will make “recolonization of extirpated areas difficult, if not impossible.”

Land is not equally protected across CHUs, creating potential barriers between areas of functional habitat. We recommend focusing compensatory habitat purchases and other types of land acquisitions on connecting functional habitat. The BLM is acquiring several thousand acres of checkerboard inholding in Chuckwalla Critical Habitat Unit which will improve connectivity to Joshua Tree National Park.

#### d. Fence, restrict, designate, close roads and routes

For functional habitat to be connected, tortoises need to be able to move and not be isolated in patches. A major action to achieve this is to establish safe tortoise road crossings and fence nearby areas along roads.

Erecting well designed tortoise exclusion fencing along major roadways and funneling them into appropriate crossings is a key recovery action. There are 500 km (~310 mi) of road identified as priority for fencing (USFWS 2022a). Currently, the regulations for highway fencing have made it extremely difficult and expensive to install tortoise fencing and are a major reason that there was very little tortoise exclusion fencing installed between 2011 and 2022. Under current practice, when an applicant applies for an ITP for a road project that includes tortoise exclusion fencing and culverts for crossing, the area of land inside the fence including the median between lanes of traffic is counted as impacted habitat that must be fully mitigated through land acquisition. The costs of procuring land adds substantial costs to fencing projects, to the point that much needed fencing is not being built. To speed up the building of fences, the

Department can work with Caltrans and other agencies to reduce cost and administrative burden of building tortoise exclusion fencing and can potentially broaden the measures considered to fully mitigate the impacts of road projects. In late 2023, there are some fencing projects in process, including the first phase of a BLM effort to build 3.5 miles of fencing along I-40 in the Rod-Ordman Critical Habitat Unit. In the Mojave National Preserve there is a road rebuilding project that includes 5 miles of tortoise fencing.

In addition to fencing paved roads, closing unauthorized OHV routes in CHUs is an important step to prevent further habitat degradation.

e. Minimize excessive predation on tortoises

Implementing multiple actions simultaneously is necessary to slow the expansion of predator populations. The DoD and the USFWS have active programs to reduce anthropogenic subsidies to ravens and coyotes by securing trash and water sources and reducing the number of raven nesting and roosting sites created by infrastructure. The USFWS has a program to reduce raven populations via egg oiling with a goal of no raven nests in priority areas for tortoise recruitment (K. Holcomb, USFWS Raven Management in CA. MOG April 16, 2022).

f. Restore desert tortoise habitat

Restore closed and unauthorized OHV trails and work to reduce non-native invasive grasses from desert tortoise habitat. Areas degraded by off road vehicles in Fremont Kramer Critical Habitat Unit are being restored by the BLM, and Marine Corps Air Ground Combat Center Twentynine Palms is restoring habitat as part of implementing the RASP.

g. Minimize factors contributing to disease (particularly upper respiratory tract disease)

Continue to discourage the release of pet tortoises into the wild. Monitor and quarantine translocated tortoises to make sure they are not diseased before relocation following recommendations in USFWS (2020).

h. Establish/continue environmental education programs

Environmental education is a preventative action that has been shown to effectively change learned behavior and can be used to reduce stakeholder conflict before it happens (Hungerford and Volk 1990). Educated citizens are more likely to be aware of the consequences they can have on desert tortoises and to be more willing to take responsibility for their actions than those with less knowledge (Vaske and Donnelly 2007). Widespread efforts in museums, hunting clubs, and in BLM and NPS visitor centers and interpretive sites are needed to inform the public about the status of the desert tortoise and its recovery needs (USFWS 2011).

Interpretive kiosks or visitor centers should be used to disseminate information about the desert tortoise and the need to minimize impacts on their habitat. Education programs should include such subjects as husbandry and adoption programs for captive tortoises, the importance of discouraging unauthorized breeding of captive tortoises, and state laws related to the release of captive tortoises. Education efforts should be focused on groups that use the desert on a regular basis, such as rock-hounds and off-highway vehicle enthusiasts. Additional

educational tools include public service announcements, news releases, informational videos, brochures and newsletters, websites, and volunteer opportunities (USFWS 2011).

Mojave National Preserve has a “Drive Like a Tortoise” campaign to promote drivers to slow down both to decrease the number of vehicle collisions and road killed tortoises. Organizations like the Living Desert Zoo and Garden have billboards to promote the covering of trash to reduce subsidies to ravens.

#### i. Increase law enforcement

Increase efforts to enforce off-roading rules in Desert Wildlife Management Areas and CHUs.

### *3. Augment depleted populations through a strategic program*

#### a. Translocation

The outcomes of translocation actions discussed in section 5.2 suggest that well designed translocation projects can result in short- and medium-term survival rates for translocated tortoises that are similar to resident tortoises. However, given the continuing decline of tortoise populations in general, translocations may often not be an effective conservation strategy without addressing the drivers of declines within the subject populations. At best, augmentation of populations through translocations can buy time and keep tortoises present on the landscape while the threats causing declines are addressed. In addition, given the long-term decline of tortoise populations, understanding the population impacts of translocation is critical so that they can be effectively incorporated into larger scale long-term strategic conservation goals (Germano et al. 2015). Projects that hold ITPs from the Department monitor translocated tortoises for 5 years and submit reports to the Department. These data should be organized and analyzed in order to understand medium-term survival rates of translocated individuals, and the impacts of potential population fragmentation (see section 9.3). Increased collaboration should occur between agencies that perform translocations to understand the landscape and population impacts of short- and long-range translocations and coordinate research on disease dynamics, recruitment rates, and gene flow (USFWS 2020b).

#### b. Head-starting

Head-starting is a strategy to try to circumvent the high mortality of juvenile tortoises in the wild. Population modeling suggests that increased juvenile survival can improve population growth rates. There is some evidence that this strategy is effective at least in the short term, however, mortality is high for juveniles smaller than 100 mm in length. Daly et al. (2019) points out that by itself, head-starting is unlikely to lead to population recovery if larger issues that depress survival such as raven density and habitat degradation are not addressed. Another consideration is that unless factors that depress adult survival are also addressed, focusing on putting more juveniles in a “degraded environment in which their parents have already demonstrated that they cannot flourish” is not an effective long-term solution (Frazer 1992).

Head-starting programs should continue to monitor the survival of juveniles and the effectiveness of the programs as a population augmentation measure.

#### *4. Monitor progress toward recovery*

The USFWS conducts surveys of the Tortoise Conservation Areas to generate estimates of density, abundance, and annual rates of change (see section 3.2 Trends in Density and Abundance). The USFWS (2011) also has detailed recommendations regarding population monitoring at the Recovery Unit scale.

The Department collects a variety of data on tortoises from holders of ITPs and Scientific Collecting Permits. Improving the capacity of the Department to summarize and analyze these data to identify the cumulative impacts of permitted projects on tortoise populations will help expand the geographic scope of monitoring and is key to developing criteria for decisions on potential limits to take for desert tortoise. Sharing this information with other state and federal agencies through the MOG will help bring a broader and more comprehensive understanding of the state of tortoise populations in California. In addition, the Department should continue to engage with the USFWS and other partners to address high priority monitoring needs through the Cooperative Endangered Species Conservation Fund (Traditional Section 6) Grant Program See sections 9.2 and 9.3 for more detail.

#### *5. Conduct applied research and modeling in support of recovery efforts within a strategic framework*

The 2011 USFWS Revised Recovery Plan includes many specific research and modeling actions needed to address desert tortoise recovery. Funding for continued long-term monitoring at sites outside of TCAs such as the Desert Tortoise Natural Area would expand our understanding of long-term trends in areas with different types of management. The Department should continue to engage with the USFWS and other partners to address high priority research needs through the Cooperative Endangered Species Conservation Fund (Traditional Section 6) Grant Program and other funding opportunities.

#### *6. Implement a formal Recovery Plan*

The Department has authority to develop and implement non-regulatory Recovery Plans and recovery criteria for CESA-listed species with the goal of improving the status of species and managing threats to the point where CESA listing may no longer be appropriate or necessary. The Department should consider whether adoption of the USFWS Recovery Plan, potentially with amendments, is warranted.

### **9.2 Regulations and Policy**

Due to the number of interacting threats facing the desert tortoise, mitigation measures developed to mitigate impacts in ITPs could address a broader suite of conservation activities. Acquiring mitigation land is an important measure, but it only addresses a few of the recovery actions for the desert tortoise. The Department should consider all available actions that meet the “fully mitigated” standard for offsetting project impacts. All measures that support and improve populations should be considered as mitigation, including installing tortoise fencing along highways, habitat enhancement, management and control of raven populations, and measures that improve connectivity. Focusing on land acquisition at the expense of other

measures could result in the protection of high-quality habitat but limited reductions in broader factors causing direct mortality or restricting movement between protected areas.

Another useful step would be to review the implementation and effectiveness of all ITPs issued since CESA listing. The Department may not issue an ITP if “issuance would jeopardize the continued existence of the species” (Fish & G. Code, § 2081, subd. (c).). Given the long-term decline of desert tortoise populations, a Department evaluation of prior mitigation measures would help it assess the impacts, both direct and cumulative, of subsequent projects proposing to incidentally take desert tortoises.

### **9.3 Capacity Building within CDFW**

#### *Personnel*

For these Management Recommendations to be most consistently implemented and successful, staffing and/or funding capacity that can be devoted to developing, supporting, and building partnerships to facilitate recovery of the Mojave Desert Tortoise is needed. A adequate staffing facilitates internal coordination and knowledge-building, as well as regular coordination and collaboration with other agencies and organizations. Dedicated Department tortoise recovery staff could serve as a primary point of contact for desert tortoise permitting and facilitate better coordination internally and externally with those working on tortoise conservation and management.

#### *Upgrading Systems*

Currently, much of the Department review and issuance of ITPs for Mojave Desert Tortoise is done on a project-by-project basis, with some take permitted through Natural Community Conservation Plans and Habitat Conservation Plans like the Coachella Valley Multi Species Habitat Conservation Plan. Projects that apply for ITPs are required to collect data and submit compliance reports to the Department. Likewise, translocation projects are required to monitor results for five years and submit reports to the Department. There is currently no central location in the Department for those types of data and reports. Much of the old data, reports, and information is in paper form and is stored in various Department offices and is functionally inaccessible. Data on project locations, recipient sites, release points, disease testing locations with test results, and mitigation lands need to be stored digitally and made available in compliance with relevant Department scientific data policies. Without a central repository for data and platforms where it can be accessed and used by staff it is difficult to understand the scope and extent of impacts of development on tortoises. Consequently, the Department does not have a complete view of how many acres have been impacted, or the amount and location of habitat that has been conserved as mitigation and the success of that mitigation. However, a permitting system is currently in development that is intended to centralize and streamline the issuing of ITPs and other permits that will make it easier for the Department to make informed decisions on future incidental take permits and jeopardy determinations.

## LITERATURE CITED

The following sources were used during the preparation of this status review:

- Agha, M., J. E. Lovich, J. R. Ennen, B. Augustine, T. R. Arundel, M. O. Murphy, K. Meyer-Wilkins, C. Bjurlin, D. Delaney, J. Briggs, M. Austin, S. V. Madrak, and S. J. Price. 2015. Turbines and terrestrial vertebrates: variation in tortoise survivorship between a wind energy facility and an adjacent undisturbed wildland area in the desert Southwest (USA). *Environmental Management* 56:332–341.
- Allison, L. J., and A. M. McLuckie. 2018. Population trends in Mojave desert tortoises (*Gopherus agassizii*). *Herpetological Conservation and Biology* 13:433–452.
- Andersen, M. C., J. M. Watts, J. E. Freilich, S. R. Yool, G. I. Wakefield, J. F. McCauley, and P. B. Fahnestock. 2000. Regression-tree modeling of desert tortoise habitat in the central Mojave Desert. *Ecological Applications* 10:890–900.
- Anderson, K. M., and K. H. Berry. 2019. *Gopherus agassizii* (Agassiz's Desert Tortoise) predation. *Herpetological Review* 50.
- Averill-Murray, R. C., and B. E. Hagerty. 2014. Translocation relative to spatial genetic structure of the Mojave desert tortoise, *Gopherus agassizii*. *Chelonian Conservation and Biology* 13:35–41.
- Barrows, C. W. 2011. Sensitivity to climate change for two reptiles at the Mojave-Sonoran Desert interface. *Journal of Arid Environments* 75:629–635.
- Barrows, C. W., B. T. Henen, and A. E. Karl. 2016. Identifying climate refugia: a framework to inform conservation strategies for Agassiz's desert tortoise in a warmer future. *Chelonian Conservation and Biology* 15:2–11.
- Bedsworth, L., D. Cayan, F. Guido, L. Fisher, and S. Ziaja. 2018. California's Fourth Climate Change Assessment Statewide Summary Report. California's Fourth Climate Change Assessment.
- Berry, K. H., L. J. Allison, A. M. McLuckie, M. Vaughn, and Murphy R.W. 2021. *Gopherus agassizii*, Mojave Desert Tortoise. The IUCN Red List of Threatened Species.
- Berry, K. H., T. Y. Bailey, and K. M. Anderson. 2006. Attributes of desert tortoise populations at the National Training Center, Central Mojave Desert, California, USA. *Journal of Arid Environments* 67:165–191.
- Berry, K. H., A. A. Coble, J. L. Yee, J. S. Mack, W. M. Perry, K. M. Anderson, and M. B. Brown. 2015. Distance to human populations influences epidemiology of respiratory disease in desert tortoises. *Journal of Wildlife Management* 79:122–136.

- Berry, K. H., and K. Keith. 2008. Status of the desert tortoise in Red Rock Canyon State Park. *California Fish and Game* 94:98–118.
- Berry, K. H., L. M. Lyren, J. L. Yee, and T. Y. Bailey. 2014. Protection benefits desert tortoise (*Gopherus agassizii*) abundance: The influence of three management strategies on a threatened species. *Herpetological Monographs* 28:66–92.
- Berry, K. H., and P. Medica. 1995. Desert tortoise in the Mojave and Colorado deserts. Pages 135–137 in E. T. LaRoe, editor. *Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems*. U.S. Department of the Interior, Washington D.C.
- Berry, K. H., and R. W. Murphy. 2019. *Gopherus agassizii* (Cooper 1861) – Mojave Desert Tortoise. *Chelonian Research Monographs* 5.
- Berry, K. H., L. Nicholson, S. Juarez, and A. P. Woodman. 1986. Changes in Desert Tortoise populations at four study sites in California. Pages 60–80 in. *Desert Tortoise Council Proceedings of the 1986 Symposium*.
- Berry, K. H., T. A. Shields, and E. R. Jacobson. 2016. *Gopherus agassizii* (Agassiz's Desert Tortoise) probable rattlesnake envenomation. *Herpetological Review* 47:652–653.
- Berry, K. H., and F. B. Turner. 1986. Spring activities and habits of juvenile Desert Tortoises, *Gopherus agassizii*, in California. *Copeia* 1986:1010–1012.
- Berry, K. H., J. L. Yee, and L. M. Lyren. 2020a. Feral burros and other influences on desert tortoise presence in the Western Sonoran Desert. *Herpetologica* 76:403–413.
- Berry, K. H., J. L. Yee, T. A. Shields, and L. Stockton. 2020b. The catastrophic decline of tortoises at a fenced Natural Area. *Wildlife Monographs* 205:1–53.
- Berry, K. H., J. Yee, L. Lyren, and J. S. Mack. 2020c. An uncertain future for a population of desert tortoises experiencing human impacts. *Herpetologica* 76:1–11.
- Bisson, H. 2008. *Off-Highway vehicle management on public lands*. Washington D.C.
- Bjurlin, C. D., and J. A. Bissonette. 2004. Survival during early life stages of the desert tortoise (*Gopherus agassizii*) in the south-central Mojave desert. *Journal of Herpetology* 38:527–535.
- BLM. 2016. *Land Use Plan Amendment, Desert Renewable Energy Conservation Plan*.
- Boarman, W. I., and K. Berry. 1995. Common Ravens in the southwestern United States, 1968–92. Pages 73–75 in E. T. LaRoe, editor. *Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems*. U.S. Department of the Interior, National Biological Survey, Washington DC, USA.

- Boarman, W. I., R. J. Camp, F. Collins, M. Hagan, and W. Deal. 1995. Raven abundance at anthropogenic resources in the Western Mojave Desert, California National Biological Service Riverside, California.
- Boarman, W. I., M. A. Patten, R. J. Camp, and S. J. Collis. 2006. Ecology of a population of subsidized predators: Common ravens in the central Mojave Desert, California. *Journal of Arid Environments* 67:248–261.
- Boarman, W. I., and M. Sazaki. 1996. Highway mortality in desert tortoises and small vertebrates: success of barrier fences and culverts. Orlando, FL, USA.
- Boarman, W., and M. Sazaki. 2006. A highway's road-effect zone for desert tortoises (*Gopherus agassizii*). *Journal of Arid Environments* 94–101.
- Boarman, W., M. Sazaki, and B. Jennings. 1997. The effect of roads, barrier fences, and culverts on desert tortoise populations in California, USA. Pages 54–58 *in*. Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles — An International Conference.
- Bradley, B. A., C. A. Curtis, and J. C. Chambers. 2016. Bromus response to climate and projected changes with climate change. Pages 257–274 *in* M. J. Germino, J. C. Chambers, and C. Brown, editors. Exotic brome-grasses in arid and semiarid ecosystems of the western US. Cham:Springer.
- Brand, L. A., M. L. Farnsworth, J. Meyers, B. G. Dickson, C. Grouios, A. F. Scheib, and R. D. Scherer. 2016. Mitigation-driven translocation effects on temperature, condition, growth, and mortality of Mojave desert tortoise (*Gopherus agassizii*) in the face of solar energy development. *Biological Conservation* 200:104–111.
- Brattstrom, B. H. 1965. Body Temperatures of Reptiles. *The American Midland Naturalist* 73:376–422.
- Brooks, M. 1999. Alien annual grasses and fire in the Mojave Desert. *Madroño* 46:13–19.
- Brooks, M. L. 2012. Effects of high fire frequency in creosote bush scrub vegetation of the Mojave Desert. *International Journal of Wildland Fire* 21:61–68.
- Brooks, M. L., and T. C. Esque. 2002. Alien annual plants and wildfire in desert tortoise habitat: status, ecological effects, and management. *Chelonian Conservation and Biology* 4:330–340.
- Brooks, M. L., and B. Lair. 2005. Ecological effects of vehicular routes in a desert ecosystem. *Conservation Biology*.
- Brooks, M. L., and J. R. Matchett. 2006. Spatial and temporal patterns of wildfires in the Mojave Desert, 1980-2004. *Journal of Arid Environments* 67:148–164.



- Brooks, M. L., J. R. Matchett, and K. H. Berry. 2006. Effects of livestock watering sites on alien and native plants in the Mojave Desert, USA. *Journal of Arid Environments* 67:125–147.
- Bureau of Land Management (BLM). 2022. Desert Renewable Energy Conservation Plan Frequently Asked Questions.
- Burgess, T. L., J. Braun, C. L. Witte, N. Lamberski, K. J. Field, L. J. Allison, R. C. Averill-Murray, K. Kristina Drake, K. E. Nussear, T. C. Esque, and B. A. Rideout. 2021. Assessment of disease risk associated with potential removal of anthropogenic barriers to Mojave desert tortoise (*Gopherus agassizii*) population connectivity. *Journal of Wildlife Diseases* 57:579–589.
- CDFW. 2000. The Status of Rare, Threatened, and Endangered Animals and Plants of California 2000.
- CDFW. 2005. The Status of Rare, Threatened, and Endangered Plants and Animals of California 2000-2004.
- CDFW. 2014. CWHR version 9.0 personal computer program. California Interagency Wildlife Task Group, Sacramento, CA, USA.
- Carter, S. K., K. E. Nussear, T. C. Esque, I. I. F. Leinwand, E. Masters, R. D. Inman, N. B. Carr, and L. J. Allison. 2020. Quantifying development to inform management of Mojave and Sonoran desert tortoise habitat in the American southwest. *Endangered Species Research* 42:167–184.
- Chaffee, M. A., and K. H. Berry. 2006. Abundance and distribution of selected elements in soils, stream sediments, and selected forage plants from desert tortoise habitats in the Mojave and Colorado deserts, USA. *Journal of Arid Environments* 67:35–87.
- Christopher, M. M., K. H. Berry, B. T. Henen, and K. A. Nagy. 2003. Clinical disease and laboratory abnormalities in free-ranging desert tortoises in California (1990-1995). *Journal of Wildlife Diseases* 39:35–56.
- Cohn, B., B. Wallace, C. Grouios, B. Dickson, R. Scherer, A. Kissel, M. E. Gray, and T. G. Jackson. 2021. Heavy metal concentrations in Mojave desert tortoises (*Gopherus agassizii*) related to a mitigation translocation project, Ivanpah Valley, California, USA. *Herpetological Conservation and Biology* 16:128–141.
- Corn, P. S. 1994. Recent trends of desert tortoise populations in the Mojave Desert. *Fish & Wildlife Research - US Fish & Wildlife Service* 13:85–93.
- Cummings, K. L., J. E. Lovich, S. R. Puffer, T. R. Arundel, and K. D. Brundige. 2020. Micro-geographic variation in burrow use of Agassiz's Desert Tortoises in the Sonoran Desert of California. *Herpetological Journal* 30:177–188.

- Curtin, A. J., G. R. Zug, and J. R. Spotila. 2009. Longevity and growth strategies of the desert tortoise (*Gopherus agassizii*) in two American deserts. *Journal of Arid Environments* 73:463–471.
- Cypher, B. L., E. C. Kelly, T. L. Westall, and C. L. Van Horn Job. 2018. Coyote diet patterns in the Mojave Desert: Implications for threatened desert tortoises. *Pacific Conservation Biology* 24:44–54.
- Cypher, B. L., T. L. Westall, C. Van Horn Job, and E. C. Kelly. 2014. Coyote foraging patterns in the central Mojave desert: implications for predation on desert tortoises.
- Dalsimer, A. 2016. Threatened and Endangered Species on DoD Lands. DoD Natural Resources.
- Daly, J. A., K. A. Buhlmann, B. D. Todd, C. T. Moore, J. M. Peaden, and T. D. Tuberville. 2019. Survival and movements of head-started Mojave desert tortoises. *Journal of Wildlife Management* 83:1700–1710.
- Davy, C. M., T. Edwards, A. Lathrop, M. Bratton, M. Hagan, B. Henen, K. A. Nagy, J. Stone, L. S. Hillard, and R. W. Murphy. 2011. Polyandry and multiple paternities in the threatened Agassiz's desert tortoise, *Gopherus agassizii*. *Conservation Genetics* 12:1313–1322.
- DeFalco, L. A., D. R. Bryla, V. Smith-Longozo, and R. S. Nowak. 2003. Are Mojave Desert annual species equal? Resource acquisition and allocation for the invasive grass *Bromus madritensis subsp. rubens* (*Poaceae*) and two native species. *American Journal of Botany* 90:1045–1053.
- Denholm, P., M. Hand, J. Maddalena, and S. Ong. 2009. Land-use requirements of modern wind power plants in the United States. National Renewable Energy Laboratory.
- Dickson, B. G., R. D. Scherer, A. M. Kissel, B. P. Wallace, K. M. Langin, M. E. Gray, A. F. Scheib, and B. Weise. 2019. Multiyear monitoring of survival following mitigation-driven translocation of a long-lived threatened reptile. *Conservation Biology* 33:1094–1105.
- Drake, K. K., L. Bowen, K. E. Nussear, T. C. Esque, A. J. Berger, N. A. Custer, S. C. Waters, J. D. Johnson, A. K. Miles, and R. L. Lewison. 2016. Negative impacts of invasive plants on conservation of sensitive desert wildlife. *Ecosphere* 7.
- Drake, K. K., T. C. Esque, K. E. Nussear, L. A. Defalco, S. J. Scoles-Sciulla, A. T. Modlin, and P. A. Medica. 2015. Desert tortoise use of burned habitat in the Eastern Mojave desert. *Journal of Wildlife Management* 79:618–629.
- Drake, K. K., K. E. Nussear, T. C. Esque, A. M. Barber, K. M. Vittum, P. A. Medica, C. R. Tracy, and K. W. Hunter. 2012. Does translocation influence physiological stress in the desert tortoise? *Animal Conservation* 15:560–570.

- Duda, J., A. Krzysik, and J. Freilich. 1999. Effects of drought on Desert Tortoise movement and activity. *Journal of Wildlife Management* 63:1181–1192.
- Edwards, T., K. H. Berry, R. D. Inman, T. C. Esque, K. E. Nussear, C. A. Jones, and M. Culver. 2015. Testing taxon tenacity of tortoises: Evidence for a geographical selection gradient at a secondary contact zone. *Ecology and Evolution* 5:2095–2114.
- Edwards, T., A. E. Karl, M. Vaughn, P. C. Rosen, C. M. Torres, and R. W. Murphy. 2016. The desert tortoise trichotomy: Mexico hosts a third, new sister-species of tortoise in the *Gopherus morafkai*–*G. agassizii* group. *ZooKeys* 2016:131–158.
- Emblidge, P. G., K. E. Nussear, T. C. Esque, C. M. Aiello, and A. D. Walde. 2015. Severe mortality of a population of threatened Agassiz’s desert tortoises: The American badger as a potential predator. *Endangered Species Research* 28:109–116.
- Ennen, Joshua R., J. E. Lovich, K. P. Meyer, C. Bjurlin, and T. R. Arundel. 2012. Nesting ecology of a population of *Gopherus agassizii* at a utility-scale wind energy facility in Southern California. *Copeia* 2012:222–228.
- Ennen, Josh R., K. Meyer, and J. Lovich. 2012. Female Agassiz’s desert tortoise activity at a wind energy facility in southern California: The influence of an El Niño event. *Natural Science* 04:30–37.
- Ernst, C. H., and J. E. Lovich. 1994. *Turtles of the United States and Canada*. John Hopkins University Press.
- Esque, T. C., K. E. Nussear, K. K. Drake, A. D. Walde, K. H. Berry, R. C. Averill-Murray, A. P. Woodman, W. I. Boarman, P. A. Medica, J. Mack, and J. S. Heaton. 2010. Effects of subsidized predators, resource variability, and human population density on desert tortoise populations in the Mojave Desert, USA. *Endangered Species Research* 12:167–177.
- Esque, T. C., C. R. Schwalbe, L. A. Defalco, R. B. Duncan, and T. J. Hughes. 2003. Effects of desert wildfires on desert tortoise (*Gopherus agassizii*) and other small vertebrates. *Southwestern Naturalist* 48:103–111.
- Faber-Langendoen, D., J. Nichols, L. Master, K. Snow, A. Tomaino, R. Bittman, G. Hammerson, B. Heidel, L. Ramsay, A. Teucher, and B. Young. 2012. NatureServe conservation status assessments: methodology for assigning ranks. NatureServe, Arlington, VA.
- Farnsworth, M. L., B. G. Dickson, L. J. Zachmann, E. E. Hegeman, A. R. Cangelosi, T. G. Jackson, and A. F. Scheib. 2015. Short-term space-use patterns of translocated Mojave desert tortoise in southern California. *PLoS ONE* 10:1–18.
- Field, K. J., C. R. Tracy, P. A. Medica, R. W. Marlow, and P. S. Corn. 2007. Return to the wild: Translocation as a tool in conservation of the Desert Tortoise (*Gopherus agassizii*). *Biological Conservation* 136:232–245.

- Foster, A. L., K. H. Berry, E. R. Jacobson, and J. J. Rytuba. 2009. Arsenic species in scute (shell plate) and lung tissues of desert tortoises. American Geophysical Union, Fall Meeting 2009.
- Frankham, R. 1995. Effective population size/adult population size ratios in wildlife: A review. *Genetics Research* 89:491–503.
- Frazer, N. B. 1992. Sea Turtle Conservation and Halfway Technology. *Conservation Biology* 6:179–184.
- Freilich, J. E., K. P. Burnham, C. M. Collins, and C. A. Garry. 2000. Factors affecting population assessments of desert tortoises. *Conservation Biology* 14:1479–1489.
- Germano, D. J., R. B. Bury, T. C. Esque, T. H. Fritts, and P. A. Medica. 1994. Range and habitats of the desert tortoise. Pages 73–84 in R. Bruce Bury and D. J. Germano, editors. *Biology of North American Tortoises*. Volume 13. National Biological Survey, Fish and Wildlife Research 13, Washington D.C.
- Germano, J. M., K. J. Field, R. A. Griffiths, S. Clulow, J. Foster, G. Harding, and R. R. Swaisgood. 2015. Mitigation-driven translocations: Are we moving wildlife in the right direction? *Frontiers in Ecology and the Environment* 13:100–105.
- Germano, J., V. E. van Zerr, T. C. Esque, K. E. Nussear, and N. Lamberski. 2014. Impacts of upper respiratory tract disease on olfactory behavior of the Mojave desert tortoise. *Journal of Wildlife Diseases* 50:354–358.
- Grandmaison, D. D., and V. J. Frary. 2012. Estimating the probability of illegal desert tortoise collection in the Sonoran Desert. *Journal of Wildlife Management* 76:262–268.
- Hagerty, B. E., and C. R. Tracy. 2010. Defining population structure for the Mojave desert tortoise. *Conservation Genetics* 11:1795–1807.
- Hammerson, G.A., D. Schweitzer, L. Master, and J. Cordeiro. 2008. Ranking species occurrences - a generic approach. NatureServe.
- Harju, S. M., P. S. Coates, S. J. Dettenmaier, J. B. Dinkins, P. J. Jackson, and M. P. Chenaille. 2021. Estimating trends of common raven populations in North America, 1966–2018. *Human-Wildlife Interactions* 15:248–269.
- Harless, M. L., A. D. Walde, D. K. Delaney, L. L. Pater, and W. K. Hayes. 2009. Home range, spatial overlap, and burrow use of the desert tortoise in the West Mojave desert. *Copeia* 378–389.
- Hazard, L. C., D. R. Shemanski, and K. A. Nagy. 2009. Nutritional quality of natural foods of juvenile desert tortoises (*Gopherus agassizii*): Energy, nitrogen, and fiber digestibility. *Journal of Herpetology* 43:38–48.

- Hegeman, E. E., B. G. Dickson, and L. J. Zachmann. 2014. Probabilistic models of fire occurrence across National Park Service units within the Mojave Desert Network, USA. *Landscape Ecology* 29:1587–1600.
- Henen, B. T. 2002. Reproductive effort and reproductive nutrition of female desert tortoises: Essential field methods. *Integrative and Comparative Biology* 42:43–50.
- Hinderle, D., R. L. Lewison, A. D. Walde, D. Deutschman, and W. I. Boarman. 2015. The effects of homing and movement behaviors on translocation: Desert tortoises in the western Mojave Desert. *Journal of Wildlife Management* 79:137–147.
- Holcomb, K. L. 2022a. Status Review of the Mojave Desert Tortoise (2012-2022). Desert Tortoise Management Oversight Group Meeting October 11, 2022.
- Holcomb, K. L. 2022b. Fall 2022 Raven Management Update. Desert Tortoise Management Oversight Group Meeting October 11, 2022.
- Holcomb, K. L., P. S. Coates, B. S. Prochazka, T. Shields, and I. Boarman, William. 2021. A desert tortoise – common raven viable conflict threshold. *Human–Wildlife Interactions* 15:405–421.
- Homer, B. L., C. Li, K. H. Berry, N. D. Denslow, E. R. Jacobson, R. H. Sawyer, and J. E. Williams. 2001. Soluble scute proteins of healthy and ill desert tortoises (*Gopherus agassizii*). *American Journal of Veterinary Research* 62:104–110.
- Hopkins, Francesca. 2018. Inland Deserts Summary Report. California’s Fourth Climate Change Assessment.
- Hughson, D. L., and N. Darby. 2013. Desert tortoise road mortality in Mojave National Preserve, California. *California Fish and Game* 99:222–232.
- Hungerford, H. R., and T. L. Volk. 1990. Changing learner behavior through environmental education. *Journal of Environmental Education* 21:8–21.
- Iknayan, K. J., and S. R. Beissinger. 2018. Collapse of a desert bird community over the past century driven by climate change. *Proceedings of the National Academy of Sciences of the United States of America* 115:8597–8602.
- Jacobson, E. R., M. B. Brown, I. M. Schumacher, B. R. Collins, R. K. Harris, and P. A. Klein. 1995. *Mycoplasmosis* and the desert tortoise (*Gopherus agassizii*) in Las Vegas Valley, Nevada. *Chelonian Conservation and Biology* 1:279–284.
- Jacobson, E. R., M. B. Brown, L. D. Wendland, D. R. Brown, P. A. Klein, M. M. Christopher, and K. H. Berry. 2014. *Mycoplasmosis* and upper respiratory tract disease of tortoises: A review and update. *Veterinary Journal* 201:257–264.

- Jacobson, E. R., C. H. Gardiner, M. B. Brown, H. P. Adams, J. M. Gaskin, J. L. Lapointe, R. K. Harris, and C. Reggiardo. 1991. Chronic upper respiratory tract disease of free-ranging desert tortoises (*Xerobates agassizii*). *Journal of Wildlife Diseases* 27.
- Jacobson, E. R., T. J. Wronski, J. Schumacher, C. Reggiardo, and K. H. Berry. 1994. Cutaneous Dyskeratosis in free-ranging desert tortoises, *Gopherus agassizii*, in the Colorado Desert of southern California. *Journal of Zoo and Wildlife Medicine* 25:68–81.
- Jennings, W. B., and K. H. Berry. 2015. Desert tortoises (*Gopherus agassizii*) are selective herbivores that track the flowering phenology of their preferred food plants. *PLoS ONE* 10.
- Johnson, A. J., A. P. Pessier, J. F. X. Wellehan, R. Brown, and E. R. Jacobson. 2005. Identification of a novel herpesvirus from a California desert tortoise (*Gopherus agassizii*). *Veterinary Microbiology* 111:107–116.
- Keehn, J. E., and C. R. Feldman. 2018. Disturbance affects biotic community composition at desert wind farms. *Wildlife Research* 45:383–396.
- Keevil, M. G., R. J. Brooks, and J. D. Litzgus. 2018. Post-catastrophe patterns of abundance and survival reveal no evidence of population recovery in a long-lived animal. *Ecosphere* 9.
- Kristan, W. B., and W. I. Boarman. 2007. Effects of anthropogenic developments on common Raven nesting biology in the west Mojave Desert. *Ecological Applications* 17:1703–1713.
- Lovich, J., M. Agha, J. R. Ennen, T. R. Arundel, and M. Austin. 2018. Agassiz's desert tortoise (*Gopherus agassizii*) activity areas are little changed after wind turbine-induced fires in California. *International Journal of Wildland Fire* 27:851–856.
- Lovich, J. E., and D. Bainbridge. 1999. Anthropogenic degradation of the southern California desert ecosystem and prospects for natural recovery and restoration. *Environmental Management* 24:309–326.
- Lovich, J. E., T. Edwards, K. H. Berry, S. R. Puffer, K. L. Cummings, J. R. Ennen, M. Agha, R. Woodard, K. D. Brundige, and R. W. Murphy. 2020. Refining genetic boundaries for Agassiz's desert tortoise (*Gopherus agassizii*) in the western Sonoran Desert: The influence of the Coachella Valley on gene flow among populations in southern California. *Frontiers of Biogeography* 12:0–14.
- Lovich, J. E., and J. R. Ennen. 2011. Wildlife conservation and solar energy development in the desert southwest. *BioScience* 61.
- Lovich, J. E., and J. R. Ennen. 2013. Assessing the state of knowledge of utility-scale wind energy development and operation on non-volant terrestrial and marine wildlife. *Applied Energy* 103:52–60.

- Lovich, J. E., J. R. Ennen, M. Agha, and J. Whitfield Gibbons. 2018. Where have all the turtles gone, and why does it matter? *BioScience* 68:771–781.
- Lovich, J. E., J. R. Ennen, S. Madrak, and B. Grover. 2011. Turtles and culverts, and alternative energy development: An unreported but potentially significant mortality threat to the desert tortoise (*Gopherus agassizii*). *Chelonian Conservation and Biology* 10:124–129.
- Lovich, J. E., C. B. Yackulic, J. Freilich, M. Agha, M. Austin, K. P. Meyer, T. R. Arundel, J. Hansen, M. S. Vamstad, and S. A. Root. 2014. Climatic variation and tortoise survival: Has a desert species met its match? *Biological Conservation* 169:214–224.
- Lovich, J., J. Ennen, S. Madrak, K. Meyer, C. Loughran, C. Bjurlin, T. Arundel, W. Turner, C. Jones, and G. Groenendaal. 2011. Effects of wind energy production on growth, demography, and survivorship of a desert tortoise (*Gopherus agassizii*) population in southern California with. *Herpetological Conservation and Biology* 6:161–174.
- Lovich, J., S. Puffer, K. Cummings, T. Arundel, M. Vamstad, and K. Brundige. 2023. High female desert tortoise mortality in the western Sonoran Desert during California’s epic 2012-2016 drought. *Endangered Species Research* 50:1–16.
- Mack, J. S., and K. H. Berry. 2023. Drivers of survival of translocated tortoises. *Journal of Wildlife Management* 1–27.
- Mack, J. S., K. H. Berry, D. M. Miller, and A. S. Carlson. 2015. Factors affecting the thermal environment of Agassiz’s desert tortoise (*Gopherus agassizii*) cover sites in the central Mojave desert during periods of temperature extremes. *Journal of Herpetology* 49:405–414.
- Manning, J. A. 2018. Genetic origins and population status of desert tortoises in Anza-Borrego Desert State Park, California: Initial steps towards population monitoring. Borrego Springs, CA, USA.
- Marine Air Ground Task Force Training Command, and Center. 2018. Marine Corps Air Ground Combat Center Integrated Natural Resources Management Plan Fiscal Years 2018 through 2022.
- McAuliffe, J. R., and E. P. Hamerlynck. 2010. Perennial plant mortality in the Sonoran and Mojave deserts in response to severe, multi-year drought. *Journal of Arid Environments* 74:885–896.
- Medica, P. A., K. E. Nussear, T. C. Esque, and M. B. Saethre. 2012. Long-term growth of Desert Tortoises (*Gopherus agassizii*) in a southern Nevada population. *Journal of Herpetology* 46:213–220.
- Mitchell, C. I., D. A. Friend, L. T. Phillips, E. A. Hunter, J. E. Lovich, M. Agha, S. R. Puffer, K. L. Cummings, P. A. Medica, T. C. Esque, K. E. Nussear, and K. T. Shoemaker. 2021*a*.

- 'Unscrambling' the drivers of egg production in Agassiz's desert tortoise: climate and individual attributes predict reproductive output. *Endangered Species Research* 44:217–230.
- Mitchell, C. I., K. T. Shoemaker, T. C. Esque, A. G. Vandergast, S. J. Hromada, K. E. Dutcher, J. S. Heaton, and K. E. Nussear. 2021b. Integrating telemetry data at several scales with spatial capture–recapture to improve density estimates. *Ecosphere* 12.
- Mulder, K. P., A. D. Walde, W. I. Boarman, A. P. Woodman, E. K. Latch, and R. C. Fleischer. 2017. No paternal genetic integration in desert tortoises (*Gopherus agassizii*) following translocation into an existing population. *Biological Conservation* 210:318–324.
- Nafus, M. G., T. C. Esque, R. C. Averill-Murray, K. E. Nussear, and R. R. Swaisgood. 2017. Habitat drives dispersal and survival of translocated juvenile desert tortoises. *Journal of Applied Ecology* 54:430–438.
- Nagy, K. A., B. T. Henen, and D. B. Vyas. 1998. Nutritional quality of native and introduced food plants of wild desert tortoises. *Journal of Herpetology* 32:260–267.
- Nagy, K. A., S. Hillard, M. W. Tuma, and D. J. Morafka. 2015. Head-started desert tortoises (*Gopherus agassizii*): Movements, survivorship and mortality causes following their release. *Herpetological Conservation and Biology* 10:203–215.
- Nussear, K. E., C. R. Tracy, P. A. Medica, D. S. Wilson, R. W. Marlow, and P. S. Corn. 2012. Translocation as a conservation tool for Agassiz's desert tortoises: Survivorship, reproduction, and movements. *Journal of Wildlife Management* 76:1341–1353.
- O'Connor, M. P., L. C. Zimmerman, D. E. Ruby, S. J. Bulova, and J. R. Spotila. 1994. Home range size and movements by desert tortoises, *Gopherus agassizii*, in the eastern Mojave Desert. *Herpetological Monographs* 8:60–71.
- OEHHA. 2018. Indicators of Climate Change in California.
- Office of Governor Gavin Newsom. 2021. Governor Newsom Signs Historic Legislation to Boost California's Housing Supply and Fight the Housing Crisis | California Governor. <<https://www.gov.ca.gov/2021/09/16/governor-newsom-signs-historic-legislation-to-boost-californias-housing-supply-and-fight-the-housing-crisis/>>. Accessed 8 Feb 2023.
- Ong, S., C. Campbell, P. Denholm, R. Margolis, and G. Heath. 2013. Land-use requirements for solar power plants in the United States (No. NREL/TP-6A20-56290).
- Pascale, S., W. R. Boos, S. Bordoni, T. L. Delworth, S. B. Kapnick, H. Murakami, G. A. Vecchi, and W. Zhang. 2017. Weakening of the North American monsoon with global warming. *Nature Climate Change* 7:806–812.



- Peterson, C. C. 1996. Ecological energetics of the desert tortoise (*Gopherus agassizii*): Effects of rainfall and drought. *Ecology* 77:1831–1844.
- Prose, D. v, and H. G. Wilshire. 2000. The lasting effects of tank maneuvers on desert soils and intershrub flora. Open-File Report OF 00-512.  
<<http://pubs.er.usgs.gov/publication/ofr00512>>.
- Rostal, D. C., J. Grumbles, V. A. Lance, and J. R. Spotila. 2002. Chronology of Sex Determination in the Desert Tortoise (*Gopherus agassizii*). *Chelonian Conservation and Biology* 4:313–318.
- Sadoti, G., M. E. Gray, M. L. Farnsworth, and B. G. Dickson. 2017. Discriminating patterns and drivers of multiscale movement in herpetofauna: The dynamic and changing environment of the Mojave desert tortoise. *Ecology and Evolution* 7:7010–7022.
- Sánchez-Ramírez, S., Y. Rico, K. H. Berry, T. Edwards, A. E. Karl, B. T. Henen, and R. W. Murphy. 2018. Landscape limits gene flow and drives population structure in Agassiz’s desert tortoise (*Gopherus agassizii*). *Scientific Reports* 8.
- Sandmeier, F. C., C. R. Tracy, B. E. Hagerty, S. Dupré, H. Mohammadpour, and K. Hunter. 2013. Mycoplasmal upper respiratory tract disease across the range of the threatened Mojave Desert tortoise: Associations with thermal regime and natural antibodies. *EcoHealth* 10:63–71.
- SDZWA. 2018. Head-starting Program for California Desert Tortoises Begins.  
<[https://dof.ca.gov/forecasting/Demographics/](https://stories.sandiegozoo.org/2018/07/03/head-starting-program-for-california-desert-tortoises-begins/#:~:text=Radio tracking of more than 30 female tortoises,returned to the wild into their original territory.></a>>.</p><p>Shine, R. 2005. Life-history evolution in reptiles. <i>Annual Review of Ecology, Evolution, and Systematics</i> 36:23–46.</p><p>Shumway, G., L. Vredenburg, and R. Hartill. 1980. Desert Fever: An Overview of Mining History of the California Desert Conservation Area.</p><p>State of California Department of Finance. 2023. Demographics | Department of Finance.<br/><<a href=)>. Accessed 8 Feb 2023.
- Tagestad, J., M. Brooks, V. Cullinan, J. Downs, and R. McKinley. 2016. Precipitation regime classification for the Mojave Desert: Implications for fire occurrence. *Journal of Arid Environments* 124:388–397.
- Tracy, C. R., R. Averill-Murray, W. I. Boarman, D. Delehanty, J. Heaton, E. McCoy, D. Morafka, N. Nussear, B. Hagerty, and P. Medica. 2004. Desert tortoise recovery plan assessment. Desert Tortoise Recovery Plan Assessment Committee for the U.S. Fish and Wildlife Service.

- Tuberville, T. D. 2022. Progress Update, Desert Tortoise Management Oversight Group.
- Tuberville, T. D., K. A. Buhlmann, R. Sollmann, M. G. Nafus, J. M. Peaden, J. A. Daly, and B. D. Todd. 2019. Effects of short-term, outdoor head-starting on growth and survival in the Mojave desert tortoise (*Gopherus agassizii*). *Herpetological Conservation and Biology* 14:171–184.
- Turner, F. B., P. Hayden, B. L. Burge, and J. B. Roberson. 1986. Egg production by the desert tortoise (*Gopherus agassizii*) in California. *Herpetologica* 42:93–104.
- Underwood, E. C., R. C. Klinger, and M. L. Brooks. 2019. Effects of invasive plants on fire regimes and postfire vegetation diversity in an arid ecosystem. *Ecology and Evolution* 9. <[www.ecolevol.org](http://www.ecolevol.org)>.
- USFWS. 1990. Endangered and threatened wildlife and plants; determination of threatened status for the Mojave population of the desert tortoise. *Federal Register* 55:12178-12191. Volume 55.
- USFWS. 1994. Desert Tortoise (Mojave population) Recovery Plan. Portland, Oregon.
- USFWS. 2006. Range-wide monitoring of the Mojave population of the Desert Tortoise: 2001-2005 summary report. Reno, Nevada, USA.
- USFWS. 2010. Mojave population of the desert tortoise (*Gopherus agassizii*): 5-year review: summary and evaluation. Reno, Nevada.
- USFWS. 2011. Revised Recovery Plan for the Mojave Population of the Desert Tortoise (*Gopherus agassizii*).
- USFWS. 2015. Range-Wide Monitoring of the Mojave Desert Tortoise (*Gopherus agassizii*): 2013 and 2014 Annual Reporting.
- USFWS. 2016. Range-wide Monitoring of the Mojave Desert tortoise (*Gopherus agassizii*): 2015 and 2016 Annual Reporting. Volume 10.
- USFWS. 2018. Range-Wide Monitoring of the Mojave Desert Tortoise (*Gopherus agassizii*): 2017 Annual Reporting.
- USFWS. 2019a. Status of the Desert Tortoise.
- USFWS. 2019b. Range-Wide Monitoring of the Mojave Desert Tortoise (*Gopherus agassizii*): 2018 Annual Reporting.
- USFWS. 2020a. Range-Wide Monitoring of the Mojave Desert Tortoise (*Gopherus agassizii*): 2019 Annual Reporting DRAFT.

- USFWS. 2020*b*. Translocation of Mojave Desert Tortoises from Project Sites: Plan Development Guidance.
- USFWS. 2022*a*. Mojave Desert Tortoise (*Gopherus agassizii*) 5-Year Review: Summary and Evaluation.
- USFWS. 2022*b*. Range-Wide Monitoring of the Mojave Desert Tortoise (*Gopherus agassizii*): 2020 Annual Reporting.
- USFWS. 2022*c*. Range-Wide Monitoring of the Mojave Desert Tortoise (*Gopherus agassizii*): 2021 Annual Reporting DRAFT.
- USFWS. 2022*d*. ESA Section 7 Consultation.
- VanDerWal, J., H. T. Murphy, A. S. Kutt, G. C. Perkins, B. L. Bateman, J. J. Perry, and A. E. Reside. 2013. Focus on poleward shifts in species' distribution underestimates the fingerprint of climate change. *Nature Climate Change* 3:239–243.
- Vaske, J. J., and M. P. Donnelly. 2007. Public Knowledge and Perceptions of the Desert Tortoise. (HDNRU Report No. 81). Report for the National Park Service.
- Webb, R. H., and S. S. Stielstra. 1979. Sheep grazing effects on Mojave Desert vegetation and soils. *Environmental Management* 3:517–529.
- Weeks, A. R., C. M. Sgro, A. G. Young, R. Frankham, N. J. Mitchell, K. A. Miller, M. Byrne, D. J. Coates, M. D. B. Eldridge, P. Sunnucks, M. F. Breed, E. A. James, and A. A. Hoffmann. 2011. Assessing the benefits and risks of translocations in changing environments: a genetic perspective. *Evolutionary Applications* 4:709–725.
- Williams, A. P., B. I. Cook, and J. E. Smerdon. 2022. Rapid intensification of the emerging southwestern North American megadrought in 2020–2021. *Nature Climate Change* 12:232–234.
- Wolf, A., N. B. Zimmerman, W. R. L. Anderegg, P. E. Busby, and J. Christensen. 2016. Altitudinal shifts of the native and introduced flora of California in the context of 20th-century warming. *Global Ecology and Biogeography* 25:418–429.
- Woodbury, A. M., and R. Hardy. 1948. Studies of the Desert Tortoise, *Gopherus agassizii*. *Ecological Monographs* 18:145–200.
- Zimmerman, L. C., M. P. O. Connor, S. J. Bulova, J. R. Spotila, S. J. Kemp, and C. J. Salice. 1994. Thermal ecology of desert tortoises in the eastern Mojave Desert: seasonal patterns of operative and body temperatures, and microhabitat utilization. *Herpetological Monographs* 8:45–59.

Zylstra, E. R., L. J. Allison, R. C. Averill-Murray, V. Landau, N. S. Pope, and R. J. Steidl. 2023. A spatially explicit model for density that accounts for availability: a case study with Mojave desert tortoises. *Ecosphere* 14:1–18

## APPENDIX A. TABLE OF ESTIMATED DENSITIES 2004–2021

**Table A1.** Estimated densities (adults/km<sup>2</sup>) of tortoises (≥ 180 mm carapace length) in Tortoise Conservation Areas in California. Estimates for 2004–2014 have standard errors (SE); estimates for 2015–2021 have coefficients of variation expressed as percentages. Data from (USFWS 2006, 2015, 2016, 2018, 2019b 2022a,b, Allison and McLuckie 2018).

Recovery Unit	TCA	2004	2005	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Western Mojave	Fremont-Kramer	8.4 (2.31)	5.3 (1.28)	3.0 (1.46)	0.5 (0.51)	3.3 (1.13)	2.4 (0.60)	3.5 (1.11)	2.2 (1.07)	NA	4.7 (1.05)	4.5 (28.0)	NA	4.1 (22.01)	NA	2.7 (24.0)	1.7 (27.6)	NA
	Ord-Rodman	7.3 (2.25)	7.7 (1.80)	7.1 (3.26)	5.0 (5.34)	7.2 (2.65)	7.5 (1.85)	3.2 (1.18)	4.6 (2.14)	NA	3.5 (0.88)	NA	NA	3.9* (19.84)	3.4* (30.79)	2.5* (20.33)	NA	2.5* (24.3)
Western Mojave	Superior-Cronese	6.3 (1.84)	6.3 (1.32)	5.9 (2.28)	1.9 (1.19)	4.6 (1.12)	2.6 (0.49)	3.4 (0.79)	4.3 (1.41)	NA	2.5 (0.60)	2.6 (26.7)	3.6 (26.3)	1.7 (23.76)	NA	1.9 (23.7)	NA	NA
Eastern Mojave	Ivanpah	4.4 (1.19)	4.4 (2.46)	5.6 (1.95)	5.1 (2.92)	4.1 (1.86)	1.0 (0.48)	4.5 (1.72)	2.8 (1.79)	NA	2.3 <sup>α</sup>	1.9 (24.3)	NA	NA	3.7 (23.62)	2.6 (24.9)	NA	3.0 (24.5)
Colorado Desert	Chocolate Mountain	11.4 (3.55)	13.4 (4.31)	6.5 (1.50)	4.5 (2.56)	7.5 (2.74)	13.8 (3.52)		6.0 (1.84)	7.3 (1.96)	8.4 (2.09)	10.3 (21.1)	8.5 (20.7)	9.4 (14.8)	7.6 (32.46)	7.0 (29.51)	7.1 (22.1)	3.9 (31.8)
Colorado Desert	Chuckwalla	4.9 (1.49)	6.0 (1.77)	4.3 (1.19)	4.2 (2.84)	NA	3.7 (1.14)	3.9 (1.37)	3.9 (1.62)	NA	3.3 <sup>α</sup>	NA	NA	4.3 (15.7)	NA	1.8 (28.8)	4.6 (19.4)	2.6 (24.0)
Colorado Desert	Chemehuevi	6.7 (1.27)	10.3 (3.10)	3.9 (1.71)	4.8 (3.07)	9.4 (5.98)	4.2 (1.40)	4.0 (1.51)	0.8 (0.90)	NA	2.8 <sup>α</sup>	NA	1.7 (30.6)	NA	2.9 (24.21)	NA	4.0 (15.2)	NA
Colorado Desert	Fenner	8.2 (1.94)	13.5 (2.80)	6.2 (2.37)	6.6 (3.05)	8.3 (4.01)	6.9 (2.49)	6.8 (2.78)	0.9 (0.95)	NA	4.8 <sup>α</sup>	NA	5.5 (30.0)	NA	6.0 (26.25)	2.8 (29.8)	NA	5.3 (19.8)
Colorado Desert	Pinto Mountains	2.2 (2.12)	9.9 (3.58)	1.9 (0.98)	3.3 (3.53)	4.3 (2.38)	3.4 (1.85)	3.3 (1.39)	3.7 (1.57)	NA	2.4 <sup>α</sup>	NA	2.1 (31.6)	2.3 (32.7)	NA	1.7 (31.8)	2.9 (20.6)	NA
Colorado Desert	Joshua Tree	1.9 (0.53)	2.7 (0.79)	3.0 (1.94)	2.3 (1.75)	2.3 (1.56)	2.8 (1.56)	3.5 (1.33)	3.4 (1.63)	NA	3.7 <sup>α</sup>	NA	2.6 (34.7)	3.6 (22.5)	NA	3.1 (20.2)	3.9 (23.3)	NA

\*724 adults were translocated into the Ord-Rodman TCA in 2017–2019 due to expansion at Twentynine Palms Marine Corps Air Gunnery Command Center. These are included in these density estimates. In 2014, the density estimates for the Western Mojave TCAs and Chocolate Mountain are estimated from line distance sampling (Allison and McLuckie 2018).

<sup>α</sup>= Estimates from Ivanpah and the Colorado Desert TCAs (excluding Chocolate Mountain) in 2014 are not based on line distance sampling in that year; they are mean densities based on trend data from previous years (USFWS 2022a)

## **APPENDIX B. PUBLIC NOTIFICATIONS**

Pursuant to Fish and Game Code 2074.4, the California Department of Fish and Wildlife (Department) and the California Fish and Game Commission (Commission) notified affected and interested parties and solicited data and comments on the petitioned action to list Mojave Desert Tortoise as endangered under the California Endangered Species Act (CESA). Requests for information were distributed by several methods:

- On October 19, 2020, the Commission published a Notice of Findings regarding the candidacy and status review of the Mojave Desert Tortoise in the California Regulatory Notice Register (Cal. Reg. Notice Register 2020, No. 44-Z, p. 1445).
- On May 27, 2022, the Department distributed by email and mail the attached public notice to approximately 130 people and offices of state and federal agencies, industry, and non-governmental organizations, notifying them of the Mojave Desert Tortoise's candidacy and to request information and comments on the petitioned action.
- On May 10, 2022, the Department distributed the attached press release to an email listserv maintained by the Department's Office of Communication, Education and Outreach, and posted the press release to the Department's News Room website, notifying the public of the Mojave Desert Tortoise's candidacy and to request information and comments on the petitioned action.

## Public Notice

May 27, 2022

SUBJECT: NOTIFICATION OF STATUS REVIEW FOR MOJAVE DESERT TORTOISE UNDER THE CALIFORNIA ENDANGERED SPECIES ACT

To Whom It May Concern:

The California Department of Fish and Wildlife (Department) has initiated a status review for the Mojave desert tortoise (*Gopherus agassizii*), pursuant to Fish and Game Code section 2074.6, and is providing this notice pursuant to Fish and Game Code section 2074.4 to solicit data and comments on the petitioned action from interested and affected parties.

The Department has initiated this status review following the Fish and Game Commission's (Commission) decision at its October 14, 2020 meeting to accept for consideration the petition to up-list the species from threatened to endangered under the California Endangered Species Act (CESA). Having provided public notice (Cal. Reg. Notice Reg. 2020, No. 44-Z, p. 1445; Fish & G. Code, § 2074.2), the Mojave desert tortoise is a candidate species under CESA, and as such, retains the same legal protection afforded to an endangered or threatened species (Fish & G. Code, §§ 2074.2 & 2085). The listing petition and the Department's petition evaluation report are available at: <https://fgc.ca.gov/CESA#adt>

Take (hunt, pursue, catch, capture, or kill, or attempt to do so) of the Mojave desert tortoise remains prohibited (Fish & Game Code § 86). However, Incidental Take may be authorized with appropriate permits (Fish & G. Code §§ 2081(b), 2080.1, 2089.2 et. seq., 2086). Activities conducted for scientific, educational, or management purposes including research and restoration, which may result in take of this species, can be authorized through permits or memorandums of understanding (Fish & G. Code § 2081(a)). For more information on take authorizations, visit <https://wildlife.ca.gov/Conservation/CESA/Permitting> or contact your regional Department office.

The Department requests any data or comments on the species' ecology, genetics, life history, distribution, abundance, habitat, the degree and immediacy of threats to its reproduction or survival, the adequacy of existing management, and recommendations for management of the species. Please provide such data or comments to the Department contact via email:

[Anne.Hilborn@wildlife.ca.gov](mailto:Anne.Hilborn@wildlife.ca.gov), and include "Mojave desert tortoise" in the subject line.

Comments may also be submitted by mail addressed to "Attn: Anne Hilborn" at the address in the letterhead.

The Department has 12 months to review the petition, evaluate the available information, and report back to the Commission whether the petitioned action is warranted (Fish & G. Code, § 2074.6). The written report will indicate, based on the best scientific information available, whether the Department concludes the petitioned action is warranted or not warranted. The Commission will place receipt of the report on the agenda for the next available Commission meeting after delivery. The report will be made available to the public at that meeting. Following receipt of the Department's report, the Commission will allow a 30-day public comment period prior to taking any action on the Department's recommendation.

The Department respectfully requests your responses and information before **June 25th, 2022**, to allow sufficient time to evaluate the information for possible incorporation in the Department's final status review report to the Commission.

If you have any questions regarding this notice, please contact the Department via email at: [Anne.Hilborn@wildlife.ca.gov](mailto:Anne.Hilborn@wildlife.ca.gov).



## California Department of Fish and Wildlife News Release

May 10, 2022

### Media Contacts:

Anne Hilborn, CDFW Wildlife Branch

Kirsten Macintyre, Office of Communications, Education and Outreach

### CDFW Seeks Public Comment Related to Mojave Desert Tortoise

The California Department of Fish and Wildlife (CDFW) is seeking public comment on a proposal to uplist the Mojave Desert Tortoise from threatened to endangered under the California Endangered Species Act (CESA).

The Mojave Desert Tortoise (*Gopherus agassizii*) is found in the Mojave Desert, the western Sonoran Desert and the southern Great Basin Desert. They spend much of the year underground in burrows to shelter from extreme temperatures. When they do emerge, they feed on native grasses. Their densities have declined drastically in many places in California in the past 20 years. Threats include habitat fragmentation, development in the desert including sustainable energy projects, increasing drought due to climate change, invasive grasses out-competing food items preferred by tortoise, disease, predation by coyotes and ravens, and human-caused mortality.

In March 2020, Defenders of Wildlife submitted a petition to the California Fish and Game Commission to formally uplist the Mojave Desert Tortoise as an endangered species under CESA. The Commission published findings of its decision to advance the species to candidacy on Oct. 14, 2020, triggering a period during which CDFW will conduct a status review to inform the Commission's decision on whether to uplist the species.

As part of the status review process, CDFW is soliciting public comment regarding the species' ecology, biology, life history, distribution, abundance, threats, and habitat that may be essential for the species, and any recommendations for management. Comments, data, and other information can be submitted by email to: [wildlifemgt@wildlife.ca.gov](mailto:wildlifemgt@wildlife.ca.gov). If submitting comments by email, please include "Mojave Desert Tortoise" in the subject heading.

Comments may also be submitted by surface mail to:

California Department of Fish and Wildlife  
Wildlife Diversity Program  
Attn: Anne Hilborn  
P.O. Box 944209  
Sacramento, CA 94244-2090

All comments received by June 10, 2022 will be evaluated prior to submission of the CDFW report to the Commission. Receipt of the report will be placed on the agenda for the next available meeting of the Commission after delivery and the report will be made available to the

public at that time. Following the receipt of the CDFW report, the Commission will allow a 30-day public comment period prior to taking any action on the petition.

CDFW's Mohave Desert Tortoise petition evaluation report can be found on the CDFW website.

### **Public Response**

The Department received 54 letters or emails from the public and 3 from NGOs/government agencies. Fifty four letters expressed or implied support for the listing of the Mojave Desert Tortoise under CESA. Three letters had no obvious stated stance.

The Department received 2 substantive comments. Information in the comments included previously published data on threats and population trends which has been addressed in the status review. One of the comments included unpublished location data that was not of a quality that could be included in the status review.

All communications are on file with the Department and can be provided on request by emailing [wildlifemgt@wildlife.ca.gov](mailto:wildlifemgt@wildlife.ca.gov).

## **APPENDIX C. TRIBAL NOTIFICATION**

In June of 2022 the Department mailed and emailed the following notifications (see below) to 85 members of Tribal governments whose ancestral lands overlap with the historic range of the Mojave Desert Tortoise.

The Xolon Salinan Tribe and the Yuhaaviatam of San Manuel Nation asked some clarifying questions which staff were able to answer.

The Fernand o Tataviam Band of Mission Indians reviewed the project and did not wish to engage in consultation.

The Rincon Band of Luise o Indians acknowledged the receipt of the notification and asked to be kept informed of findings and determinations following the review.

## Notification for Federally Listed Tribes

June 1, 2022

### NOTIFICATION OF STATUS REVIEW FOR MOJAVE DESERT TORTOISE UNDER THE CALIFORNIA ENDANGERED SPECIES ACT

Dear Honorable Member:

**NOTICE IS HEREBY GIVEN** that the California Department of Fish and Wildlife (Department) has initiated a status review for Mojave desert tortoise (*Gopherus agassizii*) pursuant to Fish and Game Code section 2074.6. The Department is providing this notice pursuant to Fish and Game Code section 2074.4, and the Department's Tribal Communication and Consultation Policy, to solicit data and comments on the petitioned action from interested and affected parties and to notify California Tribes of this process and to offer government-to-government consultation if desired by a Tribe.

The Department has initiated this status review following related action by the Fish and Game Commission. Having provided public notice (Cal. Reg. Notice Reg. 2020, No. 44-Z, p. 1445; Fish & Game Code, § 2074.2), the Mojave desert tortoise is a candidate species under the California Endangered Species Act (CESA) and as such, retains the same legal protection afforded to an endangered or threatened species (Fish & Game Code §§ 2074.2 and 2085). The listing petition and the Department's petition evaluation report are available at: <https://fgc.ca.gov/CESA#adt>

The Department welcomes direct communication and consultation to discuss the status review for Mojave desert tortoise and to identify any impacts to Tribal interests or cultural resources. The Department is committed to open communication with your Tribe under its Tribal Communication and Consultation Policy, which is available through the Department's Tribal Affairs webpage at: <https://www.wildlife.ca.gov/General-Counsel/Tribal-Affairs>.

To request formal government-to-government consultation pursuant to the Department's Tribal Communication and Consultation Policy, please contact the Department's Tribal Liaison by email at [tribal.liaison@wildlife.ca.gov](mailto:tribal.liaison@wildlife.ca.gov). Please designate and provide contact information for the appropriate Tribal lead person.

In addition to notifying the Department of any impacts to tribal interests or cultural resources, the Department welcomes any data or comments on the species' ecology, genetics, life history, distribution, abundance, habitat, the degree and immediacy of threats to its reproduction or survival, the adequacy of existing management, and recommendations for management of the species. Please provide such data or comments to the Department contact via email [wildlifemgt@wildlife.ca.gov](mailto:wildlifemgt@wildlife.ca.gov) and include "Desert Tortoise" in the subject line. Comments may also be submitted by mail addressed to "Attn: Anne Hilborn at the address in the letterhead.

The Department has 12 months to review the petition, evaluate the available information, and report back to the Commission whether the petitioned action is warranted (Fish & Game Code, § 2074.6). The written report will indicate, based on the best scientific information available, whether the Department concludes the petitioned action is warranted or not warranted. The Commission will place receipt of the report on the agenda for the next available Commission meeting after delivery. The report will be made available to the public at that meeting. Following receipt of the Department's report, the Commission will allow a 30-day public comment period prior to taking any action on the Department's recommendation.

The Department respectfully requests your responses and information before June 30th, 2022, to allow sufficient time to evaluate the information for possible incorporation in the Department's final status review report to the Commission. If you would like more information on the status review, please contact Anne Hilborn, Senior Environmental Scientist (Specialist) at [anne.hilborn@wildlife.ca.gov](mailto:anne.hilborn@wildlife.ca.gov) or at the address in the letterhead.

We look forward to your response and input on this status review.

Sincerely,

Scott Gardner, Wildlife Branch Chief

ec: California Department of Fish and Wildlife

Chad Dibble, Deputy Director, Wildlife and Fisheries Division,

Tribal Liaison

Christine Found-Jackson, Acting Environmental Program Manager, Wildlife Diversity Program

Anne Hilborn, Senior Environmental Scientist (Specialist), Wildlife Diversity Program

## Notification for Non-Federally Listed Tribes

June 1, 2022

### NOTIFICATION OF STATUS REVIEW FOR MOJAVE DESERT TORTOISE UNDER THE CALIFORNIA ENDANGERED SPECIES ACT

Dear Honorable Member:

**NOTICE IS HEREBY GIVEN** that the California Department of Fish and Wildlife (Department) has initiated a status review for Mojave desert tortoise (*Gopherus agassizii*) pursuant to Fish and Game Code section 2074.6. The Department is providing this notice pursuant to Fish and Game Code section 2074.4, and the Department's Tribal Communication and Consultation Policy, to solicit data and comments on the petitioned action from interested and affected parties and to notify California Tribes of this process and to offer consultation if desired by a Tribe.

The Department has initiated this status review following related action by the Fish and Game Commission. Having provided public notice (Cal. Reg. Notice Reg. 2020, No. 44-Z, p. 1445; Fish & Game Code, § 2074.2), the Mojave desert tortoise is a candidate species under the California Endangered Species Act (CESA) and as such, retains the same legal protection afforded to an endangered or threatened species (Fish & Game Code §§ 2074.2 and 2085). The listing petition and the Department's petition evaluation report are available at: <https://fgc.ca.gov/CESA#adt>

The Department welcomes direct communication and consultation to discuss the status review for Mojave desert tortoise and to identify any impacts to Tribal interests or cultural resources. The Department is committed to open communication with your Tribe under its Tribal Communication and Consultation Policy, which is available through the Department's Tribal Affairs webpage at: <https://www.wildlife.ca.gov/General-Counsel/Tribal-Affairs>.

To request formal consultation pursuant to the Department's Tribal Communication and Consultation Policy, please contact the Department's Tribal Liaison by email at [tribal.liaison@wildlife.ca.gov](mailto:tribal.liaison@wildlife.ca.gov). Please designate and provide contact information for the appropriate Tribal lead person.

In addition to notifying the Department of any impacts to tribal interests or cultural resources, the Department welcomes any data or comments on the species' ecology, genetics, life history, distribution, abundance, habitat, the degree and immediacy of threats to its reproduction or survival, the adequacy of existing management, and recommendations for management of the species. Please provide such data or comments to the Department contact via email [wildlifemgt@wildlife.ca.gov](mailto:wildlifemgt@wildlife.ca.gov) and include "Desert Tortoise" in the subject line. Comments may also be submitted by mail addressed to "Attn: Anne Hilborn at the address in the letterhead.

The Department has 12 months to review the petition, evaluate the available information, and report back to the Commission whether the petitioned action is warranted (Fish & Game Code,

§ 2074.6). The written report will indicate, based on the best scientific information available, whether the Department concludes the petitioned action is warranted or not warranted. The Commission will place receipt of the report on the agenda for the next available Commission meeting after delivery. The report will be made available to the public at that meeting. Following receipt of the Department's report, the Commission will allow a 30-day public comment period prior to taking any action on the Department's recommendation.

The Department respectfully requests your responses and information before June 30th, 2022, to allow sufficient time to evaluate the information for possible incorporation in the Department's final status review report to the Commission. If you would like more information on the status review, please contact Anne Hilborn, Senior Environmental Scientist (Specialist) at [anne.hilborn@wildlife.ca.gov](mailto:anne.hilborn@wildlife.ca.gov) or at the address in the letterhead.

We look forward to your response and input on this status review.

Sincerely,

Scott Gardner, Wildlife Branch Chief

cc: California Department of Fish and Wildlife

Chad Dibble, Deputy Director, Wildlife and Fisheries Division

Tribal Liaison

Christine Found-Jackson, Acting Environmental Program Manager, Wildlife Diversity Program

Anne Hilborn, Senior Environmental Scientist (Specialist), Wildlife Diversity Program

**APPENDIX D. COMMENTS FROM PEER REVIEWERS ON THE MOJAVE DESERT TORTOISE STATUS REVIEW**

Pursuant to Fish and Game Code section 2074.6, the review process included independent and competent peer review of the draft status review by persons in the scientific/academic community acknowledged to be experts on Mojave Desert Tortoise and related topics, and possessing the knowledge and expertise to critique the scientific validity of the status review contents. Appendix D contains the specific comments provided to the Department by the individual peer reviewers, the Department’s written response to the comments, and any amendments made to the status review (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2)). Independent experts that reviewed the status review are listed in Table D1, below.

**Table D1. Status Review Peer Reviewers**

Name	Affiliation
Jeffery Lovich	USGS
Kristina Drake, Kerry Holcomb, Corey Mitchell	USFWS Desert Tortoise Recovery Office
Kenneth Nussear	University of Nevada, Reno

**Comments by external reviewers and response from the Department. Line numbers refer to lines in the version of the status review sent to external reviewers (available at end of this appendix)**

GENERAL COMMENT (Lovich): This is a very thorough and well-written review but there is a lot more literature available and I will point some out. The desert tortoise is one of the most-studied turtle in the United States (Lovich, J.E., and J.R. Ennen. 2013. A quantitative analysis of the state of knowledge of turtles of the United States and Canada. *Amphibia-Reptilia* 34:11-23.). Particularly surprising was finding no citation for Ernst and Lovich. 2009. *Turtles of the United States and Canada*. Johns Hopkins University Press. 827 pp. That book summarizes more data and publications on desert tortoises that are not included in this report. Based on the available scientific information presented, the CDFW makes a compelling case for listing the tortoise as endangered in California. The weight of scientific evidence presented supports the contention that populations continue to decline since their listing as threatened decades ago. However, extinction would probably take a long time to occur given the number of tortoises that still exist, their longevity, and the availability of topographic refugia to respond to global warming as pointed out by Cam Barrows' publications.

RESPONSE: Have added citations for Ernst and Lovich 1994 version of the book, especially in section 2 on Biology. Note: As stated in section 1.2, the status review "is not intended to be an



exhaustive review of all published scientific literature on Mojave Desert Tortoise; rather it is intended to summarize key points relevant to the status of the species and address regulatory report requirements. "

GENERAL COMMENT (DTRT): Throughout the report, the referenced findings related to translocation/augmentation outcomes and associated literature for *G. agassizii* do not reflect the full body of available literature. Please review the document and include appropriate references and findings translocation outcomes. For example, publications such as Brand et al. 2016, Dickson et al. 2019, Drake et al. 2012, Esque et al. 2010, Farnsworth et al. 2015, Field et al. 2007, Harju et al. 2019, Hinderle et al. 2015, Nafus et al. 2017, Nussear et al. 2012, Mack and Berry 2023 should all be considered cumulatively. Additionally, all most no information is available on the long-term effects of translocation. Only one published paper reports outcomes for translocated tortoises for 10 years (Mack and Berry 2023), and this study did not include resident and control tortoise comparisons, excluding the ability to evaluate the efficacy of translocation. We need long-term studies (i.e., 15-25 yrs) with balanced designs (translocated, resident, and control tortoises) to evaluate translocation outcomes and its effectiveness as a conservation tool.

RESPONSE: Due to this and other feedback, the section on translocation was extensively altered. References were added (Brand et al. 2016, Dickson et al. 2019, Drake et al. 2012, Esque et al. 2010, Farnsworth et al. 2015, Field et al. 2007, Harju et al. 2019, Hinderle et al. 2015, Nafus et al. 2017, Nussear et al. 2012, Mack and Berry 2023), and specific statements about the efficacy of translocation were reworked.

GENERAL COMMENT (Nussear): Overall I agree with the assessment. Given that after more than 30 years of protection under both state and federal ESAs. While recovery planning efforts have been found to provide sound recommendations, difficulties in implementation and enforcement of implementations (e.g. maintaining closed roads and routes) have contributed toward continued habitat loss and degradation. With continued growth of urban areas and infrastructure, expansion of military training areas, expansive recreation, challenges of invasive species with respect to wildfire and nutrition, subsidization of key predators, and a changing climate the tortoise faces a challenging road to recovery, and indeed continues to decline in much of its range.

While the right decision for the species, this decision will no doubt draw scrutiny and contestation. Toward improving the factual evidence brought to bear, there are several areas where the literature cited could be improved as the attribution is either incorrect, or incomplete.

LINE 140 (DTRT)

Suggested edit: "his Status Review of the Mojave desert tortoise (*Gopherus agassizii*, tortoise; also known as Agassiz's desert tortoise)." Edit throughout document.

RESPONSE: The USFWS doesn't capitalize the full name, however the Department made the decision to fully capitalize Mojave Desert Tortoise.

LINE 144-158 (DTRT)

Suggested edit: The tortoise was designated a threatened species under CESA in 1989. On March 23, 2020, the Commission received a petition from Defenders of Wildlife, Desert Tortoise Council, and Desert Tortoise Preserve Committee to change the status of the tortoise

from threatened to endangered. On April 13, 2020, the Commission referred the Petition to the Department for evaluation pursuant to Fish and Game Code section 2073 and published a formal notice of receipt of the petition (Cal. Reg. Notice Register 2020, No. 18-Z, p. 693). At its meeting on August 20, 2020, the Commission received the Department's petition evaluation report. which was based on available information and recommended to the Commission that the petition be accepted. At its October 14, 2020, meeting, the Commission accepted the petition to change the status of the tortoise from threatened to endangered (Cal. Reg. Notice Register 2020, No. 44-Z, p. 1445). As a result, the Department was directed to complete this Status Review, which is a detailed evaluation of the current status of the tortoise and includes its recommendation regarding whether the tortoise's status should be changed from threatened to endangered.

RESPONSE: This section has been extensively reworked to get closer to statutory requirements  
LINE 169-177 (DTRT)

Suggested edit: In 2011, studies of tortoise genetics, morphometrics, and ecology led experts to conclude that the species complex formerly known as the "desert tortoise" in fact consists of two separate species—Mojave desert tortoise—and Sonoran desert tortoise (*G. morafkai*), (Murphy et al. 2011). Five years later, in 2016, the Sonoran desert tortoise was further split into two species – Sonoran desert tortoise and thornscrub tortoise (*G. evgoodei*) (Edwards et al. 2016). The Mojave Desert Tortoise, retains the binomial *G. agassizii*, and ranges contemporarily across the Mojave and Sonoran deserts of southeastern California, southern Nevada, and small areas of Arizona north of the Colorado River as well as southwestern Utah.

LINE 172 (DTRT)

Citation for recommendation above: Murphy, R.W., Berry, K.H., Edwards, T., Leviton, A.E., Lathrop, A. and Riedle, J.D., 2011. The dazed and confused identity of Agassiz's land tortoise, *Gopherus agassizii* (Testudines, Testudinidae) with the description of a new species, and its consequences for conservation. *ZooKeys*, (113), p.39.

RESPONSE: The executive summary acts as an abstract without references. The Murphy et al. 2011 reference is cited in section 2.1 on Taxonomy

LINE 172 (DTRT)

Citation for recommendation above: Edwards, T., Karl, A.E., Vaughn, M., Rosen, P.C., Torres, C.M. and Murphy, R.W., 2016. The desert tortoise trichotomy: Mexico hosts a third, new sister-species of tortoise in the *Gopherus morafkai*–*G. agassizii* group. *ZooKeys*, (562), p.131.

RESPONSE: The executive summary acts as an abstract without references. The Edwards et al. 2016 reference is cited in section 2.1 on Taxonomy.

RESPONSE: This paragraph has been deleted but in the taxonomy section (2.1) the text now reads "In 2011, studies of tortoise genetics, morphometrics, and ecology led experts to conclude that the species complex formerly known as "Desert Tortoise" in fact consists of two separate species—Mojave Desert Tortoise and Sonoran Desert Tortoise (*G. morafkai*). The Mojave Desert Tortoise, also known as Agassiz's Desert Tortoise, retains the binomial *G. agassizii*, and ranges currently across the Mojave and Sonoran deserts of southeastern California, southern Nevada, and small areas of Arizona and Utah north of the Colorado River as well as southwestern Utah..... More recent work by Edwards et al. (2016) separates Desert tortoises living in the thorn scrub and tropical deciduous forests of southern Mexico into another species *Gopherus evgoodei*."

LINE 180 (Lovich)

I was surprised that no papers by David Germano were cited. This line should cite GERMANO, D. J. 1994. Growth and age at maturity of North American tortoises in relation to regional climates. *Can. J. Zool.* 72:918-931. AND GERMANO, D. J. 1994. Comparative life histories of North American tortoises. National Biological Survey, Fish and Wildlife Research 13.

RESPONSE: The executive summary acts as an abstract without references.

LINE 180 (DTRT)

Recommended citation for line 180: Peterson, C.C., 1996. Anhomeostasis: seasonal water and solute relations in two populations of the desert tortoise (*Gopherus agassizii*) during chronic drought. *Physiological Zoology*, 69(6), pp.1324-1358.

RESPONSE: The executive summary acts as an abstract without references. Pederson et al. 1996 is cited in section 2.2 on Life History

LINE 180 (DTRT)

Recommended citation for line 180: Medica, P.A., Nussear, K.E., Esque, T.C. and Saethre, M.B., 2012. Long-term growth of desert tortoises (*Gopherus agassizii*) in a southern Nevada population. *Journal of Herpetology*, pp.213-220.

RESPONSE: The executive summary acts as an abstract without references. Medica et al. 2012 has been added to the relevant text in section 2.2 on Life History

LINE 180 (Lovich)

30 eggs per year is impossible. This claim is later associated with a citation by Berry and Murphy but they say that nowhere in the publication. Instead, someone assumed that if tortoises can have up to 10 eggs in a clutch and up to three clutches/year they can produce 30. The literature says annual egg production can be 16-18 eggs, about half the number given.

RESPONSE: Altered text to read "typically lay one or two clutches of eggs (about 6 eggs per clutch)"

LINE 181 (DTRT)

Recommended citation for line 181: Mitchell, C.I., Friend, D.A., Phillips, L.T., Hunter, E.A., Lovich, J.E., Agha, M., Puffer, S.R., Cummings, K.L., Medica, P.A., Esque, T.C. and Nussear, K.E., 2021. 'Unscrambling' the drivers of egg production in Agassiz's desert tortoise: climate and individual attributes predict reproductive output. *Endangered Species Research*, 44, pp.217-230.

RESPONSE: The executive summary acts as an abstract without references. Mitchell et al. 2021 is cited IN relevant text in section 2.2 on Life History.

LINE 182 (DTRT)

Recommended citation for line 182: Spotila, J.R., Zimmerman, L.C., Binckley, C.A., Grumbles, J.S., Rostal, D.C., List Jr, A., Beyer, E.C., Phillips, K.M. and Kemp, S.J., 1994. Effects of incubation conditions on sex determination, hatching success, and growth of hatchling desert tortoises, *Gopherus agassizii*. *Herpetological Monographs*, pp.103-116.

RESPONSE: The executive summary acts as an abstract without references. Rostal et al. 2002 is a reference for incubation temperatures in section 2.2

LINE 182 (DTRT)

Recommended citation for line 182: Bjurlin, C.D. and Bissonette, J.A., 2004. Survival during early life stages of the desert tortoise (*Gopherus agassizii*) in the south-central Mojave Desert. *Journal of Herpetology*, pp.527-535.

RESPONSE: The executive summary acts as an abstract without references. Bjurlin and Bissonette 2004 is cited on relevant text in section 2.2 on Life History

LINE 175 - 179 (DTRT)

Suggested edit: The Mojave Desert Tortoise is a long-lived, desert-dwelling reptile. Consequently, tortoises must use behavioral and physiological adaptations to avoid extreme body temperatures <15 to >35°C (<59 to >95°F Zimmermann et al. 1994) and dehydration (Peterson 1996), as well as budget stored energy (Henen 1997, Peterson 1996) They primarily regulate their temperature by using underground burrows where the air is cooler and higher in humidity than ~~the~~ outside air in summer and warmer in winter, which results in tortoises spending more than 90% of their lives underground (Zimmermann et al. 1994).

RESPONSE: Text has been altered to "The Mojave Desert Tortoise is a long-lived, desert-dwelling reptile that uses behavioral and physiological adaptations to avoid extreme temperatures and dehydration, and to budget stored energy. Mojave Desert Tortoises primarily regulate their temperature by using underground burrows where the air is cooler and higher in humidity in summer, and warmer in winter. They can spend more than 90% of their lives underground." The executive summary does not contain references.

LINE 180-184 (DTRT)

Suggested edit: Females become sexually mature at 12–20 (mean 18.8, Medica et al. 2012) years old and typically lay one or two clutches of eggs (~ 6 eggs per clutch) per year; however, some females have been document to oviposit more than two clutches (Mitchell et al. 2021). Tortoise nests are typically placed near the mouth or entrance to the burrow or within suitable soil (Ennen et al 2012). Nest predation is common, with 12-26% of nests generally destroyed by predators (Ennen et al. 2012, Bjurlin & Bissonette 2004). Reported incubation time in the wild varies from 67–104 days (Berry and Murphy 2019) and incubation temperatures determine the sex of the hatchlings, with hotter temperatures (>32.8°C) producing female-skewed clutches (Spotila et al. 1994).

RESPONSE: The executive summary acts as an abstract without references. Text has been altered to read "Females become sexually mature at 12–20 years old, typically lay one or two clutches of eggs (about 6 eggs per clutch) per year. Nest predation is common, with 12–47% of nests lost to predators annually. Reported incubation time in the wild varies from 67–104 days and incubation temperatures determine the sex of the hatchlings, with hotter temperatures producing female-skewed clutches." 47% is the depredation rate on nests in 1998 in Bjurlin & Bissonette 2004. Suggested references (Medica et al 2012, Mitchell et al. 2021, Ennen et al. 2012, Bjurlin & Bissonette 2004) have been added to the relevant text in section 2.2 on life history.

Line 185-190 (Nussear)

Your summation of dietary preferences given in lines 185 to 190 is inaccurate - we have published information indicating that they neither avoid plants with high potassium, nor exotics - although these can be detrimental to health. With respect to annual forage they are really more of a generalist"

RESPONSE: The information referred to has been deleted.

LINE 185-186 (DTRT)

Suggested edit: Tortoises selectively feed on annual forbs, annual and perennial grasses, and herbaceous perennial plants and will consume some cacti.

RESPONSE: Done

LINE 191-198 (DTRT)

Suggested edit: Tortoise habitat typically occurs on alluvial fans and plains and colluvial/bedrock slopes that facilitate the digging of burrows. Tortoises need sufficient forage as well as large shrubs and bushes for shade and protection of burrows. They are associated with saltbush, creosote bush, white bur-sage, and cheesebush. At higher elevations, tortoises are more likely to be found near Joshua tree, Mojave yucca, and blackbrush. Tortoises occur in very low densities or are absent where shrub cover is sparse, and annual food plants are available only intermittently (e.g., the lower elevations in Death Valley). They also occur at low densities in moderately to severely disturbed areas, regardless of desert or region.

RESPONSE: The executive summary has been shortened and much of this paragraph has been cut.

LINE 191 (Lovich)

*G. agassizii* can also occupy boulder piles as they often do in Joshua Tree National Park. See Cummings, K.C., J.E. Lovich, S.R. Puffer, T.R. Arundel, and K.D. Brundige. 2020. Micro-geographic variation in burrow use of Agassiz's desert tortoises in the Sonoran Desert of California. *Herpetological Journal* 30:177-188.

RESPONSE: The executive summary is not that detailed but have added "by using underground burrows or rock shelters (Cummings et al., 2020)" in the relevant place in section 2.2.

LINE 197-198 (DTRT)

A terrestrial development index of approximately 7 (or 7% developed) resulted in mean maximum encounter rates of live tortoise that approached zero -- see Carter et al. 2020. Recommended citation - Carter, S.K., Nussear, K.E., Esque, T.C., Leinwand, I.I., Masters, E., Inman, R.D., Carr, N.B. and Allison, L.J., 2020. Quantifying development to inform management of Mojave and Sonoran desert tortoise habitat in the American southwest. *Endangered Species Research*, 42, pp.167-184.

RESPONSE: The results from Carter et al 2020 are discussed in section 4.1 on habitat modification and destruction.

LINE 199-201 (DTRT)

Suggested edit: Ravens are a major predator of juvenile tortoises while coyotes target both juvenile and adult tortoises. Raven populations have expanded dramatically in the desert due to resource subsidies from humans (Holcomb et al. 2021).

RESPONSE: The executive summary acts as an abstract without references. Holcomb et al. 2021 is cited in section 4.4 on Predation.

LINE 201 (DTRT)

Recommended citation for Line 201: Holcomb, K.L., Coates, P.S., Prochazka, B.G., Shields, T. and Boarman, W.I., 2021. A desert tortoise–common raven viable conflict threshold. *Human–Wildlife Interactions*, 15(3), p.14.

RESPONSE: The executive summary acts as an abstract without references. Holcomb et al. 2021 is cited in section 4.4 on Predation.

LINE 203-207 (DTRT)

Suggested edit: In California, the range of the tortoise includes the Mojave Desert and Colorado Subunit of the Sonoran Desert and even a sliver of the Great Basin deserts, from the southern end of the Owens Valley south of the town of Lone Pine in Inyo County to the Mexican border

near the southeastern corner of the state, and from the Colorado River in the east to the lower slopes of the Peninsular , Sierra Nevada, and Transverse mountains in the west.

RESPONSE: The executive summary has been shortened and much of this text has been cut. Text now reads "In California, the range of the Mojave Desert Tortoise includes the Mojave Desert and portions of the Sonoran and Great Basin deserts. "

LINE 208 (DTRT)

Surveys began in 2001. Edit accordingly.

RESPONSE: Done

LINE 210-221 (DTRT)

Suggest updating tortoise trends based on Zylstra et al. 2023:

Zylstra, E.R., Allison, L.J., Averill-Murray, R.C., Landau, V., Pope, N.S. and Steidl, R.J., 2023. A spatially explicit model for density that accounts for availability: a case study with Mojave desert tortoises. *Ecosphere*, 14(3), p.e4448.

RESPONSE: Have updated this using the results from Zylstra et al. 2023.

LINE 233 (DTRT)

Comment to line 233 "critical habitat units" - Critical habitat was designated based on the best available data available prior to 1994. The Service considers Critical habitat to be areas considered essential for the conservation of a listed species.

RESPONSE: The relevant sentence has been removed in the editing of the executive summary

LINE 255 (DTRT)

This statement is incorrect. "large scale translocations do not tend to have high survival rates". Most unpublished and published data related to small scale and large scale translocations indicate that survival is similar between resident, control, and translocated tortoises. Mortality rates do vary by rate based on climate (drought), habitat condition, and predator-prey dynamics in the area.

RESPONSE: Have deleted this sentence following a re write of the translocation section.

LINE 255 (Nussear)

Your statement on translocations on line 255 is potentially misleading: "*Large scale tortoise translocations do not tend to have high survival rates.*" What have you defined as a high survival rate? Is this relative to 100%? Relative to resident and control populations inhabiting the same areas and conditions? The potential losses if tortoises are otherwise removed, or worse yet left in place where development or increased military training will occur? Without explicit decisions about what your criteria are this sounds arbitrary

RESPONSE: Have deleted this sentence following a rewrite of the translocation section.

LINE 223-225 (DTRT)

Suggested edit: The population data available indicate that there were sharp drops in density before listing as threatened, and those losses have continued to the point where most tortoise habitats no longer supports viable tortoise densities and adult densities are rapidly declining. This sentence has been deleted following a rewrite of the population status due to using Zylstra et al. 2023.

LINE 226-236 (DTRT)

Suggested edit: The slow maturation and low reproductive rates of tortoises means that if past and current management is successful at addressing threats and stemming the decline of tortoise populations, it would still take at more than 25 years of positive population growth to

reach the USFWS Recovery Criteria (U.S. Fish and Wildlife Service 2022a). For example, the USFWS 1994 Recovery Plan estimates that when adult survivorship is 98%, population growth would be less than 0.5% per year, and would take 140 years to double in size. Contemporary annual survival rates for both adults and juveniles are much lower than 98% in all areas, making population stability, let alone growth, unlikely. Collectively, the available data show that in the critical habitat units, tortoise densities are low to very low, and despite 30 years of state and federal protection as a threatened species, tortoise populations continue to decline and do not show consistent signs of recovery.

RESPONSE: This paragraph has been reworked to shorten the executive summary. It now reads in part "For example, the USFWS 1994 Recovery Plan estimates that when adult survivorship is 98%, population growth would be less than 0.5% per year, and would take 140 years to double in size. Annual survival rates for both adults and juveniles are much lower than 98% in most areas, and since the late 1970s, the number of juveniles detected on surveys has also fallen sharply, to the point that in some recent surveys in the western Mojave Desert almost no juveniles were found. "

LINE 238-241 (DTRT)

Suggested edit: The dramatic declines of tortoise populations are likely due to the extensive number and interconnected nature of the threats they face. The important threats fall into two categories, those that directly kill adults and juveniles, and those that cause longer-term changes to habitat availability and quality.

RESPONSE: Done

LINE 242-249. (DTRT)

Suggested edit: In long-lived species that are slow to reproduce, decreased survival has long lasting impacts on the population viability and can alter demographic rates for decades. Increased numbers of predators including ravens and coyotes reduce the survival of juvenile and adult tortoises, respectively. Development within the tortoise range often creates roads that can lead to road-killed tortoises, and extensive networks of trails for off highway vehicles on public land increase the chance that tortoises will be run over in areas without paved roads. Moreover, road infrastructure provides subsidies in the form of roadkill and garbage to ravens and coyotes. Well-designed fences and culverts can help prevent tortoises and other wildlife from being killed by vehicles along major roads, but little fencing has been built since 2011.

RESPONSE: Done

LINE 250-255 (DTRT)

Suggested edit: Habitat modification, fragmentation, and destruction reduces the amount of habitat that can support tortoises in the long-term and reduce the size of remaining habitat patches. Although a large proportion of the tortoise's range is under federal control, renewable energy, housing, illegal cannabis, and other types of development reduce the amount of habitat available. Most concerningly, subsidized predators like the raven and coyote leverage habitat fragmentation and disturbances to expand their densities throughout "undisturbed" habitats. The Department of Defense is a large landowner in the tortoise's range and frequently expands the areas that it uses for training, requiring the translocation of hundreds of tortoises. Large scale tortoise translocations do not tend to have high survival rates.

RESPONSE: Done

LINE 256 (Nussear)

Line 256: the effects of climate change are likely under stated you state "Additional factors have direct and indirect impacts on tortoises and their habitat. Climate change, which is likely to cause hotter and periodically drier conditions in the desert tortoise range, will increase their physiological stress and change activity patterns." it will likely make areas of habitat unsuitable, potentially alter reproduction, hibernation, and many other facets of tortoise ecology. I think this is well beyond the changing of activity patterns and increased physiological stress. I think that Barrows did a paper on this with tortoises in Joshua tree, and there is certainly more that could be referenced here.

RESPONSE: Have added "In combination, the impacts of climate change will likely result in less available suitable habitat." But this is a brief summary, and section 4.6 on Climate change and drought goes into more detail.

LINE 259 (DTRT)

Suggested edit: The nutritious native vegetation tortoises feed on is being outcompeted

RESPONSE: Done

LINE 270-274 (DTRT)

Consider updating with Zylstra et al. 2023 density information. "However, there is still a large amount of available habitat and even at low densities, in 2014 there were estimated to be more than 61,000 adult tortoises within the TCAs. This is a decrease from an estimated 310,000 adults in 2004, and as densities have continued to fall since 2014, current abundance is likely lower than 60,000 adult tortoises".

RESPONSE: Have updated with information from Zylstra et al. 2023

LINE 356 (Lovich)

What about *G. evgoodei*? See EDWARDS, T., A. KARL, M. VAUGHN, P. ROSEN, C. MELÉNDEZ TORRES, AND R. W. MURPHY. 2016. The desert tortoise trichotomy: Mexico hosts a third, new sister-species of tortoise in the *Gopherus morafkai*–*G. agassizii* group. *ZooKeys*. 562:131-158.

RESPONSE: Have added "More recent work by Edwards et al. (2016) separates Desert tortoises living in the thorn scrub and tropical deciduous forests of southern Mexico into another species *Gopherus evgoodei*. "

LINE 366 (Lovich)

There are *G. agassizii* and hybrids "east of the Colorado River in the Kingman area of AZ. See EDWARDS, T., K. H. BERRY, R. D. INMAN, T. C. ESQUE, K. E. NUSSEAR, C. A. JONES, AND M. CULVER. 2015. Testing taxon tenacity of tortoises: evidence for a geographical selection gradient at a secondary contact zone. *Ecology and Evolution*. 5:2095-2114.

RESPONSE: Have added "However, there is "anomalous" population of *G. agassizii* east of the Colorado River in the Black Mountains of Arizona (Edwards et al. 2015)."

LINE 357-362 (DTRT)

Suggested edit: Desert tortoises are members of the order Testudines, family Testudinidae, genus *Gopherus*. When the Commission listed Desert Tortoise as threatened in 1989, *Gopherus agassizii* was understood to range from southeastern California, across southern Nevada, through western Arizona, and south into Sonora and Sinaloa, Mexico. In 2011, studies of tortoise genetics, morphometrics, and ecology led experts to conclude that the complex formerly known as "desert tortoise" in fact consists of two separate species, Mojave desert tortoise and Sonoran desert tortoise (Murphy et al. 2011, Iverson et al. 2017). Five years later,



in 2016, the Sonoran desert tortoise was further split into two species – Sonoran desert tortoise and thornscrub tortoise (*G. evgoodei*) (Edwards et al. 2016).

RESPONSE: Text now reads "More recent work by Edwards et al. (2016) separates Desert tortoises living in the thorn scrub and tropical deciduous forests of southern Mexico into another species *Gopherus evgoodei*."

LINE 363-365 (DTRT)

Suggested edit: "Desert tortoises east of the Colorado River in Arizona and northern Mexico are now classified as Sonoran desert tortoise, also known as Morafka's desert tortoise (*Gopherus morafkai*). See the 2022 USFWS 5-year review for more details regarding tortoise populations found east of the Colorado River that are genetically *G. agassizii*."

RESPONSE: See above comments for additions to text regarding this population of tortoises. This document is California specific and doesn't focus on this population.

LINE 379 (Lovich)

what about the largest female they reported? It was bigger

RESPONSE: Have amended sentence to "Generally males are larger than females (Ernst and Lovich 1994) but the largest measured wild individual was a female in 1986 whose carapace length was 374 mm (Berry and Murphy 2019)"

LINE 396 (Lovich)

See comment in line 4 of the spreadsheet

RESPONSE: This references the comment about line 191 and the text in section 2.2 now reads "by using underground burrows or rock shelters (Cummings et al., 2020)"

LINE 397 (DTRT)

Medica et al. 2012 reported a mean of 18.8, please include.

RESPONSE: Done

LINE 402 (DTRT)

Citation referenced above. Include in literature. Mitchell, C.I., Friend, D.A., Phillips, L.T., Hunter, E.A., Lovich, J.E., Agha, M., Puffer, S.R., Cummings, K.L., Medica, P.A., Esque, T.C. and Nussear, K.E., 2021. 'Unscrambling' the drivers of egg production in Agassiz's desert tortoise: climate and individual attributes predict reproductive output. *Endangered Species Research*, 44, pp.217-230.

RESPONSE: Done

LINE 403 (Nussear)

Line 403: "There are anecdotal reports of females nest guarding against humans and Gila Monsters, but there is no parental care once eggs have hatched (Berry and Murphy 2019)" This is the wrong reference to cite here - you should probably cite Gienger and Tracy 2008 In general throughout this assessment it appears that you put entirely too much emphasis on Berry and Murphy 2019 - rather than more direct references.

RESPONSE: Changed to "Tortoise nests are typically placed near the mouth or entrance to the burrow or within suitable soil (Ennen et al. 2012), and there is no parental care once eggs have hatched (Berry and Murphy 2019)." Made the changes since Gila Monsters not being widespread in California and human attacks on nests not necessarily being a major issue.

LINE 404 (DTRT)

"Gila Monsters": Gila monsters occur at low densities in only a few locations in California and likely do not pose a threat to tortoise nest success for this reason.

RESPONSE: Changed to "Tortoise nests are typically placed near the mouth or entrance to the burrow or within suitable soil (Ennen et al. 2012), and there is no parental care once eggs have hatched (Berry and Murphy 2019). "due to Gila Monsters not being widespread in California and human attacks on nests not necessarily being a major issue

LINE 392-394 (DTRT)

Suggested edit: They also found that the overlap in the area in an individual's home range from one year to the next was ~35% and did not vary significantly by sex. Individuals tend to have fidelity to home ranges and activity centers, even after a fire (Drake et al. 2015, Lovich et al. 2018).

RESPONSE: Done

LINE 401-402 (DTRT)

Suggested edit: Females lay 0–3 clutches in the spring and the number of eggs laid per clutch ranges from 1–10. Females typically lay one or two clutches of eggs (~ 6 eggs per clutch) per year; however, some females have been document to oviposit more than two clutches (Mitchell et al. 2021). Tortoise nests are typically placed near the mouth or entrance to the burrow or within suitable soil (Ennen et al 2012).

RESPONSE: Done

LINE 403-404 (Lovich)

Not true. See Agha, M., J.E. Lovich, J.R. Ennen, and E. Wilcox. 2013. Nest-guarding by female Agassiz's desert tortoise (*Gopherus agassizii*) at a wind-energy facility near Palm Springs, California. *The Southwestern Naturalist* 58:254-257.

RESPONSE: Changed to "Tortoise nests are typically placed near the mouth or entrance to the burrow or within suitable soil (Ennen et al. 2012), and there is no parental care once eggs have hatched (Berry and Murphy 2019). " due to Gila Monsters not being widespread in California and human attacks on nests not necessarily being a major issue

LINE 409 (DTRT)

Replace 52% with 26%. Nest predation is common, with 12–26% . Comment - I cant seem to find 55% nest predation stat in Berry and Murry 2019. Please revise accordingly.

RESPONSE: Percentages changed to 26-47% based on yearly numbers in Bjurlin and Bissonette 2004

LINE 410 (Nussear)

Line 410: "When nests are not predated, hatchling success is about 80% " - The verb here should be depredated, predated is to come before something - e.g. [ pree-deyt ] verb (used with object), pre-dat-ed, pre-dat-ing. to date before the actual time; antedate: He predated the check by three days. to precede in date: a house that predates the Civil War.

RESPONSE: Done

LINE 412 (DTRT)

Delete "At that age they become less vulnerable to predators.

RESPONSE: Done

LINE 418 (DTRT)

Add scientific names to "red brome, cheat grass, red stem filaree, and African mustard".

RESPONSE: Done

LINE 419 (Nussear)

Line 419–420: "but tortoises avoid eating exotic grasses when possible as they are low in nitrogen and require relatively large amounts of water to process."

no, they don't. See Esque 1984, and Tracy et al. 2006

RESPONSE: Deleted. Text now reads "Much of the range of the desert tortoise is highly invaded by nonnative plants including grasses like red brome (*Bromus rubens*) and cheatgrass (*Bromus tectorum*). Experimental studies found that grass diets that included no forbs were detrimental to tortoises, leading to weight loss, poor body condition, or even death (Hazard et al. 2009, Drake et al. 2016). This was the case even when the diet included native grasses (Drake et al. 2016)."

LINE 433 (Nussear)

Line 433: Berry and Murphy (2019) report that desert tortoises spend >90% of their lives underground. - this has been reported by numerous other studies, and entirely too much accredited to this reference - see also lines 438 - 441. lines 444 - 445, and I can't even list how many places. Repeatedly gives the appearance of a really shallow review of the primary literature.

RESPONSE: Noted, and the thoroughness of the citations provide throughout is appreciated. However, as stated in section 1.2, the status review " is not intended to be an exhaustive review of all published scientific literature on Mojave Desert Tortoise; rather it is intended to summarize key points relevant to the status of the species and address regulatory report requirements."

LINE 435 (Lovich)

You may want to cite HUTCHISON, V. H., A. VINEGAR, AND R. J. KOSH. 1966. Critical thermal maxima in turtles. *Herpetologica*. 22:32-41. and ZIMMERMAN, L. C., M. P. O'CONNOR, S. J. BULOVA, J. R. SPOTILA, S. J. KEMP, AND C. J. SALICE. 1994. Thermal ecology of desert tortoises in the eastern Mojave Desert: seasonal patterns of operative and body temperatures, and microhabitat selection. *Herpetological Monographs*. 8:45-59.

RESPONSE: Have expanded the range of temperatures when tortoises go to shade based on info in Zimmerman et al 1994

LINE 447 (Lovich)

See Ennen, J.R., K.P. Meyer, and J.E. Lovich. 2012. Female Agassiz's desert tortoise activity at a wind energy facility in southern California: the influence of an El Niño event. *Natural Science* 4:30-37. doi:10.4236/ns.2012.41006.

RESPONSE: Changed/ added so text now reads "Tortoises moved less, used fewer burrows, and had smaller home ranges during drought years as compared to wet years in the mid-1990s (Duda et al. 1999). However, at a different site in the late 1990s, the relationships between precipitation and activity area, rate of movement, and burrows used were less clear (Ennen et al. 2012), suggesting that there are many interacting forces that determine tortoise activity and movement levels."

LINE 409-412 (DTRT)

Suggested edit: Nest predation is common, with 12–26% of nests generally destroyed by predators (Berry and Murphy 2019, Ennen et al. 2012, Bjurlin & Bissonette 2004). When nests are not predated, hatchling success is about 80% (Bjurlin and Bissonette 2004). Newly hatched tortoises are about 4–5 cm in length (Bjurlin and Bissonette 2004) and their shells do not fully ossify until they are 5–7 years old. For more information about predation, see section 4.4.

RESPONSE: Percentages changed to 26-47% based on yearly numbers in Bjurlin and Bissonette 2004

LINE 434-436 (DTRT)

"Tortoises are active when their body temperatures are between 19.0°C and 37.8°C (66.2–100°F), they retreat to shade when body temperatures are 37–38°C (98.6–100.4°F), and body temperatures of 43°C (109.4°F) are deadly (Brattstrom 1965)". Review and add Zimmerman, L.C., O'Connor, M.P., Bulova, S.J., Spotila, J.R., Kemp, S.J. and Salice, C.J., 1994. Thermal ecology of desert tortoises in the eastern Mojave Desert: seasonal patterns of operative and body temperatures, and microhabitat utilization. *Herpetological Monographs*, pp.45-59.

RESPONSE: Have expanded the range of temperatures when tortoises go to shade based on info in Zimmerman et al 1994

LINE 460-461 (Nussear)

Lines 460–461: "Therefore, desert tortoise habitat typically consists of alluvial fans and plains and colluvial/bedrock slopes (Nussear et al. 2012)". This isn't the best reference for this, how about Germano 1994, or Nussear and Tuberville 2014? See also 465 and 466

RESPONSE: Have changed citation to Germano et al. 1994

LINE 515-417 (DTRT)

Delete these sentences "Tortoises favor native plants and plant parts that are high in water and low in potassium (Oftedal et al. 2002). Potassium is potentially toxic and requires a large amount of water and nitrogen to excrete."

RESPONSE: Deleted

LINE 451 (Lovich)

Citation?

RESPONSE: Have added Ernst and Lovich 1994 as a reference to this cluster of sentences

LINE 461 (Lovich)

How about burrows under caliche layers?

RESPONSE: Although not mentioned specifically, this sentence is sufficiently broad enough to cover caliche layers. "Due to their dependence on burrows, they require soils, topography, geological features, and vegetation that facilitate the creation of burrows or dens (Andersen et al. 2000)."

LINE 482 (Lovich)

Berry 1984 not in lit cit

RESPONSE: Citations within a quote are not included in the bibliography

LINE 485 (Lovich)

Lower elevation areas free of tortoises include the Salton Trough. See Lovich, J.E., T. Edwards, K.H. Berry, S. Puffer, K. Cummings, J. Ennen, M. Agha, R. Woodard, K. Brundige, and R.W. Murphy. 2020. Refining genetic boundaries in the western Sonoran Desert for Agassiz's desert tortoise (*Gopherus agassizii*): the influence of the Coachella Valley on gene flow among populations in southern California. *Frontiers of Biogeography* 12:1-14. <https://escholarship.org/uc/item/54r0m1cq>.

RESPONSE: Have added some text to the section on range and distribution "While caution should be used in using these types of data, there appear to be fewer occurrences in the

northern part of the range and in the Death Valley/Mojave Central Trough (see grey area on Figure 3), and few occur in low areas near the Salton Sea (Lovich et al. 2020)."

LINE 494 (DTRT)

Suggested edit: In California, the range of the Mojave Desert Tortoise includes the Mojave Desert and portions of the Colorado subunit of the Sonoran and Great Basin Deserts

RESPONSE: Done

LINE 507 (DTRT)

Suggested edit: In 2016, park staff began surveying for tortoises and formally collecting incidental observation data, and subsequent genetic analysis of tortoise blood and scat suggested "evidence of a naturally reproducing Mojave desert tortoise population in Anza Borrego Desert State Park" (Manning 2018).

RESPONSE: Done

LINE 516-520 (DTRT)

Suggested edit: The distribution of desert tortoises within California is uneven, and portions of the range no longer provide suitable tortoise habitat due to agriculture, development, and military activity. Data on tortoise occurrences from the California Natural Diversity Database (CNDDDB) and the Global Biodiversity Information Facility (GBIF) were used to plot the distribution

RESPONSE: Done

LINE 548 (DTRT)

"Outbreeding depression has not been studied in *G. agassizii*." Also see Averill-Murray and Hagerty 2014 for discussion/calculations related to outbreeding depression. Translocation Relative to Spatial Genetic Structure of the Mojave Desert Tortoise, *Gopherus agassizii*. *Chelonian Conservation and Biology* 13:35-41.

RESPONSE: Altered text to read "Outbreeding depression has not been well studied in *G. agassizii*; however, the potential negative impacts of outbreeding are expected to occur at long time scales (~600 years; Averill-Murray and Hagerty 2014). This suggests that habitat quality and predator numbers are more important than outbreeding depression when evaluating suitable recipient sites for translocation. Despite this, Sánchez-Ramírez et al. (2018) advise caution when moving tortoises long distances for translocation or population augmentation. For more details about translocations see section 5.2"

LINE 538-551 (DTRT)

Please also consider Scott, P.A., Allison, L.J., Field, K.J., Averill-Murray, R.C. and Shaffer, H.B., 2020. Individual heterozygosity predicts translocation success in threatened desert tortoises. *Science*, 370(6520), pp.1086-1089. and the Translocation of Mojave Desert Tortoises from Project Sites: Plan Development Guidance: <https://www.fws.gov/sites/default/files/documents/Revised%20USFWS%20DT%20Translocation%20Guidance.20200603final.pdf>

RESPONSE: This paper is focused on tortoises from captive origins, and is not a great fit for this section of the status review.

LINE 638 (DTRT)

The use of square transects with 3 km sides was initiated in 2004, prior to this different transect lengths/shapes were used for line distance surveys

RESPONSE: Added text "In 2001–2003, two person teams surveyed TCAs using line transect surveys. Transects were searched out to 8–10 m from the centerline. The shape and length of the transect changed year to year (USFWS 2006). Starting in 2004, square transects with 3 km sides were set up to provide good coverage of each TCA, and a random selection of these transects are surveyed each year."

LINE 649 (DTRT)

As currently presented, the estimates in Table 2 for 2014 do not represent a survey in IV, CK, CM, FE, PT, or JT, but rather an extrapolated estimate based on trends outlined in USFWS 2022a. Recommend updating the table to reflect either only years surveyed or adding notation to differentiate.

RESPONSE: Following the inclusion of Zylstra et al. 2023, this table has been moved to the Appendix. Have listed the density estimates from line sampling from Allison and McLuckie, and bolded the densities estimated from trends as presented in USFWS 2022a. Added following text to legend "In 2014, the density estimates for the Western Mojave TCAs and Chocolate Mountain are estimated from line distance sampling and are found in Allison and Mcluckie (2018). The bolded estimates from Ivanpah and the Colorado Desert TCAs (excluding Chocolate Mountain) come not from that years' line distance sampling but are mean densities calculated from trends using data from previous years (USFWS 2022a)"

LINE 639-640 (DTRT)

Suggested edit: Two surveyors walk line transects along the boundary of the square or as close to it as is feasible, where the lead surveyor walks in a straight line on a specified compass bearing, trailing 25m of cord, and the second crew member follows at the end of the line.

RESPONSE: Done

LINE 640-642 (DTRT)

Suggested edit: They record the distance and bearing from the survey line to all tortoises seen and live tortoises are measured and sexed. In addition, data from tortoises carrying radio transmitters are used to estimate what portion of tortoises are above ground. These data are then used to calculate the proportion of tortoises that are detectable during the entire period transects are walked in an area.

RESPONSE: Text modified to "In addition, data from tortoises carrying radio transmitters are used to estimate what portion of tortoises are above ground and detectable during the transects."

LINE 684 (DTRT)

Spatially explicit estimates based on line distance data presented in Zylstra et al. 2023 demonstrate that in 2020 all TCA's are below the 3.9 threshold.

Have updated this section to use results from Zylstra et al 2023

LINE 682-685 (DTRT)

"The most recent surveys (2019–2021) show that in the Eastern and Western Mojave Recovery Units, all of the TCAs surveyed were below the 3.9 adult tortoises/km<sup>2</sup> threshold. In the Colorado Desert Recovery Unit, two were at the threshold, two were below it, and only one TCA (Fenner) was above (U.S. Fish and Wildlife Service 2022a)". Comment - Spatially explicit estimates based on line distance data presented in Zylstra et al. 2023 demonstrate that in 2020 all TCA's are below the 3.9 threshold.

RESPONSE: Have updated this section to use results from Zylstra et al 2023

LINE 688 (DTRT)

Recommend updating figures 8 and 9 based on updated values in Table 2

RESPONSE: Done

LINE 698 (DTRT)

Table 2. 2014, density estimate values listed for this year come from two different sources, estimates calculated from annual line distance sampling in TCAs (Chocolate Mtn and SC; Allison and McLuckie 2018) and extrapolated estimates based on trends (all other TCAs) from USFWS 2022a. However, FK and OR were also surveyed in 2014. Recommend consistency in citing estimates, either 1) list density estimates for all areas surveyed in 2014 (AG, SC, FK, OR) from Allison and McLuckie 2018, include extrapolated estimates for other TCAs not surveyed and **add notation to differentiate** OR 2) list extrapolated estimates for all **including notation to differentiate extrapolated estimates** from actual years surveyed.

RESPONSE: Following the inclusion of Zylstra et al. 2023, this table has been moved to the Appendix. Have listed the density estimates from line sampling from Allison and McLuckie, and bolded the densities estimated from trends as presented in USFWS 2022a. Added following text to legend "In 2014, the density estimates for the Western Mojave TCAs and Chocolate Mountain are estimated from line distance sampling and are found in Allison and McLuckie (2018). The bolded estimates from Ivanpah and the Colorado Desert TCAs (excluding Chocolate Mountain) come not from that years' line distance sampling but are mean densities calculated from trends using data from previous years (USFWS 2022a)"

LINE 698 (DTRT)

Table 2. 2015, missing values for Ivanpah and Chocolate Mountain (USFWS 2016)

RESPONSE: Done

LINE 698 (DTRT)

Table 2. 2016, missing values for Chocolate Mountain, please update to include (USFWS 2016)

RESPONSE: Done

LINE 698 (DTRT)

Table 2, 2017, no value should be listed for Ivanpah, this TCA was not surveyed in 2017, please delete (USFWS 2018)

RESPONSE: Done

LINE 698 (DTRT)

Table 2, 2018, please correct the coefficient of variation for the Ord-Rodman estimate from 20.79 to 30.79 (USFWS 2019b)

RESPONSE: Done

LINE 698 (DTRT)

Table 2, 2019, missing values for Chocolate Mountain, please update (USFWS 2020a)

RESPONSE: Done

LINE 700 (DTRT)

Table 2, need to add USFWS 2022a citation

RESPONSE: Done

LINE 718 (Lovich)

Estimating live tortoises from sign is not a reliable method.

RESPONSE: Added text "These early monitoring programs sometimes relied on tortoise sign (tracks, scats, burrows, or carcasses) as well as observations of live tortoises, or employed

mark-recapture methods to obtain estimates of abundance or density. It should be noted that survey methods that rely on sign to estimate numbers of live tortoises are not reliable. In addition, mark recapture methods contain several assumptions that are violated in surveys of tortoises (Corn 1994), and the lack of spatial information in conventional mark recapture analysis leads to inflated estimates of density (Mitchell et al. 2021b). Therefore, estimates of density before 2001 must be approached with caution and direct comparisons between density estimates from mark recapture and line transect density methods are not advised. However, we can use these studies to give a rough picture of the state of tortoise populations in the late 20th century." Deleted "From 1979–1980 to 2020–2021, densities of adults in the corresponding TCAs fell 93% in Fenner, 96% in Chuckwalla, 89% in Chemehuevi, and 93% in Ivanpah" as this is a flawed direct comparison.

LINE 738 (DTRT)

"In addition, the BLM density estimates are only for the single plot per TCA". Comment - In addition, these results are likely biased high due to violations of statistical assumptions (Mitchell et al. 2021). Mitchell, C. I., K. T. Shoemaker, T. C. Esque, A. G. Vandergast, S. J. Hromada, K. E. Dutcher, J. S. Heaton, and K. E. Nussear. 2021. "Integrating Telemetry Data at Several Scales with Spatial Capture-Recapture to Improve Density Estimates." *Ecosphere* 12: e03689.

RESPONSE: Added text "In addition, mark recapture methods contain several assumptions that are violated in surveys of tortoises (Corn 1994), and the lack of spatial information in conventional mark recapture analysis leads to inflated estimates of density (Mitchell et al. 2021b)." Added text "Comparing the density estimates in Berry and Medica (1995) to the USFWS estimates in 2001–2021 is not appropriate due to the differences in methodology described above. However, comparing the mark recapture density estimates between 1979 and 1992 can give us a sense of the general scale of decline even if the estimates themselves are biased high (Berry and Medica 1995, Mitchell et al. 2021b). "

LINE 711 and forward (Lovich)

These plot-based surveys cannot reliably be compared to data from line distance sampling data as that is like comparing apples to oranges. In the omitted Ernst and Lovich 2009 citation (page 564) mentioned above we compared and contrasted the techniques, their strengths and weaknesses. Plot-based surveys cannot be reliably extrapolated to surrounding areas and have been heavily criticized in the literature for their limitations. See CORN, P. S. 1994. Recent trends of desert tortoise populations in the Mojave Desert, p. 85-93. In: *Biology of North American Tortoises*. R. B. Bury and D. J. Germano (eds.). United States Department of the Interior, National Biological Survey. Fish and Wildlife Research 13. AND BURY, R. B., AND P. S. CORN. 1995. Have desert tortoises undergone a long-term decline in abundance? *Wildlife Society Bulletin*. 23:41-47. While I believe the plot-based data are valuable when those limitations are considered, you need to clarify that they are very different techniques and may not be useful for integration of data on declines.

RESPONSE: Bury and Corn 1995 question the assertions in Berry 1984 that there has been large scale declines in the desert tortoise densities up until that point and to claims of a 60-90% decline from 1900-1970s. The status review does not touch on population status or density prior to Berry 1984's strip transects which have rough density classes. Corn 1994 has a similar



data set to Berry and Medina 1995, however because the violations of assumption in mark recapture in 60 days surveys, they present the data as relative abundance. The overall trends are similar over 1979-1990 as reported in Berry and Medina. Have reworded the section on Berry and Medina 1995's results to make it more clear about their limitations. See above

LINE 768 (Lovich)

Freilich worked on a one square mile plot (the Barrow Plot) in JTREE. That's "well-defined"  
RESPONSE: Removed "and since they did not have a well-defined effective trapping area, their density estimates are rough. "

LINE 816 (Lovich)

Desert tortoises have the following life history traits: long-lived, late maturing, variable nest success due to predation, high adult survival, bet-hedging reproductive strategy (see ENNEN, J. R., J. E. LOVICH, R. C. AVERILL-MURRAY, C. B. YACKULIC, M. AGHA, C. LOUGHRAN, L. TENNANT, AND B. SINERVO. 2017. The evolution of different maternal investment strategies in two closely related desert vertebrates. *Ecology and Evolution*:1-13.), and relatively high juvenile survival to compensate for variable nest success. Classic studies of turtles with similar traits are: CONGDON, J. D., A. E. DUNHAM, AND R. C. LOBEN SELS. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): Implications for conservation management of long-lived organisms. *Conserv Biol.* 7. AND CONGDON, J. D., A. E. DUNHAM, AND R. C. VAN LOBEN SELS. 1994. Demographics of common snapping turtles (*Chelydra serpentina*): implications for conservation and management of long-lived organisms. *Amer. Zool.* 34:397-408. You even show fairly high rates of juvenile survivorship on page 37. Without compensation for high nest mortality if hatchlings (you say this is high on page 37 line 903 and with the Daly et al. citation on page 37) populations could not survive.

RESPONSE: Have added text "In long-lived species like the tortoise, if adult survivorship drops, reproductive rates or juvenile survival would have to increase dramatically to keep populations stable. Analysis by the USFWS (1994) estimated that "a 10% increase in adult mortality can require a 300% increase in juvenile survivorship" to maintain a stable population. Many of the threats to adult survival also affect juveniles, making it unlikely that juvenile survivorship can naturally increase to the levels needed to compensate for the decreasing adult survival documented above"

Page 34 Figure (Lovich)

All of the presumed confidence intervals overlap each other so they aren't really different

RESPONSE: Assume this refers to figure 12. Have added/altered relevant text to read "In the yearly transect surveys done in the TCAs, the median midline carapace length did not change significantly between 2001 and 2015 (Figure 10). However, fewer juveniles small enough to be classified as outliers (the small circles below the lower 'whisker' in the box and whisker plot of Figure 10) were found in 2007–2015 compared to 2001–2005. In 2011, only one juvenile (midline carapace length <180 mm) was found, and in 2012 none were found. In some areas, the youngest tortoises found in recent years were at least 30 years old (Holcomb 2022a). Despite a steady median carapace length across 2001–2015, the range of carapace lengths decreased, with most of that change due to fewer smaller individuals found. Even with thousands of adults in a population, if sufficient juvenile tortoises are not surviving to breeding age, the population will decline without interventions like head-starting, although that decline may take decades to manifest (Lovich et al. 2018)."

LINE 856-857 (Lovich)

Prey switching was the mechanism proposed

RESPONSE: Text amended to read "It should be noted that other factors that impact survival, such as predation, roadkill, and disease were not tested independently" prey switching is discussed more in section 4.5 on predation.

LINE 870-881 (DTRT)

Comment - Esque et al. 2010 highlighted that we have too many subsidized predators (e.g., coyotes) throughout the Mojave Desert and that prolonged drought conditions likely created a shift in predator-prey dynamics. Increased mortality for *G. agassizii* was observed range-wide in 2008-2009. Please rephrase to include the importance of this finding.

RESPONSE: Prey switching and Esque et al 2010 is talked about at the end of the section 4.4 on predation. The addition of Cypher et al. 2018 adds some counterpoints to the discussion. Text read "During periods of suppressed rodent and prey populations following dry years, it has been suggested that coyotes will switch to preying on tortoises (Esque et al. 2010). This may help explain the widespread high mortality rates due to predation in 2008 (Esque et al. 2010). However, work by Cypher et al. (2018) did not necessarily support that hypothesis. In a study following the 2008 translocation of tortoises to an area south of Fort Irwin, they collected data on the relative abundance of rodents and rabbits, as well as the contents of coyote scats in 2009–2014. The years 2011–2014 were very dry compared to the wetter years of 2009–2010. While the frequency of occurrence of rodents in scat was lower in dry years (24.3%–46.3%) than in the wet years (53%–65%), the frequency of tortoises in scat was also lower in dry years (2.4%–2.6%) compared to wet years (5.6%–5.8%). These results suggest that it is unlikely coyotes switched to tortoise prey because of lack of rodents. Instead, as coyotes ate fewer rodents in the dry years, their amount of anthropogenic food sources increased (Cypher et al. 2018). While 2008 may have been an anomalous widespread pulse in predation pressure (Esque et al. 2010), there is a lack of rigorous evidence that coyotes regularly prey switch to tortoises when rodent or lagomorph populations are low because of drought. "

LINE 897 (Lovich)

is 300% the right number?

RESPONSE: Full quote is "Indeed, somewhere in the order of only 1% of all eggs need survive to reproductive age. On the other hand, a 10% increase in adult mortality can require a 300% increase in juvenile survivorship. Furthermore, any reduction in the fecundity of adults exacerbates this further."

LINE 901 (DTRT)

"Several factors limit the number of hatchlings that are produced in the wild each year."

Comment See Mitchell et al. 2021 for more information related to the drivers of egg production. The authors modeled reproductive output as a factor of climate and individual attributes and detected a declining trend in egg production across all recovery units over time.

RESPONSE: Citation was previously added. Altered text to read "Several factors limit the number of hatchlings that are produced in the wild each year. Temperature, precipitation and body size influence the number eggs females lay (Mitchell et al. 2021a), with the maximum being 12-18 eggs a year (J. Lovich Pers comm 2023). "

LINE 902 (Lovich)

See earlier comment about 30 eggs/year being wrong

RESPONSE: Altered text to read "Several factors limit the number of hatchlings that are produced in the wild each year. Temperature, precipitation and body size influence the number eggs females lay (Mitchell et al. 2021a), with the maximum being 12-18 eggs a year (J. Lovich Pers comm 2023). "

LINE 918 (Lovich)

This addresses a proximate (not enough turtles) not an ultimate (impacts continue to kill turtles in the wild) cause. See FRAZER, N. B. 1992. Sea turtle conservation and halfway technology. Conservation Biology. 6:179-184. for a critique of headstarting.

RESPONSE: True, but this distinction may not be necessary here.

LINE 901-917 (Lovich)

juvenile survival rates aren't that low. See comments line 23 of spreadsheet

RESPONSE: Have deleted that sentence.

LINE 953 (DTRT)

Again, you say survival rates of juveniles are low but you say 100% on page 37 line 928

RESPONSE: That is a modelled survival rate that hasn't been ground truthed and focused mostly on predation risk from ravens. Other factors make it unlikely annual survival would be 100%

LINE 986-987 (Lovich)

The west Mojave is highly built up and growing. See HUNTER, L. M., M. D. J. GONZALEZ G, M. STEVENSON, K. S. KARISH, R. TOTH, T. C. EDWARDS, R. J. LILIEHOLM, AND M. CABLK. 2003. Population and land use change in the California Mojave: Natural habitat implications of alternative futures. Population Research and Policy Review. 22:373-397.

RESPONSE: Added some text at the end of the paragraph to add context about how the results of the Carter et al. 2020 paper may not hold into the future "However, these categories of development used above do not take into account unpaved roads and tracks for off-highway vehicles (OHVs) which are allowed on BLM land (see section 4.2), and given the pace of a variety of development in the desert, the conclusions may be less applicable in the future."

LINE 997 (Lovich)

Cite Hunter et al. above?

RESPONSE: This paper is interesting, but it is from 2003 and offers 2 potential development possibilities by 2020 with amounts of DT tortoise habitat in conflict with development. With the information easily available it would be hard to judge which scenario most closely matches reality and it is unclear it would add much to what information is already presented.

LINE 1034 (Lovich)

Cite Lovich and Bainbridge for recovery

RESPONSE: Done "Recovery from disturbance can take a long time in desert ecosystems (Lovich and Bainbridge 1999). "

LINE 1043 (Lovich)

How about fire as an impact esp. on bases like China Lake where lots of ordinance is fired

RESPONSE: Unable to find specific information about fires on DoD land.

LINE 1055 (Lovich)

Citation is Lovich and Ennen, not et al.

RESPONSE: Changed. "

LINE 1057 (Lovich)

after "infrastructure" add "for wind"

RESPONSE: The relevant sentence has been removed due to further editing  
LINE 1112 (Nussear)

line 1112 Cannabis operations - this seems like a trivial inclusion. 12 km<sup>2</sup>? This seems to be about the equivalent of party balloon effects, surprised to see this here.

RESPONSE: As noted, the visited acres of illegal cannabis grows are likely an underestimate of the true number of acres and it is probable that active and abandoned acres will continue to grow. The Department felt it is worthy to mention as something to keep an eye on in the future.

LINE 1117 (Lovich)

Guard dogs or any dogs?

RESPONSE: In the context of cannabis operations the dogs are mostly guard dogs. Pet/ feral dogs can be an issue generally near homes.

LINE 1208 (Lovich)

West where? Mojave?

RESPONSE: Have modified to clarify "According to the BLM, in 2008 there were four times the number of off-highway vehicles in western states than in 1998 (Bisson 2008)."

LINE 1258 (DTRT)

Suggested edit: Grasses are high in fiber, contain less digestible energy, and little protein (Hazard et al. 2009; Drake et al. 2016),

RESPONSE: That text is within a quote, alterations would not be appropriate

LINE 1242-1243 (DTRT)

"Fueled in part by nitrogen pollution carried by wind from the Los Angeles Basin which enriches desert soils (Fenn et al. 2010), invasive Mediterranean grasses have spread through much of the Mojave Desert." Comment- nitrogen pollution is not a significant contributor to the spread and establishment of invasive Mediterranean grasses. Habitat disturbance, recreation activities, and loss of native plants plays the biggest roles.

RESPONSE: Have deleted the relevant part of the sentence.

LINE 1297 (DTRT)

Suggested edit: The best studied predators of tortoises are ravens , coyotes, and badgers. " Include scientific name the first time predators are referenced in document.

RESPONSE: Have added scientific names to the document.

LINE 1341-1343 (DTRT)

Suggested edit: Ten years later, 104 were dead, an estimated 60% of which were killed by coyotes (Esque et al. 2010; Mack and Berry 2023). Increased tortoise mortality due to coyote depredation was observed throughout the tortoise's range (Esque et al. 2010).

RESPONSE: Sentence has been altered to read "Coyotes are thought to be a major predator of adult tortoises. In a study of translocated tortoises in the Superior-Cronese CHU, between 2008 and 2018 an estimated 60% were killed by predators, likely coyotes based on nearby tracks and scat (Esque et al. 2010, Mack and Berry 2023). " Esque et al. 2010 range wide results are discussed in the paragraph that follows this text.

LINE 1357 (DTRT)

Add Emblidge et al. 2014 citation after badger. Suggest adding this citation from Endangered Species Research 28:109-116 and maybe a statement that evidence is mounting that badgers may play an important role in heavy localized mortality event.

RESPONSE: Have added the text "Badgers are thought to be partially responsible for high levels of mortality of tortoises in 2012-2013 on and near Ft. Irwin and may be important predators in certain locales (Emblidge et al. 2015). "

LINE 1360 (Lovich)

The following two citations also discuss prey switching: Lovich, J.E., S.R. Puffer, K. Cummings, T.R. Arundel, M.S. Vamstad, and K.D. Brundige. 2023. High female desert tortoise mortality in the western Sonoran Desert during California's epic 2012–2016 drought. *Endangered Species Research* 50:1-16. <https://doi.org/10.3354/esr01215> and Lovich et al. 2014 already in lit cit.

RESPONSE: The coyote predation/scavenging discussion in Lovich et al. 2014 is included the section on predation. The 2023 reference was useful for the section on impacts of drought.

LINE 1505 (Nussear)

line 1505 - 1506 " foraging for annuals in the burned areas, while using the cover of perennial shrubs only found in unburned areas (Drake et al. 2015). "

This really isn't true, and not what Drake et al says if you read beyond just the abstract.

Tortoises also used cover in burned areas, and that consisted of both burned and unburned perennials in the scar of the burn. - see also Snyder et al. 2019

RESPONSE: Altered text to "Tortoises tend to remain in same areas after fire (Lovich et al. 2018), and one study found that tortoises used burned and unburned areas nearly equally, starting the first year after the fire (Drake et al. 2015). Tortoises moved into the burned areas seasonally to forage for preferred annuals and herbaceous perennials (Drake et al. 2015). The use of burned habitats did not appear to affect their health or reproduction in the short term. However, the expansion of red brome grass in burned areas and the injuries that fire can cause tortoises remained concerns (Drake et al. 2015)."

LINE 1531 (Lovich)

You might cite SCHUMACHER, I. M., D. C. ROSTAL, R. A. YATES, D. R. BROWN, E. R. JACOBSON, AND P. KLEIN, A. 1999. Persistence of maternal antibodies against *Mycoplasma agassizii* in desert tortoise hatchlings. *American Journal of Veterinary Research*. 60:826-831. as there is no evidence of transmission of URTD from females to their embryos

RESPONSE: Was unable get a copy of this paper and mother to offspring transmission is not mentioned in the document.

LINE 1534 (Lovich)

add "potentially" I'm not aware of evidence that tortoises have to smell to find food

RESPONSE: Have added the word potentially "The disease both directly kills tortoises and can potentially interfere with their sense of smell and therefore their ability to forage for food and can potentially negatively affect their reproductive fitness (Germano et al. 2014, Jacobson et al. 2014)"

LINE 1527-1528 (DTRT)

Suggested edit: The disease presents as lesions in the nasal cavity and inflammation of mucosa of the upper respiratory tract, mucooid discharge from the nares, damaged nasal scales due to chronic mucooid discharge

RESPONSE: Done

LINE 1569 (DTRT)

Delete this sentence. There is no evidence of this. Being captured by humans for research and/or translocation can stress tortoises and make them more susceptible to URTD.

RESPONSE: Unclear what this comment refers to as the original sentence says "Being captured by humans for research and/or translocation can stress tortoises and make them more susceptible to URTD. " However, that sentence has been deleted in the general editing process.

LINE 1580 (Lovich)

Change associated to correlated

RESPONSE: Done. "Shell lesions were correlated with high mortality rates of desert tortoises in Chuckwalla Bench in 1982–1988 "

LINE 1569-1570 (DTRT)

Edit this sentence to the following: Official handling protocols have strict guidelines in place to minimize human-mediated transfer of pathogens stress as much as possible (U.S. Fish and Wildlife Service 2020b, a).

RESPONSE: text altered to "Official handling protocols include strict guidelines to minimize human mediated transfer of pathogens and stress (USFWS 2020b). "

LINE 1636 (Lovich)

morafkai misspelled

RESPONSE: Fixed

LINE 1643 (Lovich)

15.4 tortoises/km squared at my Palm Springs tortoise site as cited in Lovich et al. 2011 already in lit cit

RESPONSE: This whole section has been deleted.

LINE 1647 (DTRT)

"the most recent estimates of abundance..." Predicted abundances at the recovery unit level are available for 2020 from Zylstra et al 2023

RESPONSE: Have deleted this section and deleted the table with abundances from 2014

LINE 1648 (DTRT)

Predicted abundances at the recovery unit level are available for 2020 from Zylstra et al 2023

RESPONSE: Have deleted this section and deleted the table with abundances from 2014

1658 (DTRT)

Recommend incorporating trends and predicted densities from Zylstra et al. 2023 into this section

RESPONSE: Have deleted this section

LINE 1678 (Lovich)

While adult sex ratios in desert tortoises tend to be equal the issue is much more complicated. See these citations: LOVICH, J. E., AND J. W. GIBBONS. 1990. Age at maturity influences adult sex ratio in the turtle *Malaclemys terrapin*. *Oikos*. 59:126-134. AND Lovich, J. E. 1996. Possible demographic and ecologic consequences of sex ratio manipulation in turtles. *Chelonian Conservation and Biology* 2:114-117. AND Lovich, J.E., J.W. Gibbons, and M. Agha. 2014. Does the timing of attainment of maturity influence sexual size dimorphism and adult sex ratio in turtles? *Biological Journal of the Linnean Society* 112:142-149. AND Lovich, J.E., S.R. Puffer, K. Cummings, T.R. Arundel, M.S. Vamstad, and K.D. Brundige. 2023. High female desert tortoise mortality in the western Sonoran Desert during California's epic 2012–2016 drought. *Endangered Species Research* 50:1-16. <https://doi.org/10.3354/esr01215>

RESPONSE: Have added Lovich 2023 as a citation, see below.

LINE 1680 (Lovich)

Not true. See Lovich, J.E., S.R. Puffer, K. Cummings, T.R. Arundel, M.S. Vamstad, and K.D. Brundige. 2023. High female desert tortoise mortality in the western Sonoran Desert during California's epic 2012–2016 drought. *Endangered Species Research* 50:1-16. <https://doi.org/10.3354/esr01215>

RESPONSE: This comment refers to sex ratios. The sex ratio text has been moved to section 4.6 Climate Change and Drought and now reads "There is some evidence that drought is affecting sex ratios of adult tortoises. Unequal sex ratios are thought to lower effective population size, which in small populations with limited connectivity could exacerbate inbreeding (Frankham 1995). In 2015–2016, Lovich et al. (2023) surveyed two sites in Shaver's Valley about 70 km southeast of Palm Springs along the boundary of the Joshua Tree and Chuckwalla TCAs. At both sites there was a male bias in live tortoises. At the cooler, wetter site there was an even sex ratio in tortoises found dead, but in the hotter and drier Chuckwalla site, more females were found dead. It is possible that the energetic requirements required for reproduction make females less likely to survive long-term drought conditions (Lovich et al. 2023)."

LINE 1680 (Nussear)

Line 1680 you state "Unfortunately, there are no published data on sex ratios in the 17 TCAs (Berry and Murphy 2019)," - this isn't really the case, Allison and Mcluckie, Esque et al, and many other studies and datasets exist.

RESPONSE: Deleted

LINE 1658-1659 (Lovich)

Are these "small populations"?

RESPONSE: Have deleted section on small populations.

LINE 1671-1676 (Lovich)

This is discussed in more detail in Lovich, J.E., J.R. Ennen, M. Agha, and J.W. Gibbons. 2018. Where have all the turtles gone, and why does it matter? *BioScience* 68:771–781. The long lives of tortoises can give the perception of population persistence even with no juvenile recruitment.

RESPONSE: Moved text to section 3.2 Trends in Density and Abundance has been added "Even with thousands of adults in a population, if sufficient juvenile tortoises are not surviving to breeding age, the population will decline without interventions like head-starting, although that decline may take decades to manifest (Lovich et al. 2018)."

LINE 1694 (Lovich)

cite Lovich, J.E., S.R. Puffer, K. Cummings, T.R. Arundel, M.S. Vamstad, and K.D. Brundige. 2023. High female desert tortoise mortality in the western Sonoran Desert during California's epic 2012–2016 drought. *Endangered Species Research* 50:1-16. <https://doi.org/10.3354/esr01215>

RESPONSE: Resolved, see above

LINE 1815 (Lovich)

"The" Mojave Desert Tortoise

RESPONSE: Fixed

LINE 1847 (Lovich)

How about Utah?

RESPONSE: Added Utah. "The Desert Tortoise Management Oversight Group (MOG), formed in 1994, is comprised of senior managers from USFWS, BLM, state transportation agencies, state

wildlife agencies, county governments, and non-governmental organizations (NGOs) that work in the tortoise range in Arizona, Nevada, Utah, and California. "

LINE 1871 (DTRT)

"In 2008 and 2011....". 2008 was a draft for review. Please only use 2011.

RESPONSE: Deleted 2008

LINE 1871 (DTRT)

Suggested edit: "the USFWS published revisions to the a Revised Recovery Plan..."

RESPONSE: Done

LINE 1880 (DTRT)

delete 2008

RESPONSE: Done

LINE 1886 (DTRT)

Edit to "As part of the revised 2011 Revised Recovery Plan".

RESPONSE: Done

LINE 1957 (Lovich)

You included the Yermo logistics base earlier but not here (and they have tortoises)

RESPONSE: Amended "DoD facilities within the Mojave Desert Tortoise range include Naval Air Weapons Station China Lake, Edwards Air Force Base, Fort Irwin, Marine Air Ground Task Force Training Command and Marine Corps Air Ground Combat Center Twenty-Nine Palms, Marine Corps Logistics Base Barstow, and the Chocolate Mountain Aerial Gunnery Range. "

LINE 2079 (Nussear)

Line 2079 - competition, you should probably address that there is active grazing of sheep and cattle in California, and whether that overlaps with desert tortoises (it does), and where and to what extent that occurs.

RESPONSE: This section has been reworked and a new section 4.4 Competition has been added to better align the document with statutory requirements. The text now reads "Grazing by livestock is a major part of the recent history of the desert. While grazing on BLM lands was historically permitted in tortoise range (Berry et al. 2014) after federal listing in 1990 it was halted in the CHUs. However, grazing is allowed on private inholdings within the CHUs, which are often unfenced. The documented impacts of livestock on tortoises include competition for food, trampling to death, and causing the collapse of burrows (see Berry and Murphy (2019)). Livestock also degrade habitat by creating or expanding trails which reduces annual plant cover and can (but does not always) promote wind erosion and compaction (Webb and Stielstra 1979, Lovich and Bainbridge 1999). "

LINE 2097 (Nussear)

Line 2097: Climate change - there are local and regional modeling efforts that demonstrate a predicted loss of habitat. The potential for this to impact tortoise populations lies far beyond the potential for the military to train more.

RESPONSE: True, have added this sentence "Modelling by Barrows (2011) predicts that under 2°C (3.6°F) of warming with 50 mm decrease in precipitation, habitat area will decrease by about 88% in the Sonoran Desert portion and by about 66% in the Mojave Desert portion."

LINE 2172 (Lovich)

You should cite Lovich, J.E., J.R. Ennen, S.V. Madrak, and B. Grover. 2011. Turtles, culverts and alternative energy development: an unreported but potentially significant mortality threat to



the desert tortoise (*Gopherus agassizii*). *Chelonian Conservation and Biology* 10:124-129.  
Culverts can be death traps for tortoises.

RESPONSE: This section has been deleted, but have added this sentence section 4.2 on road fencing "However, proper design is key, culverts can become death traps for tortoises if not properly designed and implemented (Lovich et al. 2011)."

LINE 2176 (Lovich)

Cite Hunter et al. above?

RESPONSE: This section has been deleted to bring the document in line with regulatory requirements

LINE 2230-2237 (DTRT)

General Comment. Given the declining status Mojave desert tortoises in California and continued habitat loss and degradation due to increased human activity and infrastructure, we agree that the Department's recommendation to change the status of Mojave desert tortoises from threatened to endangered is warranted in California.

LINE 2330 (Lovich)

There is no discussion of the negative effects of fencing on tortoises and other wildlife and there is a huge literature on that needs to be mentioned

RESPONSE: Have emphasized that the fencing has to be well designed "Erecting well designed tortoise exclusion fencing along major roadways and funneling them into appropriate crossings is a key recovery action. "

LINE 2374 (Lovich)

Has anyone ever quantified the effectiveness of these efforts? It may use funds that could be more meaningful in other recovery efforts

RESPONSE: There may not be specific quantification of the impact of outreach in this particular case, but there is a large body of research about effective ways to communicate with the public and how it can impact behavior change.

LINE 2397-2401 (DTRT)

Suggested edit: Population augmentation is currently accomplished through two types of projects, mitigation-driven translocation and release of head-started juveniles. Mitigation-driven translocation involves moving tortoises from a site where they would be harmed and into an appropriate recipient site. Head-starting is a strategy to reduce predation mortality on juvenile tortoises by hatching and rearing juveniles in captivity until they are large enough to avoid most predators. In the future, conservation-based translocations of adults may also be possible.

RESPONSE: Much of this section has been moved to section 5.2 Management Efforts. The first suggested text changes were made but the Department will leave any discussion of conservation-based translocation to a future Recovery Plan

LINE 2406-2411 (DTRT)

Suggested edit. There are a number of considerations that need to be taken into account when tortoises are translocated as laid out in the USFWS's guidance on translocating tortoises from project sites Plan Development Guidelines (U.S. Fish and Wildlife Service 2020b).

Considerations Major concerns include the habitat suitability of potential translocation sites

and the disease prevalence of both tortoises being moved and at the recipient site possibility of disease transfer from transplants to resident tortoises.

RESPONSE: Much of this section has been moved to section 5.2 Management Efforts, but the suggested text edits were made.

LINE 2408 (DTRT)

Suggested edit: Considerations recipient site of potential translocation sites and the disease prevalence of both tortoises being moved into and at the recipient site.

RESPONSE: The section on translocation was heavily modified and moved. This sentence has been deleted.

LINE 2409 (DTRT)

In reference to resident tortoises - This is only part of it. The residents can also transfer pathogens to the translocated and increased contacts rates could change the background disease dynamics at the site.

RESPONSE: Have clarified with the suggested edits above.

LINE 2410 (DTRT)

In reference to "ITP holders monitor" - Please consider the monitoring guidance in USFWS 2020b vs requiring the monitoring of small numbers of translocated tortoises.

RESPONSE: Have re arranged the paragraphs and add the text "The Department" to clarify that these are monitoring actions via CDFW ITPs and not guidance issued by USFWS

LINE 2412 (DTRT)

In reference to "sufficient burrows of appropriate size...": Existing burrows should not be a requirement. The focus should be on shelter sites in general. They must be able to seek shade and protection immediately, but that doesn't need to be within a burrow. The abundance of other types of shelter is likely more important, as tortoises released into a new environment would need to find the existing burrow vs taking immediate shelter under shrubs, boulders, etc.

RESPONSE: This paragraph discusses actions related to ITPs issued by CDFW which can differ from the USFWS guidance on burrows vs shelter sites. Have rearranged the paragraphs and added some text to make that more clear "The Department requires that ITP holders monitor any tortoises translocated, and has teams carefully examine recipient sites for soil and vegetation communities that are suitable for all life stages of the tortoise, evaluate the presence and abundance of predators, and make sure there are sufficient burrows of appropriate size so that translocated tortoises can quickly find shelter"

LINE 2419 (DTRT)

Start this paragraph as... "There is evidence from more than a dozen sites that translocation, including large-scale translocation, can be an important conservation tool (Brand et al. 2016, Dickson et al. 2019, Drake et al. 2012, Esque et al. 2010, Farnsworth et al. 2015, Field et al. 2007, Harju et al. 2019, Hinderle et al. 2015, Nafus et al. 2017, Nussear et al. 2012). Finding recipient sites for for large numbers of tortoises is challenging. If donor sites are chosen because resident populations are depleted ..."

RESPONSE: Have included these references in this paragraph "Beyond the survival of tortoises involved in large scale translocations, there have been many studies looking at how body conditions and temperature (Brand et al. 2016), environmental feature and conditions (Nafus et al. 2017, Dickson et al. 2019), physiological stress (Drake et al. 2012), proximity of anthropogenic resources (Esque et al. 2010), movement and space use (Nussear et al. 2012,

Farnsworth et al. 2015, Hinderle et al. 2015), and water availability (Field et al. 2007) affect the outcomes of translocations. These results should be used to keep improving and refining decision making around translocations." This text is now in section 5.2 Management Efforts

LINE 2429 (Nussear)

you misrepresent the findings in Esque 2010 - animals that were in control groups also suffered similar mortality rates, as did animals throughout the range of the tortoise. Another oversight is that you don't factor in the number of animals lost from habitat if they are removed and not translocated. This is an important consideration - The better option is to find alternative siting for things like solar facilities etc that result in the loss and degradation of tortoise habitat, but the continued lack of the ability to say no to these large scale disturbances leaves you with little choice.

RESPONSE: The translocation section was extensively rewritten to incorporate this and other feedback

LINE 2402 onward (Lovich)

This section doesn't do much to change my perception of the lack of effectiveness of translocation based on the literature. You should cite: SULLIVAN, B. K., E. M. NOWAK, AND M. A. KWIATKOWSKI. 2015. Problems with mitigation translocation of herpetofauna. *Conservation Biology*. 29:12-18. AND GERMANO, J. M., K. J. FIELD, R. A. GRIFFITHS, S. CLULOW, J. FOSTER, G. HARDING, AND R. R. SWAISGOOD. 2015. Mitigation-driven translocations: are we moving wildlife in the right direction? *Frontiers in Ecology and the Environment*. 13:100-105. AND GERMANO, J. M., AND P. J. BISHOP. 2008. Suitability of amphibians and reptiles for translocation. *Conservation Biology*. 23:7-15.

RESPONSE: The translocation section was extensively rewritten to incorporate this and other feedback

LINE 2413-2414 (DTRT)

In reference to "most of the tortoises translocated under IPTs...." - Does the Department try to keep them within 4 miles or is this a result of moving from harm's way into adjacent habitat? Putting such restraints on the distance tortoises can be moved will limit the ability to get tortoises into good quality, high priority augmentation sites that are consistent with greater conservation objectives.

RESPONSE: Have added the text "(although distance is only one of many considerations when choosing a recipient site)" This sentence is now in section 5.2 Management Efforts

LINE 2456- (DTRT)

Edit translation to translocation

RESPONSE: Done

LINE 2489 (DTRT)

In reference to "high death rates". Unlikely. Studies showed former captives did very well when in good health upon release. More likely factors were the lack of stringent translocation suitability evaluations and rigorous health assessments as are now requirements.

RESPONSE: The translocation section was extensively rewritten to incorporate this and other feedback

LINE 2486-2499 (DTRT)

Suggest editing this paragraph to the following. "The failure of these large and long-term translocations to either keep translocated tortoises alive or the resident population stable

suggests translocation may often not be an effective management strategy without figuring out and addressing the drivers of declines within the subject populations. Augmentation of populations through translocations may buy time and keep tortoises present on the landscape while the threats causing declines are addressed. The majority of the tortoises translocated into LSTS came from captivity and were likely not well adapted to surviving in the wild, which is likely a factor in their high death rates. Most official translocations in California involve moving wild tortoises from a project site to a nearby area, and so may not face the same difficulties in survival that releasing captive tortoises appear to create. However, the evidence from Ord-Rodman suggests that even an addition of large numbers of new adults to a nearby area can slow but does not prevent population declines. The low survival rates of translocated adults and the lack of genetic integration of males suggest that large scale translocation may not provide much recorded benefit to recipient populations and does not necessarily remove the translocated tortoises from harm's way. Thus, identification of the reasons for the depleted population in the recipient site is important to ensure translocation is conducted in a manner appropriate to facilitate survival, and to prevent its failure as a minimization measure."

RESPONSE: The translocation section has been modified extensively, but this particular text is now "However, given the continuing decline of tortoise populations in general, translocations may often not be an effective conservation strategy without addressing the drivers of declines within the subject populations. At best, augmentation of populations through translocations can buy time and keep tortoises present on the landscape while the threats causing declines are addressed. "

LINE 2487-2488 (Lovich)

If it isn't an effective strategy, why pursue it?

RESPONSE: The translocation section was extensively rewritten to incorporate this and other feedback

LINE 2520 (Lovich)

The Frazer citation above should be incorporated in this section

RESPONSE: Have added text " Daly et al. (2019) points out that by itself, head-starting is unlikely to lead to population recovery if larger issues that depress survival such as raven density and habitat degradation are not addressed. Another consideration is that unless factors that depress adult survival are also reduced, focusing on putting more juveniles in a "degraded environment in which their parents have already demonstrated that they cannot flourish" is not an effective long-term solution (Frazer 1992). "

LINE 2541 (DTRT)

Delete "yearly"

RESPONSE: Done

LINE 2545 (Lovich)

How would making sex ratio data public help stakeholders given the complexities of interpreting sex ratios listed above in this spreadsheet?

RESPONSE: Have deleted this paragraph

LINE 2545 (Nussear)

Line 2545 - Regarding sex ratio data - these are easily obtained. Just ask the FWS for it, I have done so repeatedly and they have always been happy to provide it. This seems like a straw man argument that is a result of poor communication.

RESPONSE: Have deleted this paragraph

LINE 2568 (Lovich)

Adaptive management is thrown around by people that don't fully understand what it means. In its simplest form it is using policy as a testable hypothesis, monitoring its effectiveness, adjusting the policy to increase effectiveness and repeating the cycle. Is that what you mean? It requires a substantial investment of time and people as shown in the Glen Canyon Dam Adaptive Management Program <https://www.usbr.gov/uc/progact/amp/index.html>.

RESPONSE: Have altered to "Implement a formal Recovery Plan"

LINE 2615 (Lovich)

Why only 5 years for a species with a cohort generation time of about 25 years that lives to be 50 or so? Isn't recruitment an important component of success?

RESPONSE: Ideally the monitoring period would be longer for such a long lived animal, but until the Department effectively organizes and analyzes the data they have, asking permit holders to do more monitoring seems like an unnecessary burden.

LINE See section 2.2. (DTRT)

Comment. Too much of 2.2 Species Description and Life History is extrapolated from Berry and Murphy 2019. Please review broader literature for appropriate citations and information.

RESPONSE: Some primary references have been added to this section thanks to the suggestions of multiple reviewers, but as stated in section 1.2, the status review is not intended to be an exhaustive review of all published scientific literature on Mojave Desert Tortoise; rather it is intended to summarize key points relevant to the status of the species and address regulatory report requirements.

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State of California  
Natural Resources Agency  
Department of Fish and Wildlife

**DRAFT** REPORT TO THE FISH AND GAME COMMISSION  
STATUS REVIEW OF MOJAVE DESERT TORTOISE  
(*Gopherus agassizii*)

[DATE]



Mojave Desert Tortoise, BLM photo by Dana Wilson

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Charlton H. Bonham, Director  
Department of Fish and Wildlife



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33 *Suggested citation:*

34 California Department of Fish and Wildlife (CDFW). [DATE]. Status Review of Mojave Desert  
35 Tortoise (*Gopherus agassizii*). Report to the California Fish and Game Commission. California  
36 Department of Fish and Wildlife, 715 P Street, Sacramento, CA 95814. 188 pp., with appendices.

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121	<b>LIST OF ABBREVIATIONS, ACRONYMS, AND TERMS</b>	
122	CEQA – California Environmental Quality Act	
123	NEPA – National Environmental Policy Act	
124	CESA – California Endangered Species Act	
125	CNDDDB – California Natural Diversity Database	
126	Commission – California Fish and Game Commission	
127	Department – California Department of Fish and Wildlife	
128	CHU – Critical Habitat Unit	
129	RU – Recovery Unit	
130	TCA –Tortoise Conservation Area	

- 131 DoD – Department of Defense
- 132 ESA – Endangered Species Act
- 133 NPS – National Park Service
- 134 USFWS – United States Fish and Wildlife Service
- 135 BLM – Bureau of Land Management
- 136 ITP – Incidental Take Permit
- 137 NEPA – The National Environmental Policy Act
- 138 et al. – “and others”

139 **EXECUTIVE SUMMARY**

140 This Status Review of Mojave Desert Tortoise (*Gopherus agassizii*; also known as Agassiz’s Desert  
141 Tortoise) has been prepared by the California Department of Fish and Wildlife (Department) for  
142 the California Fish and Game Commission (Commission) pursuant to the requirements of the  
143 California Endangered Species Act (CESA; Fish & G. Code, § 2050 et seq.).

144 The Mojave Desert Tortoise was designated a threatened species under CESA in 1989. On  
145 March 23, 2020, the Commission received a petition from the Defenders of Wildlife, the  
146 Desert Tortoise Council, and the Desert Tortoise Preserve Committee to change the status of  
147 the Mojave Desert Tortoise from threatened to endangered. On April 13, 2020, the  
148 Commission referred the Petition to the Department for evaluation pursuant to Fish and  
149 Game Code section 2073 and published a formal notice of receipt of the petition (Cal. Reg.  
150 Notice Register 2020, No. 18-Z, p. 693). At its meeting on August 20, 2020, the Commission  
151 received the Department’s petition evaluation report. The Department based its evaluation  
152 on available information and recommended to the Commission that the petition be  
153 accepted. At its October 14, 2020 meeting, the Commission accepted the petition to change  
154 the status of the Mojave Desert Tortoise from threatened to endangered (Cal. Reg. Notice  
155 Register 2020, No. 44-Z, p. 1445). As a result, the Department was directed to complete this  
156 Status Review, which is a detailed evaluation of the current status of the tortoise and  
157 includes its recommendation regarding whether the tortoise's status should be changed  
158 from threatened to endangered.

159  
160 This Status Review is based on the best scientific information currently available to the  
161 Department regarding each of the components listed under section 2072.3 of the Fish and Game  
162 Code, and section 670.1 of Title 14 of the California Code of Regulations. In addition, this Status  
163 Review includes a preliminary identification of habitat that may be essential to the continued  
164 existence of the species, and the Department’s recommendations for management activities and  
165 other recommendations for recovery of the species. (Fish & G. Code, § 2074.6.). This Status  
166 Review has been independently reviewed by scientific peers pursuant to Fish and Game Code  
167 section 2074.6.

168 **Species Description, Biology, and Ecology**

169 In 2011, studies of tortoise genetics, morphometrics, and ecology led experts to conclude that  
170 the complex formerly known as “Desert Tortoise” in fact consists of two separate species—  
171 Mojave Desert Tortoise and Sonoran Desert Tortoise. Mojave Desert Tortoise, also known as  
172 Agassiz’s Desert Tortoise, retains the binomial *G. agassizii*, and ranges across the deserts of  
173 southeastern California, southern Nevada, and small areas of Arizona and Utah north of the  
174 Colorado River.

175 The Mojave Desert Tortoise is a long-lived, desert-dwelling reptile. Tortoise body temperature is  
176 closely linked to the temperature in the environment, and Mojave Desert Tortoises live in places  
177 that can fluctuate up to 40°C (104°F) seasonally. They primarily regulate their temperature by

178 using underground burrows where the air is cooler and moister than the outside air in summer  
179 and warmer in winter and can spend more than 90% of their lives underground.

180 Females become sexually mature at 12–20 years old and lay a maximum of 30 eggs per year and  
181 nest in a den or burrow or under trees. Nest predation is common, with 12–55% of nests  
182 generally destroyed by predators. Reported incubation time in the wild varies from 67–104 days  
183 and incubation temperatures determine the sex of the hatchlings, with hotter temperatures  
184 producing female-skewed clutches.

185 Tortoises selectively feed on forbs, grasses, and herbaceous perennial plants and will consume  
186 cacti during droughts. They favor native plants and plant parts that are high in water and low in  
187 potassium. Much of the range of the desert tortoise is highly invaded by nonnative plants like  
188 red brome, cheat grass, red stem filaree, and African mustard, but tortoises avoid eating exotic  
189 grasses when possible as they are low in nitrogen and require relatively large amounts of water  
190 to process.

191 Desert tortoise habitat typically consists of alluvial fans and plains and colluvial/bedrock slopes  
192 that facilitate the digging of burrows. Tortoises need sufficient food plants as well as larger  
193 shrubs and bushes for shade and protection of burrows. They are associated with saltbush,  
194 creosote bush, white bur-sage, and cheesebush. At higher elevations, tortoises are more likely to  
195 be found near Joshua tree, Mojave yucca, and blackbrush. Tortoises occur in very low densities  
196 or are absent where shrub cover is sparse, precipitation is low, and annual food plants are  
197 available only intermittently (e.g., the lower elevations in Death Valley). They also occur at low  
198 densities in moderately to severely disturbed areas, regardless of desert or region.

199 Ravens are a major predator of juvenile tortoises while coyotes target both juvenile and adult  
200 tortoises. Raven populations have expanded dramatically in the desert due to resource subsidies  
201 from humans.

## 202 **Status and Trends**

203 In California, the range of the Mojave Desert Tortoise includes the Mojave Desert and portions  
204 of the Sonoran and Great Basin deserts from the southern end of the Owens Valley south of the  
205 town of Lone Pine in Inyo County to the Mexican border near the southeastern corner of the  
206 state, and from the Colorado River in the east to the lower slopes of the Sierra Nevada,  
207 Transverse, and Peninsular mountains in the west.

208 The most robust estimates of densities come from annual systematic surveys done in the  
209 Tortoise Conservation Areas (TCAs). These surveys began in 2004 and cover large areas of the  
210 best habitat for tortoises, including federally designated critical habitat. Most of the surveys  
211 provide consistent evidence that populations are declining at rapid rates. In 2004–2014,  
212 densities in the TCAs declined between 3.3% and 10.8% per year. These rates are unsustainable  
213 for most species, but especially for a long-lived and slow-reproducing species such as the desert  
214 tortoise. Sixty percent of the TCAs currently have densities below that which is necessary for  
215 population viability (3.9 adult tortoises/km<sup>2</sup>), while another 30% are at the threshold. Only one

216 TCA currently has a tortoise density above what is needed for population viability. While we do  
217 not have estimates of density in all the TCAs prior to the desert tortoise being listed as  
218 threatened in 1989, densities in select TCAs varied between 35 and 90 adults/km<sup>2</sup> in the early  
219 1980s, and between 35 and 70 adults/km<sup>2</sup> when they were listed. It is estimated that densities  
220 of adults in certain TCAs fell between 89% and 97% from the early 1980s to 2020–2021. Since  
221 the late 1970s, the number of juveniles detected on surveys has also fallen sharply, to the point  
222 that in recent surveys in the western Mojave Desert almost no juveniles were found. The  
223 population data available indicate that there were sharp drops in density before listing as  
224 threatened, and those losses have continued to the point where much of the best tortoise  
225 habitat no longer supports viable tortoise densities.

226 The slow maturation and low reproductive rates of tortoises means that if past and current  
227 management is successful at addressing threats and stemming the decline of tortoise  
228 populations, it would still take at least 25 years of positive population growth to reach the  
229 USFWS Recovery Criteria (U.S. Fish and Wildlife Service 2022a). For example, the USFWS 1994  
230 Recovery Plan estimates that when adult survivorship is 98%, population growth would be less  
231 than 0.5% per year, and would take 140 years to double in size. Annual survival rates for both  
232 adults and juveniles are much lower than 98% in most areas, making population stability, let  
233 alone growth, unlikely. Collectively, the available data show that in the critical habitat units  
234 (which are assumed to be the best tortoise habitat), tortoise densities are low to very low, and  
235 despite 30 years of state and federal protection, tortoise populations continue to decline and do  
236 not show consistent signs of recovery.

### 237 **Threats**

238 The dramatic declines in Mojave Desert Tortoise populations are likely due to the extensive  
239 number and interconnected nature of the threats they face. The important threats fall in two  
240 categories, those that directly kill adults and juveniles, and those that cause longer-term changes  
241 to habitat availability and quality.

242 In long-lived species that are slow to reproduce, decreased survival has long lasting impacts on  
243 the population and can alter demographic patterns for decades. Increased numbers of predators  
244 including ravens and coyotes reduce the survival of juvenile and adult tortoises, respectively.  
245 Development within the tortoise range often creates roads that can lead to road-killed tortoises,  
246 and extensive networks of trails for off highway vehicles on public land increase the chance that  
247 tortoises will be run over in areas without paved roads. Well-designed fences and culverts can  
248 help prevent tortoises and other wildlife being killed by vehicles along major roads, but little  
249 fencing has been built since 2011.

250 Habitat modification and destruction reduces the amount of habitat that can support tortoises  
251 in the long-term. Although a large proportion of desert tortoise range is under federal control,  
252 renewable energy, housing, illegal cannabis, and other types of development reduce the amount  
253 of habitat available. The Department of Defense is a large landowner in desert tortoise range  
254 and frequently expands the areas that it uses for training, requiring translocation of hundreds of  
255 tortoises. Large scale tortoise translocations do not tend to have high survival rates.

256 Additional factors have direct and indirect impacts on tortoises and their habitat. Climate  
257 change, which is likely to cause hotter and periodically drier conditions in the desert tortoise  
258 range, will increase their physiological stress and change activity patterns. The nutritious native  
259 vegetation tortoises feed on are being outcompeted by nutritionally poor invasive grasses,  
260 which can lower tortoise survival rates. Fires fueled by invasive grasses decrease the amount of  
261 native vegetation available for tortoises to feed on and remove other important vegetation  
262 components of tortoise habitat.

263 Some threats appear to be declining since the species was listed. Upper respiratory tract  
264 diseases were a major concern when tortoises were listed as threatened. Encouragingly, the  
265 prevalence of diseased tortoises is lower than in previous decades, and it does not appear to be  
266 an acute threat to wild populations. The prevalence of gunshot deaths has also decreased in the  
267 past several decades, but it is unclear if this is due to change in human behavior or simply  
268 reflects a lower tortoise encounter rate due to declining tortoise density.

269 Historical and current conservation efforts have not proven sufficient to halt the population  
270 declines of desert tortoise. However, there is still a large amount of available habitat and even at  
271 low densities, in 2014 there were estimated to be more than 61,000 adult tortoises within the  
272 TCAs. This is a decrease from an estimated 310,000 adults in 2004, and as densities have  
273 continued to fall since 2014, current abundance is likely lower than 60,000 adult tortoises. Given  
274 that there are multiple interacting threats that are reducing the amount and quality of viable  
275 habitat and lowering survival rates of adults and juveniles, the available information suggests  
276 that tortoises populations will continue to decline for the foreseeable future. However, several  
277 of the major threats like raven predation on juveniles and the lack of tortoise exclusion fencing  
278 on highways are issues that can be addressed with the appropriate resources and policy  
279 changes. Implementing these actions where appropriate to improve survival in the short term is  
280 critical to give desert tortoises populations the resilience to weather longer term habitat and  
281 climactic effects.

282 Several recommended management actions are described in this report. Improved coordination  
283 and communication between the Department and other state and federal agencies would help  
284 the implementation of these actions. We also point to several needs for increasing capacity at  
285 the Department to better track the impact of threats and conservation actions on tortoise  
286 populations.

287 **Recommendation**—The Department provides this status review report, including its  
288 recommendation, to the Commission in an advisory capacity based on the best scientific  
289 information available. In consideration of the scientific information contained herein, the  
290 Department has determined that listing the Mojave Desert Tortoise as endangered under CESA  
291 is warranted at this time.

## 292 **1. REGULATORY SETTING**

### 293 **1.1 Petition Evaluation Process**

294 On March 23, 2020, the Commission received a Petition from Defenders of Wildlife, The  
295 Desert Tortoise Council, and The Desert Tortoise Preserve Committee to change the status  
296 of Mojave Desert Tortoise from threatened to endangered. On April 13, 2020, the  
297 Commission referred the Petition to the Department for evaluation pursuant to Fish and  
298 Game Code section 2073 and published a formal notice of receipt of the petition (Cal. Reg.  
299 Notice Register 2020, No. 18-Z, p. 693). At its meeting on April 16, 2020, the Commission  
300 officially received the Petition.

301  
302 A petition to list, delist, or change the status of a species under CESA must include  
303 “information regarding the population trend, range, distribution, abundance, and life  
304 history of a species, the factors affecting the ability of the population to survive and  
305 reproduce, the degree and immediacy of the threat, the impact of existing management  
306 efforts, suggestions for future management, and the availability and sources of  
307 information. The petition shall also include information regarding the kind of habitat  
308 necessary for species survival, a detailed distribution map, and any other factors that the  
309 petitioner deems relevant” (Fish & G. Code, § 2072.3).

310  
311 The Department’s charge and focus in its advisory capacity to the Commission is scientific,  
312 and it evaluates petitions based on the best scientific information available regarding  
313 potential listing factors including those listed above. At its meeting on August 20, 2020, the  
314 Commission received the Department’s petition evaluation report, which is intended to  
315 assist the Commission in making a determination as to whether the petitioned action may  
316 be warranted based on the sufficiency of scientific information (Fish & G. Code, §§ 2073.5  
317 & 2074.2; Cal. Code Regs., tit. 14, § 670.1, subds. (d) & I). Focusing on the information  
318 available to the Department relating to each of the required information categories listed  
319 above, the Department recommended to the Commission that the petition be accepted.

320  
321 At its public meeting on October 14, 2020, the Commission considered the petition, the  
322 Department’s petition evaluation and recommendation, and comments received. The  
323 Commission found that sufficient information existed to indicate the petitioned action may  
324 be warranted and accepted the petition for consideration. Upon publication of the  
325 Commission’s notice of its findings, the Mojave Desert Tortoise was designated a candidate  
326 species on October 19, 2020 (Cal. Reg. Notice Register 2020, No. 44-Z, p. 1445).

## 327 328 **1.2 Status Review Overview**

329 The Commission’s decision to designate the Mojave Desert Tortoise as a candidate species  
330 triggered the Department’s process for conducting a 12-month status review to inform the  
331 Commission’s decision on whether the change in status is warranted (Fish & G. Code, § 2074.6  
332 and Cal. Code of Regs., title 14, § 670.1). At its meeting on October 14, 2021, the Commission  
333 granted the Department a six-month extension to complete the status review and facilitate  
334 external peer review.



335 This status review report is not intended to be an exhaustive review of all published scientific  
336 literature relevant to the Mojave Desert Tortoise. Rather, it is intended to summarize the best  
337 scientific information available relevant to the status of the species, provide that information to  
338 the Commission, and to serve as the basis for the Department’s recommendation to the  
339 Commission on whether the petitioned action is warranted. This final report is informed by  
340 independent peer review of an earlier draft by scientists with expertise relevant to the Mojave  
341 Desert Tortoise. Specifically, this status review represents the Department’s evaluation of  
342 whether the status of the tortoise should be changed from threatened to endangered. Species  
343 that are “threatened” are not presently threatened with extinction but are likely to become  
344 endangered in the foreseeable future without special protection and management. An  
345 “endangered” species is one that is in serious danger of becoming extinct throughout all or a  
346 significant portion of its range due to one or more of the following factors: present or  
347 threatened modification or destruction of its habitat; overexploitation; predation; competition;  
348 disease; or other natural occurrences or human-related activities. (Fish & G. Code, § 2062; §  
349 2067; Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A.)). The status review report also identifies  
350 habitat that may be essential to the continued existence of the species and provides  
351 management recommendations for recovery of the species (Fish & G. Code, § 2074.6).

352 Receipt of this report is to be placed on the agenda for the next available meeting of the  
353 Commission after delivery. At that time, the report will be made available to the public for a 30-  
354 day public comment period prior to the Commission taking any action on the petition.

## 355 **2. BIOLOGY**

### 356 **2.1 Taxonomy**

357 Desert tortoises are members of the order Testudines, family Testudinidae, genus *Gopherus*.  
358 When the Commission listed Desert Tortoise as threatened in 1989, *Gopherus agassizii* was  
359 understood to range from southeastern California, across southern Nevada, through western  
360 Arizona, and south into Sonora and Sinaloa, Mexico. In 2011, studies of tortoise genetics,  
361 morphometrics, and ecology led experts to conclude that the complex formerly known as  
362 “Desert Tortoise” in fact consists of two separate species, Mojave Desert Tortoise and Sonoran  
363 Desert Tortoise (Murphy et al. 2011, Iverson et al. 2017). Mojave Desert Tortoise, also known as  
364 Agassiz’s Desert Tortoise or Mohave Desert Tortoise, retains the binomial *G. agassizii*, and  
365 ranges across the deserts of southeastern California, southern Nevada, and small areas of  
366 Arizona and Utah north of the Colorado River. Desert tortoises east of the Colorado River in  
367 Arizona and northern Mexico are now classified as Sonoran Desert Tortoise, also known as  
368 Morafka’s Desert Tortoise (*Gopherus morafkai*). Only the Mojave Desert Tortoise occurs in  
369 California. This status review uses the common name Mojave Desert Tortoise when referring to  
370 *G. agassizii* as the species is currently understood. Any reference to Agassiz’s or Mohave Desert  
371 Tortoise in this document should be considered synonymous with Mojave Desert Tortoise.

### 372 **2.2 Species Description and Life History**

373 Much of the information in this section is summarized from a Berry and Murphy (2019)  
374 monograph on *Gopherus agassizii*. The Mojave Desert Tortoise is a long-lived, desert-dwelling  
375 reptile. The upper shell or carapace of adults ranges in size from 178mm to over 370mm in  
376 length. Shell color varies from light yellow to dark charcoal in hatchling tortoises and from light  
377 to dark brown in adults (Berry and Murphy 2019). The largest measured wild individual was a  
378 female in 1986 whose carapace length was 374 mm. The largest male measured in the wild was  
379 330 mm carapace length (Berry and Murphy 2019).



380  
381 **Figure 1.** Mojave Desert Tortoise. Pictures by Dana Wilson BLM (left) and Roy Averill-Murray  
382 USFWS (right).  
383

384 Desert tortoises make extensive use of underground burrows to regulate body temperature and  
385 as protection from predators. Temperatures in burrows can be up to 20°C (36°F) cooler than  
386 summer air temperatures, especially very deep in the burrows (Berry and Murphy 2019). Home  
387 range size depends on sex, age, and environmental conditions. Over a 2-year study in the  
388 western Mojave Desert, male home range size was 39–47 ha and female home range size was  
389 14–17 ha (Harless et al. 2009). Home ranges of juveniles tend to be smaller, and home ranges  
390 are larger during wet years than in dry years. Home ranges of individuals can overlap (O’Connor  
391 et al. 1994) and in the western Mojave Desert Harless et al. (2009) found that males overlap  
392 more with other tortoises than do females. They also found that the overlap in area in an  
393 individual’s home range from one year to the next was ~35% and did not vary significantly by  
394 sex. Individuals tend to have fidelity to home ranges and activity centers, even after fire (Drake  
395 et al. 2015, Lovich et al. 2018).

396 Tortoises are long-lived and females are thought to become sexually mature at 12–20 years old,  
397 depending on locality (Woodbury and Hardy 1948, Turner et al. 1986, Curtin et al. 2009).  
398 Generation time is estimated to be around 25 years (U.S. Fish and Wildlife Service 1994). Mating  
399 occurs in late summer and fall, and females can mate with multiple males (Davy et al. 2011).  
400 Female tortoises can store sperm/delay implantation so that nesting and egg laying occurs in  
401 April–July depending on the region (Berry and Murphy 2019). Females lay 0–3 clutches in the  
402 spring and the number of eggs laid per clutch ranges from 1–10. Females nest in a den or burrow  
403 under large shrubs. There are anecdotal reports of females nest guarding against humans and  
404 Gila Monsters, but there is no parental care once eggs have hatched (Berry and Murphy 2019).  
405 Reported incubation time in the wild varies from 67–104 days (McLuckie and Fridell 2002) and

406 incubation temperatures determine the sex of the hatchlings. Sex ratios were 1:1 at an  
407 incubation temperature of 31.3°C (88.3°F), while eggs incubated at under 30°C (86°F) produced  
408 only male hatchlings and only females hatched from eggs incubated over 32.5° (90.5°F) (Rostal  
409 et al. 2002). Nest predation is common, with 12–55% of nests generally destroyed by predators  
410 (Berry and Murphy 2019). When nests are not predated, hatchling success is about 80% (Bjurlin  
411 and Bissonette 2004). Newly hatched tortoises are about 4–5 cm in length (Bjurlin and  
412 Bissonette 2004) and their shells do not fully ossify until they are 5–7 years old. At that age they  
413 become less vulnerable to predators. For more information about predation, see section 4.4.

414 Tortoises selectively feed on annual and perennial forbs, grasses, and will consume cacti during  
415 droughts (Berry and Murphy 2019). Tortoises favor native plants and plant parts that are high in  
416 water and low in potassium (Oftedal et al. 2002). Potassium is potentially toxic and requires a  
417 large amount of water and nitrogen to excrete. Much of the range of the desert tortoise is highly  
418 invaded by nonnative plants like red brome, cheat grass, red stem filaree, and African mustard,  
419 but tortoises avoid eating exotic grasses when possible as they are low in nitrogen and require  
420 relatively large amounts of water to process. Experimental studies found that grass diets that  
421 included no forbs were detrimental to tortoises, leading to weight loss, poor body condition, or  
422 even death (Hazard et al. 2009, Drake et al. 2016). This was the case even when the diet  
423 included native grasses (Drake et al. 2016). According to Berry & Murphy (2019), tortoises  
424 “favored species of forbs or herbaceous perennials from several plant families: Asteraceae,  
425 Boraginaceae, Cactaceae, Fabaceae, Malvaceae, Nyctaginaceae, Onagraceae, and  
426 Plantaginaceae (Burge and Bradley 1976; Avery and Neibergs 1997; Jennings and Berry 2015).”

427 Tortoises are ectotherms whose body temperature is closely linked to the temperature in the  
428 environment around them. Mojave Desert Tortoises live in places that can fluctuate up to 40°C  
429 (104°F) seasonally and they primarily regulate their temperature by using underground burrows  
430 where the air is cooler and moister than the outside air in summer and warmer in winter.  
431 Depending on the type, length, and depth of burrow, average temperatures inside vary from  
432 33.7–36.6°C (92.6–97.8°F) in the summer and 8.9–13.5°C (48–56.3°F) in the winter (Mack et al.  
433 2015). Berry and Murphy (2019) report that desert tortoises spend >90% of their lives  
434 underground. Tortoises are active when their body temperatures are between 19.0°C and 37.8°C  
435 (66.2–100°F), they retreat to shade when body temperatures are 37–38°C (98.6–100.4°F), and  
436 body temperatures of 43°C (109.4°F) are deadly (Brattstrom 1965). However, tortoises can be  
437 active above ground at any time of year, especially if it has rained and they can drink, or if they  
438 need to move between shelters. They generally are underground or in rock shelters in late fall  
439 and winter, and in late spring through the hot summer. In early spring and fall they are more  
440 active above ground, feeding, travelling, and interacting with other tortoises (Berry and Murphy  
441 2019). On a given day, air temperature determines when the tortoises are active above ground.  
442 In the cooler late winter and spring, they are active late morning to mid-afternoon. In the hotter  
443 summer and fall, if activity occurs, it tends to be in the cool of the morning and late evening.  
444 Smaller juvenile tortoises can be active at cooler temperatures than larger tortoises so tend to  
445 be active more days per year (Berry and Murphy 2019). Available water and forage have a strong  
446 impact on activity and movement. Tortoises had lower metabolic rates, moved less, used fewer  
447 burrows, and had smaller home ranges during drought years.

448 Tortoises also have additional behavioral and physiological strategies to deal with extremes of  
449 temperature and resource availability. During droughts, tortoises can lose up to 40% of their  
450 body mass. They can resorb water from their bladders and store sodium, chloride, and urea in  
451 their blood and in the bladder. When it rains, they drink, void their bladders, and rapidly  
452 increase their body weight (Peterson 1996, Berry and Murphy 2019).

### 453 2.3 Habitat Associations



454  
455 **Figure 2.** Mojave Desert Tortoise in the Mojave Desert. Photo by Rachel London via USFWS

456  
457 Mojave Desert Tortoises in California can be found in part of the southern Great Basin, Mojave,  
458 and western Sonoran deserts in southeastern California (Berry and Murphy 2019). Due to their  
459 dependence on burrows, they require soils, topography, geological features, and vegetation that  
460 facilitate the creation of burrows or dens (Andersen et al. 2000). Therefore, desert tortoise  
461 habitat typically consists of alluvial fans and plains and colluvial/bedrock slopes (Nussear et al.  
462 2012). Tortoises also need appropriate vegetation communities for forage and shelter. Most  
463 burrows are found beneath shrubs, though they can also be dug into the sides of ephemeral  
464 streams.

465 The vegetation types that tortoises use varies across their range and by altitude. As Berry and  
466 Murphy (2019) put it:

467 “Within the Mojave Desert ecosystem, tortoises occur in several vegetation  
468 associations. At lower elevations or adjacent to dry lake beds, saltbush associations  
469 (*Atriplex* spp.) and other members of the Chenopodiaceae provide habitat. The most  
470 common associations contain creosote bush (*Larrea tridentata*), usually with white bur-  
471 sage (*Ambrosia dumosa*) or cheesebush (*A. salsola*) and several other species of shrubs,  
472 cacti, and perennial grasses. With increasing elevation, multiple species of woody  
473 shrubs and tree yuccas (Joshua tree, *Yucca brevifolia*, and Mojave yucca, *Y. schidigera*)  
474 become more common, with blackbrush (*Coleogyne ramosissima*) associations present  
475 in higher elevations.

476 The western Sonoran Desert is a warmer, hotter desert with a higher proportion of  
477 precipitation occurring in summer. This desert is also characterized by creosote bushes,  
478 but a major difference is the presence of microphyll woodlands of blue palo verde  
479 (*Parkinsonia florida*), smoke tree (*Psoralea spinosus*), and ironwood (*Olneya*  
480 *tesota*) in ephemeral stream channels separated by desert pavements or open desert  
481 with ocotillo (*Fouquieria splendens*) mixed with creosote bush, other shrubs, and cacti  
482 (Berry 1984).

483 Tortoises occur in very low densities or are absent where shrub cover is sparse,  
484 precipitation is low and timing erratic, and annual food plants are available only  
485 intermittently (e.g., the lower elevations in Death Valley). They are also in low densities  
486 in moderately to severely disturbed areas, regardless of desert or region (e.g., Bury and  
487 Luckenbach 2002; Keith et al. 2008; Berry et al. 2013).”

## 488 **2.4 Range and Distribution**

489 Range is the general geographical area in which a species occurs. For purposes of CESA and this  
490 status review, we are describing and evaluating the tortoise’s range in California. Distribution  
491 describes the sites where individuals and populations of the species occur, and the spatial  
492 arrangement of individuals within the species’ range.

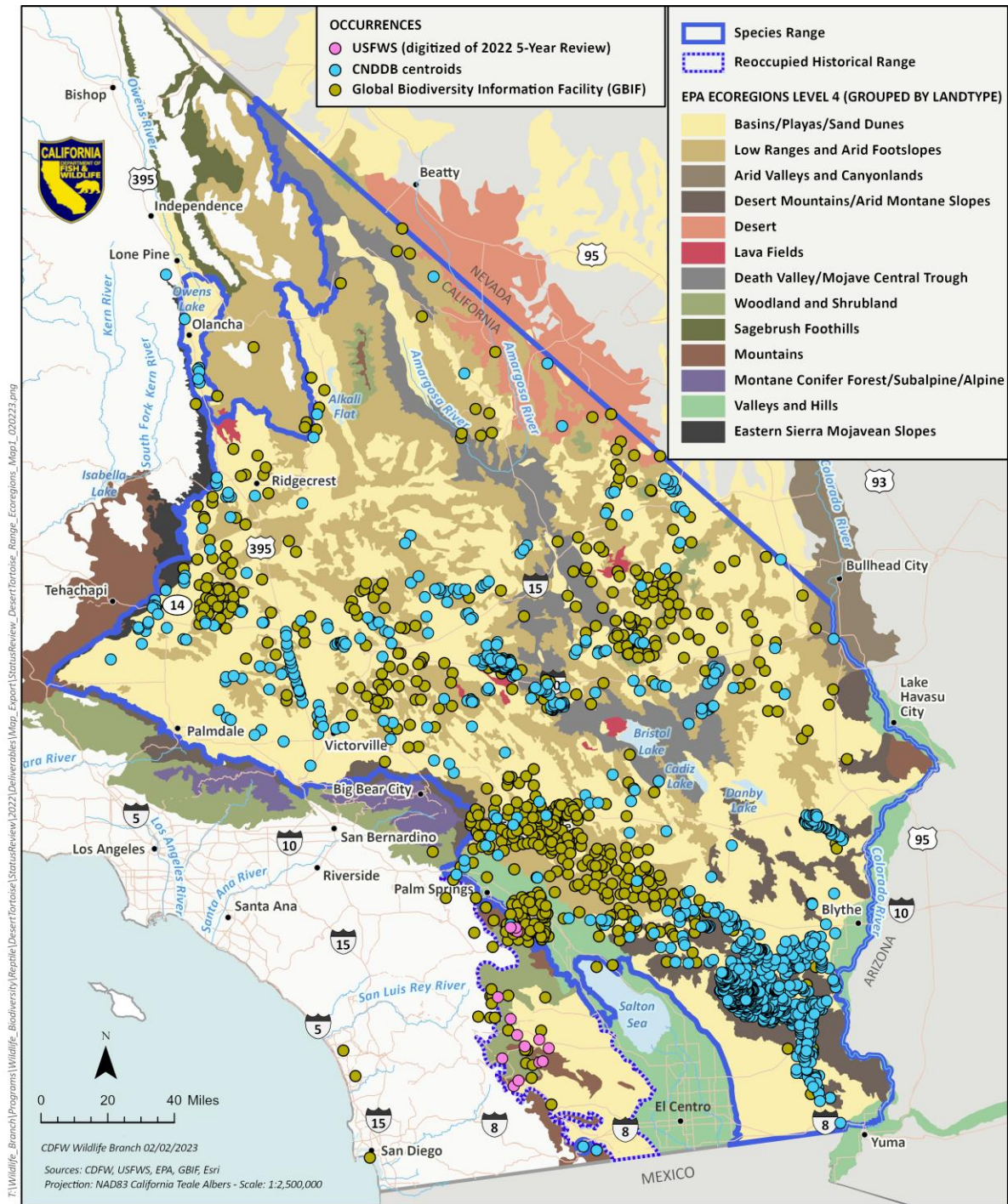
493 In California, the range of the Mojave Desert Tortoise includes the Mojave Desert and portions  
494 of the Sonoran and Great Basin Deserts from the southern end of the Owens Valley south of the  
495 town of Lone Pine in Inyo County to the Mexican border near the southeastern corner of the  
496 state, and from the Colorado River in the east to the lower slopes of the Sierra Nevada,  
497 Transverse, and Peninsular mountains in the west (Berry and Murphy 2019).

498 The range of tortoises has also been dynamic due to the release of captive tortoises and  
499 potential immigration into areas from which they were previously extirpated. For example,  
500 tortoises were largely extirpated from the area of Anza Borrego Desert State Park by the 1940s  
501 (Manning 2018). In the early 1970s taking tortoises from the wild became illegal, and people  
502 began turning in their captive tortoises to the Department. Between 1970 and 1972 the  
503 Department released about 65 previously captive tortoises into the park. There were occasional  
504 sightings in the decades since, with more sightings since 2010. The tortoises there today could  
505 be descendants of released tortoises, however natural immigration to the park is possible as

506 there is a tenuous corridor of suitable habitat that connects the park to habitat occupied by  
507 tortoises to the north. In 2016, park staff began surveying for tortoise and formally collecting  
508 incidental observation data, and subsequent genetic analysis of tortoise blood and scat  
509 suggested “evidence of a naturally reproducing Mojave Desert Tortoise population in Anza  
510 Borrego Desert State Park” (Manning 2018). These tortoises extend “the distribution of  
511 reproducing Mojave Desert Tortoises greater than 60 km south of Palm Springs and beyond the  
512 southern edge of the Colorado Desert Recovery Unit boundary depicted in the recovery plan  
513 (Service 2011a)” (U.S. Fish and Wildlife Service 2022a). We show this reoccupation of historical  
514 range in Figure 3, delineated using suitable ecoregion boundaries.

515

516 The distribution of desert tortoises within the California range is uneven, and portions of the  
517 range no longer provide suitable tortoise habitat due to agriculture, development, and military  
518 activity. Data on tortoise occurrences from the California Natural Diversity Database (CNDDB)  
519 and the Global Biodiversity Information Facility (GBIF) were used to plot distribution of  
520 observations in California (Figure 3). These datasets do not represent exhaustive and  
521 comprehensive inventories of desert tortoises in California and are largely presence-only  
522 datasets. While caution should be used in using these types of data, there appear to be fewer  
523 occurrences in the northern part of the range and in the Death Valley Mojave Central Trough  
524 (see grey area on Figure 3).



525  
 526 **Figure 3.** Map of the California range of the Mojave Desert Tortoise, occurrence locations, and  
 527 Ecoregions. CNDDB data are sightings from 1935 to 2011. The GBIF occurrences are sightings  
 528 that are confirmed by a picture from 1978 to 2022. The pink dots are the locations of tortoises in  
 529 the reoccupied historical range as reported in U.S. Fish and Wildlife Service (2022a). Range  
 530 boundary is from the California Wildlife Habitat Relationship System (California Department of  
 531 Fish and Wildlife 2014).

## 532 2.5 Population Genetic Structure

533 For imperiled species, understanding the populations' genetic structuring is important for  
534 effective management. Head-starting and translocation are two actions used in desert tortoise  
535 conservation (see section 9.1 for more details), and the efficacy of both depends on knowledge  
536 of genetic boundaries to avoid the potentially negative impacts of artificially mixing individuals  
537 from different genetic populations (Sánchez-Ramírez et al. 2018).

538 The 1994 U.S. Fish and Wildlife Service (USFWS) Recovery Plan outlined recovery units consisting  
539 of "evolutionarily distinct" populations, with three recovery units occurring in California:  
540 Western Mojave, Eastern Mojave, and Colorado Desert Recovery Units (see section 3.1 for  
541 details). However, a recent study found that the best supported number of genetic clusters in  
542 California was five, with the Western Mojave Recovery Unit which encompasses much of the  
543 northern and western part of tortoise range in California, consisting of three genetic groups  
544 (Sánchez-Ramírez et al. 2018) (Figure 4). This differs from the earlier work of Hagerty and Tracy  
545 (2010) which found the Western Mojave Recovery Unit to be one genetic group. This means that  
546 populations within 200–300 km of each other which were previously considered genetically  
547 correlated and a single genetic unit for management purposes may actually be several  
548 genetically identifiable populations. Outbreeding depression has not been studied in *G. agassizii*,  
549 and the impacts of moving tortoises between genetic units are unknown, but Sánchez-Ramírez  
550 et al. (2018) advise caution when moving tortoises long distances for translocation or population  
551 augmentation. For more detail about translocations see section 9.1.

## 552 3. STATUS AND POPULATION TRENDS IN CALIFORNIA

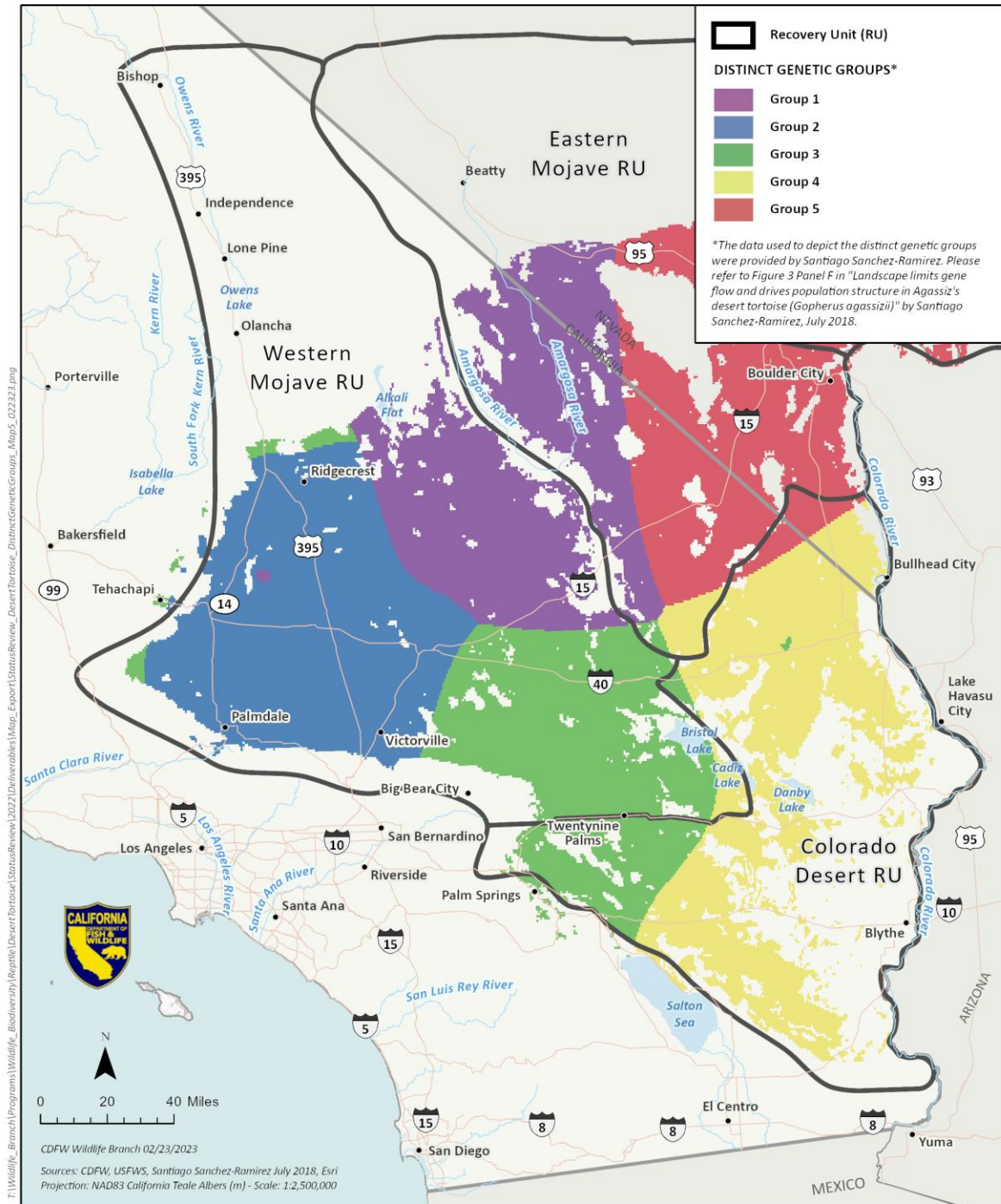
### 553 3.1 Administrative Status

554 The Mojave Desert Tortoise has been protected as a threatened species under the California  
555 Endangered Species Act (CESA) (Title 14, §670.5) since 1989 and under the federal Endangered  
556 Species Act (ESA) since 1990. Unauthorized "take" of threatened and endangered species is  
557 prohibited. "Take" is defined under CESA as hunt, pursue, catch, capture, or kill, or attempt to  
558 hunt, pursue, catch, capture, or kill (*Id.*, § 86).

559 The 1994 USFWS Desert Tortoise Recovery Plan designated six federal recovery units that cover  
560 desert tortoise range in California, Arizona, Nevada, and Utah. The recovery units were based on  
561 genetics, morphology, behavior, ecology, and habitat use, and each was considered an  
562 "evolutionarily distinct" population. These recovery units were revised in the 2011 Recovery  
563 Plan with better information and mapping tools. Of the six, all the Western Mojave, the majority  
564 of the Colorado Desert, and the western portion of the Eastern Mojave (formerly the  
565 Northeastern Mojave) Recovery Units are within California (Figure 4).

566 The Western Mojave Recovery Unit is differentiated from the other recovery units by rainfall  
567 and vegetation (U.S. Fish and Wildlife Service 2011). Summers are warm and winters are cold,  
568 with most rainfall occurring in fall and winter. Tortoises in the Western Mojave Recovery Unit  
569 dig deep burrows (usually located under shrubs on bajadas) for winter hibernation and summer





570

571 **Figure 4.** Map of genetic groups of the Mojave Desert Tortoise. Superimposition of the  
 572 boundaries of the Recovery Units over Figure 3 panel F in Sánchez-Ramírez et al. (2018). The  
 573 base map is the “spatial interpolation of ancestry coefficients of Agassiz’s desert tortoises using  
 574 Krig modeling...combines areas of maximal ancestry proportion for each of the five genetic  
 575 groups”

576 estivation. Above-ground activity occurs primarily in spring when winter annuals provide food  
577 (U.S. Fish and Wildlife Service 2011).

578 The Colorado Desert Recovery Unit receives about 1/3 of its annual rainfall in summer and  
579 supports distinct summer and winter annual plants that tortoises feed on. The climate is  
580 somewhat warmer than in other recovery units, with very few freezing days per year. Tortoises  
581 are found in the valleys, on bajadas, desert pavements, rocky slopes, and in the broad, well-  
582 developed washes (U.S. Fish and Wildlife Service 2011).

583 The Eastern Mojave Recovery Unit is separated from the Western Mojave Recovery Unit by an  
584 inhospitable barrier created by the Saline Valley, Death Valley, and Silurian Valley. Desert  
585 tortoises in the Eastern Mojave Recovery Unit are generally found in creosote bush scrub  
586 communities of flats, valley bottoms, alluvial fans, and bajadas. They are often active in spring,  
587 late summer, and early fall, as this region receives up to about 40% of its annual rainfall in  
588 summer and there are two distinct annual floras on which tortoises can feed (U.S. Fish and  
589 Wildlife Service 2011).

590 Each recovery unit contains one or more Critical Habitat Units (CHUs). Under section 3 of the  
591 ESA, the Department of the Interior is directed to designate the specific areas supporting those  
592 physical and biological features that are essential for the conservation of the species. The  
593 Department of Interior designated critical habitat areas for the Mojave Desert Tortoise in early  
594 1994 (59 FR 5820) that encompass over 24,281 km<sup>2</sup> in the Mojave and Colorado deserts (U.S.  
595 Fish and Wildlife Service 2011). The critical habitat units are administrative areas managed to  
596 give reserve-level protection to desert tortoise populations while maintaining and protecting  
597 other sensitive species and ecosystem functions (U. S. Fish and Wildlife Service 1994). According  
598 to USFWS (2019a):

599       “The specific physical and biological features of desert tortoise critical habitat are  
600       (1) sufficient space to support viable populations within each of the six recovery  
601       units and to provide for movement, dispersal, and gene flow; sufficient quality and  
602       quantity of forage species and the proper soil conditions to provide for the growth  
603       of these species; (2) suitable substrates for burrowing, nesting, and overwintering;  
604       (3) burrows, caliche caves, and other shelter sites; (4) sufficient vegetation for  
605       shelter from temperature extremes and predators; and (5) habitat protected from  
606       disturbance and human-caused mortality.”

607 In California, federal critical habitat designation totals 19,239 km<sup>2</sup>. Of this, 13,465 km<sup>2</sup> are  
608 Bureau of Land Management (BLM) land, 980 km<sup>2</sup> are military land, 538 km<sup>2</sup> are state land, and  
609 4,255 km<sup>2</sup> are private land (U. S. Fish and Wildlife Service 1994) (Figure 5).

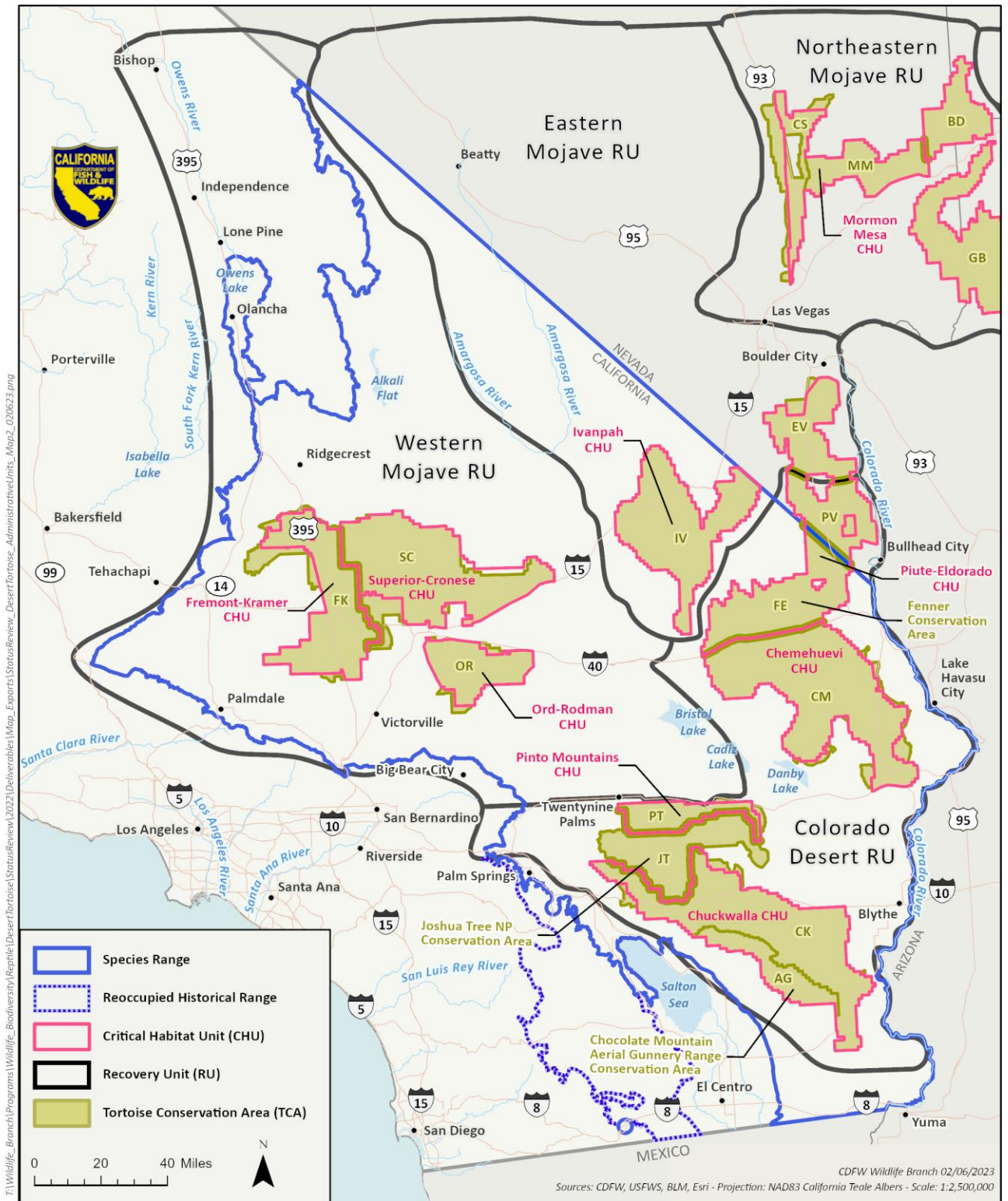


612 Tortoise Conservation Areas (TCAs) are areas that mostly align with CHUs that the USFWS has  
 613 designated for surveys to evaluate tortoise population status and recovery (see Figures 5, 6 and  
 614 Table 1). They include “designated critical habitat as well as contiguous areas with potential  
 615 tortoise habitat and compatible management” (U.S. Fish and Wildlife Service 2019b). The TCAs  
 616 have the same name as the CHU they encompass, with a few exceptions where there are  
 617 multiple TCAs within a CHU (Allison 2015), and Joshua Tree TCA which is not within a CHU. See  
 618 Figure 6 for boundaries of CHUs and TCAs, and Table 1 for overall size and amount of habitat  
 619 within the CHUs, and size of TCAs.

620 **Table 1.** Area of modeled desert tortoise habitat within California CHUs, and size of associated  
 621 TCAs (U.S. Fish and Wildlife Service 2019a). Modeled habitat is suitable desert tortoise habitat  
 622 per Nussear et al. (2009).

Recovery Unit	Critical Habitat Unit	Modeled		Tortoise Conservation Area	Area (km <sup>2</sup> )
		Area (km <sup>2</sup> )	Habitat (km <sup>2</sup> )		
Western Mojave	Fremont-Kramer	2,096	2,028	Fremont-Kramer	2,417
	Ord-Rodman	1,025	745	Ord-Rodman	1,124
	Superior-Cronese	3,104	2,934	Superior-Cronese	3,332
Eastern Mojave	Ivanpah	2,559	2,067	Ivanpah	2,567
Colorado Desert	Chuckwalla	4,130	3,275	Chuckwalla	3,509
	Chuckwalla			Chocolate Mountain Gunnery Range	755
	Chemehuevi	3,794	3,701	Chemehuevi	4,038
	Piute-El Dorado	3,928	3,764	Fenner	1,841
	Pinto Mountains	695	583	Pinto Mountains	751
				Joshua Tree	1,567

623



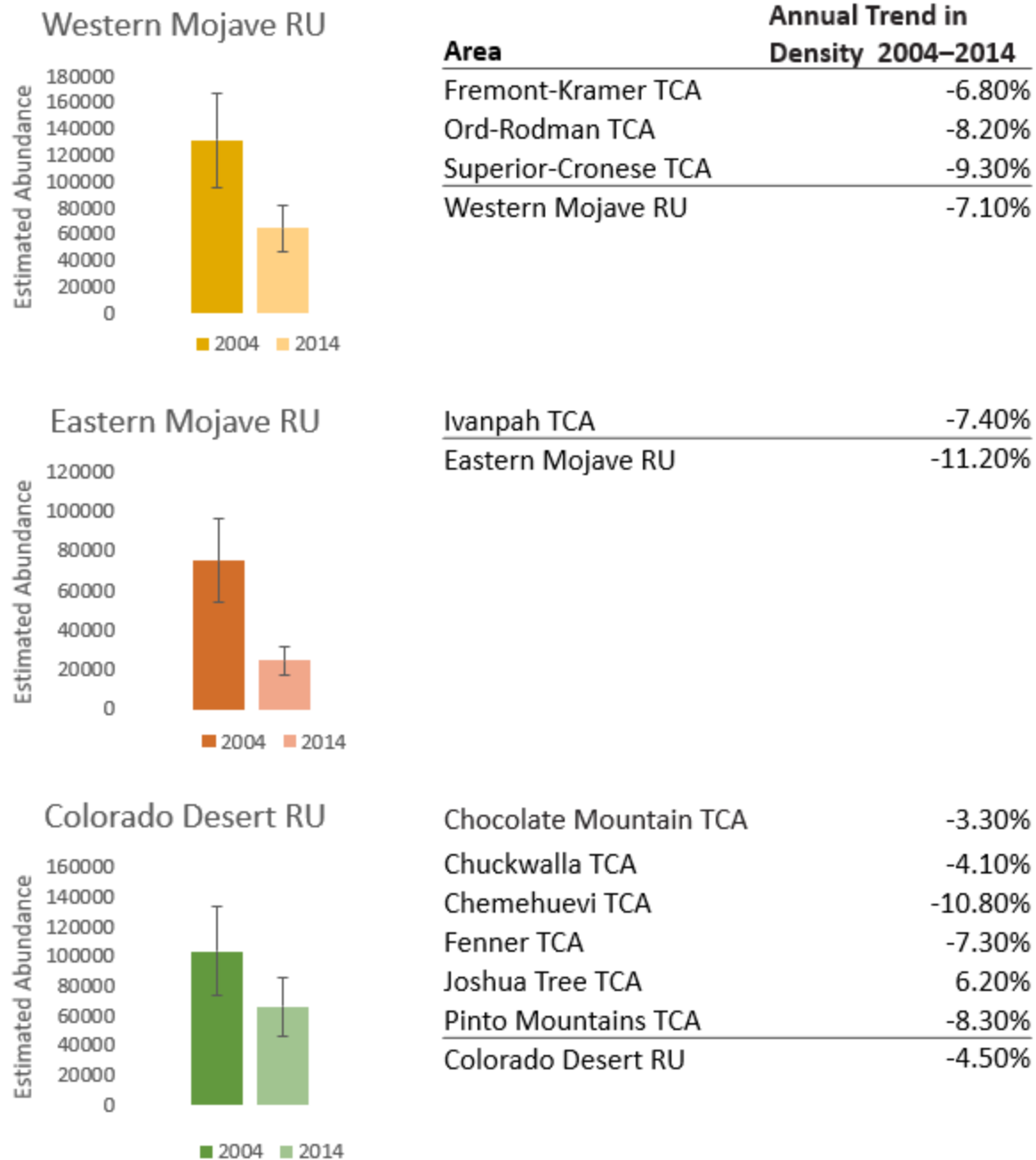
626 **Figure 6.** Mojave Desert Tortoise range, RUs, CHUs, and TCAs.

### 627 3.2 Trends in Density and Abundance

628 Tortoises are long lived, reach sexual maturity late, and have decades of reproductive life. These  
629 life history characteristics make it difficult to assess trends in tortoise populations. For such  
630 species, short- and medium-term studies (1–10 years) may not be long enough to adequately  
631 understand population trends (Tracy et al. 2004). Also, studies that cover only very small,  
632 localized portions of the tortoise’s range have limited value in assessing the overall population  
633 status. This makes long-term studies with consistent methodology that cover large portions of  
634 the range in California key to understanding the extent to which tortoise populations are  
635 declining or recovering over time.

636 Since the species was listed as threatened under CESA in 1989, the most robust estimates of  
637 density over time come from long-term surveys of TCAs within each CHU using line distance  
638 sampling. Square transects with 3 km sides were set up to provide good coverage of each TCA,  
639 and a random selection of these transects are surveyed each year. Two surveyors walk line  
640 transects along the boundary of the square or as close to it as is feasible. They record the  
641 distance and bearing from the survey line to all tortoises seen and live tortoises are measured  
642 and sexed. In addition, data from tortoises carrying radio transmitters are used to estimate what  
643 portion of tortoises are above ground during the transects. Transects are scheduled in mid-  
644 March to May to maximize the chance tortoises will be active and above ground. Standard  
645 models are used to calculate density for the TCA from the line transect data in each sampling  
646 stratum. Funding for these efforts has varied, but in most years from 2001 to 2021 the USFWS  
647 has coordinated the distance sampling monitoring program for desert tortoises in the three  
648 recovery units that cover tortoise range in California (U.S. Fish and Wildlife Service 2015, 2019b,  
649 2020a, 2022b, c). The years that each specific TCA was surveyed are presented in Table 2.

650 Despite the protections afforded though the federal ESA and CESA, tortoise populations have  
651 declined in recent decades. The 1994 USFWS Recovery Plan for desert tortoise identified 3.9  
652 adult tortoises/km<sup>2</sup> as the minimum density necessary for population viability (U. S. Fish and  
653 Wildlife Service 1994, U.S. Fish and Wildlife Service 2011). Only one of the TCAs was below this  
654 threshold in 2004, but by 2014, 8 out of 10 were at or below it. Between 2004 and 2014, annual  
655 declines per year ranged from 3.3% in the Chocolate Mountain Gunnery Range to 10.8% in  
656 Chemehuevi (Allison and McLuckie 2018) (Figure 7). Joshua Tree was the only TCA in California  
657 where the population increased (6.2% annual rate of increase). However, Joshua Tree started  
658 with a very low estimated density of 1.9 tortoise/km<sup>2</sup> in 2004, most likely due to extended  
659 drought (Lovich et al. 2014, Allison and McLuckie 2018). These annual rates of decline are very  
660 high, and a species that reproduces as slowly as the desert tortoise will likely require a long time  
661 to recover from such losses.



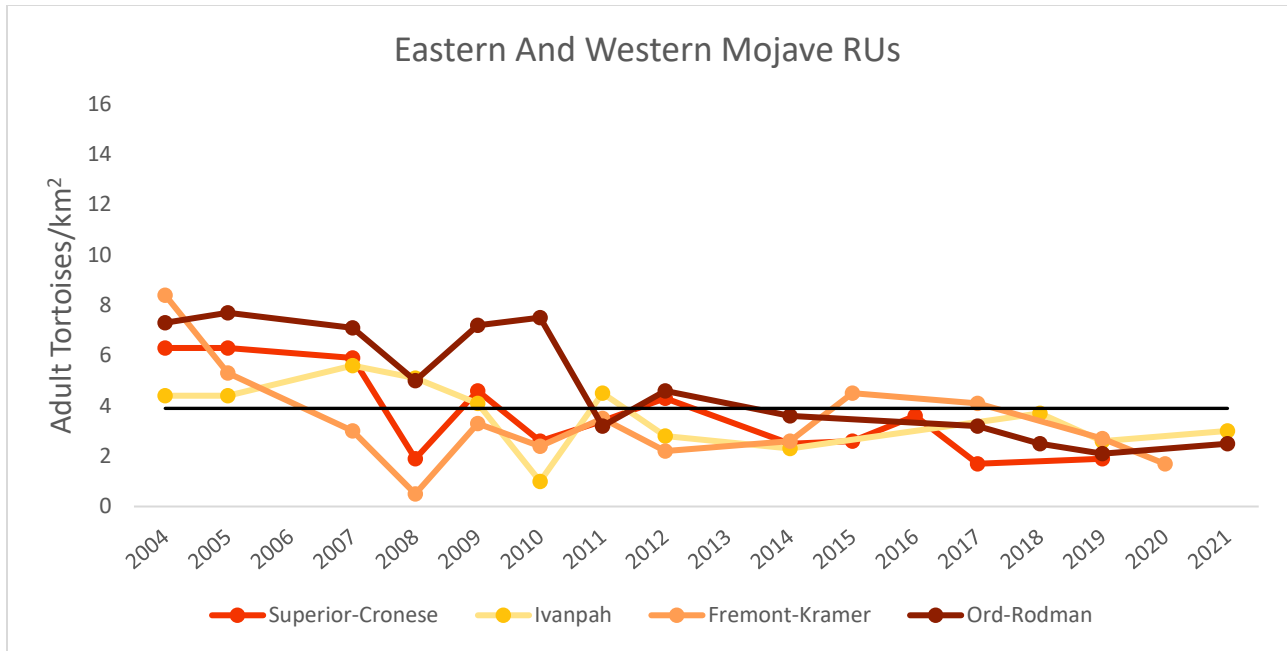
662

663 **Figure 7.** Estimated abundances (with standard errors) of adult Mojave Desert Tortoises  
 664 (*Gopherus agassizii*) in 2004 and 2014 in the recovery units relevant to California (left).  
 665 Estimated annual rates of change in density for recovery units and associated Tortoise  
 666 Conservation Areas (right). Abundance estimates for recovery units are based on densities  
 667 calculated from the model in Table 4 of Allison and McLuckie (2018) and applied to all areas of  
 668 the associated recovery unit that meet criteria as modeled habitat. TCA annual trends in  
 669 population are from U.S. Fish and Wildlife Service (2022a).

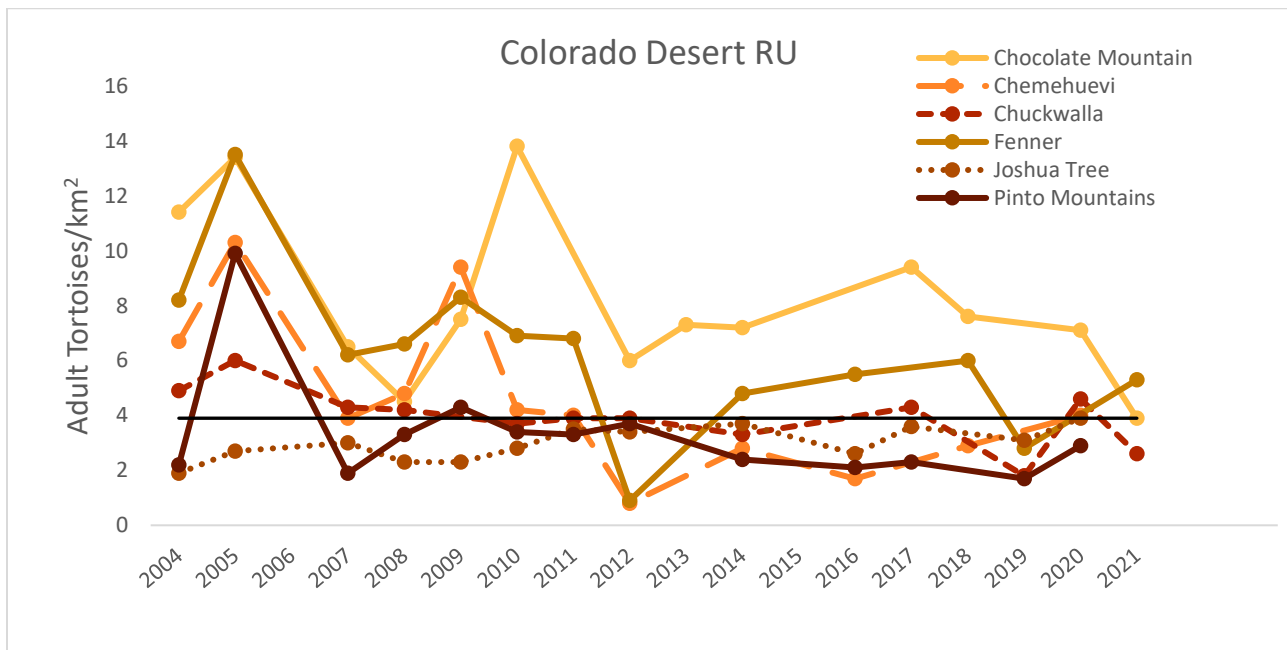
670 Allison and McLuckie (2018) estimated the abundance of desert tortoises in the three recovery  
671 units that fall within California in 2004 and 2014 from the density estimates in the TCAs (Figure  
672 7). Abundance declined precipitously between 2004 and 2014 in the Western Mojave, Colorado  
673 Desert, and Eastern Mojave Recovery Units, with each of them losing between 35,000 and  
674 65,000 adults. It should be noted that the Eastern Mojave and Colorado Desert Recovery Units  
675 each have one TCA outside of California so the abundance estimates are an over-estimate for  
676 California. Allison and McLuckie (2018) estimated that the Western Mojave Recovery Unit  
677 experienced a 51% decline in adults from 2004 to 2014.

678 Since 2014, densities have not declined as steeply as in the previous decade. Although no  
679 populations have reached pre-2014 highs, between 2015 and 2021, densities increased  
680 somewhat in Chemehuevi, Fenner, and Ivanpah. The declines continued in Chocolate  
681 Mountains, Ord-Rodman, Fremont-Kramer, and Superior-Cronese (U.S. Fish and Wildlife Service  
682 2022a, c) (Figures 8 and 9, Table 2). The most recent surveys (2019–2021) show that in the  
683 Eastern and Western Mojave Recovery Units, all of the TCAs surveyed were below the 3.9 adult  
684 tortoises/km<sup>2</sup> threshold. In the Colorado Desert Recovery Unit, two were at the threshold, two  
685 were below it, and only one TCA (Fenner) was above (U.S. Fish and Wildlife Service 2022a)  
686 (Figures 8 and 9, Table 2). The declines in the TCAs occurred despite most of the land falling  
687 under federal land management agency ownership (Figure 5).





688  
 689 **Figure 8.** Estimated densities of adult tortoises ( $\geq 180$  mm carapace length) in TCAs in the Eastern  
 690 and Western Mojave RUs in California 2004–2021. Black horizontal line represents 3.9 adults/km<sup>2</sup>,  
 691 the estimated minimum density needed for population viability. For time series figures of  
 692 individual TCAs including error bars, see Appendix A.



693  
 694 **Figure 9.** Estimated densities of adult tortoises ( $\geq 180$  mm carapace length) in TCAs in Colorado  
 695 Desert RU in California 2004–2021. Black horizontal line represents 3.9 adults/km<sup>2</sup>, the  
 696 estimated minimum density needed for population viability. For time series figures of individual  
 697 TCAs including error bars, see Appendix A.

698 **Table 2.** Estimated densities of adult tortoises ( $\geq 180$  mm carapace length) in Tortoise Conservation Areas in California. Estimates  
699 for 2004–2014 have standard errors (SE); estimates for 2015–2021 have coefficients of variation expressed as percentages. Data  
700 from (U.S. Fish and Wildlife Service 2015, 2016, 2018, 2019*b*, 2020*a*, 2022*c*, *b*, Allison and McLuckie 2018), and presented in Figures  
701 8 and 9.

		Estimated Density (number/km <sup>2</sup> )																
Recovery Unit	TCA	2004	2005	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Western Mojave	Fremont-Kramer	8.4 (2.31)	5.3 (1.28)	3.0 (1.46)	0.5 (0.51)	3.3 (1.13)	2.4 (0.60)	3.5 (1.11)	2.2 (1.07)		2.6 (0.3)	4.5 (28.0)		4.1 (22.01)		2.7 (24.0)	1.7 (27.6)	
	Ord-Rodman	7.3 (2.25)	7.7 (1.80)	7.1 (3.26)	5.0 (5.34)	7.2 (2.65)	7.5 (1.85)	3.2 (1.18)	4.6 (2.14)		3.6 (0.4)			3.9* (19.84)	3.4* (20.79)	2.5* (20.33)		2.5* (24.3)
	Superior-Cronese	6.3 (1.84)	6.3 (1.32)	5.9 (2.28)	1.9 (1.19)	4.6 (1.12)	2.6 (0.49)	3.4 (0.79)	4.3 (1.41)		2.5 (0.6)	2.6 (26.7)	3.6 (26.3)	1.7 (23.76)			1.9 (23.7)	
Eastern Mojave	Ivanpah	4.4 (1.19)	4.4 (2.46)	5.6 (1.95)	5.1 (2.92)	4.1 (1.86)	1.0 (0.48)	4.5 (1.72)	2.8 (1.79)		2.3 (0.2)			3.7 (23.62)	3.7 (23.62)	2.6 (24.9)		3.0 (24.5)
Colorado Desert	Chocolate Mountain	11.4 (3.55)	13.4 (4.31)	6.5 (1.50)	4.5 (2.56)	7.5 (2.74)	13.8 (3.52)		6.0 (1.84)	7.3 (1.96)	8.4 (0.8)			9.4 (14.8)	7.6 (32.46)		7.1 (22.1)	3.9 (31.8)
	Chuckwalla	4.9 (1.49)	6.0 (1.77)	4.3 (1.19)	4.2 (2.84)		3.7 (1.14)	3.9 (1.37)	3.9 (1.62)		3.3 (0.4)			4.3 (15.7)		1.8 (28.8)	4.6 (19.4)	2.6 (24.0)
	Chemehuevi	6.7 (1.27)	10.3 (3.10)	3.9 (1.71)	4.8 (3.07)	9.4 (5.98)	4.2 (1.40)	4.0 (1.51)	0.8 (0.90)		2.8 (0.3)		1.7 (30.6)		2.9 (24.21)		4.0 (15.2)	
	Fenner	8.2 (1.94)	13.5 (2.80)	6.2 (2.37)	6.6 (3.05)	8.3 (4.01)	6.9 (2.49)	6.8 (2.78)	0.9 (0.95)		4.8 (0.5)		5.5 (30.0)		6.0 (26.25)	2.8 (29.8)		5.3 (19.8)
	Pinto Mountains	2.2 (2.12)	9.9 (3.58)	1.9 (0.98)	3.3 (3.53)	4.3 (2.38)	3.4 (1.85)	3.3 (1.39)	3.7 (1.57)		2.4 (0.3)		2.1 (31.6)	2.3 (32.7)		1.7 (31.8)	2.9 (20.6)	
	Joshua Tree	1.9 (0.53)	2.7 (0.79)	3.0 (1.94)	2.3 (1.75)	2.3 (1.56)	2.8 (1.56)	3.5 (1.33)	3.4 (1.63)		3.7 (0.4)		2.6 (34.7)	3.6 (22.5)		3.1 (20.2)	3.9 (23.3)	

702 \*724 adults were translocated into the Ord-Rodman TCA in 2017–2019 due to expansion at 29 Palms Marine Corps Air Gunnery Command Center. These are  
703 included in these density estimates.

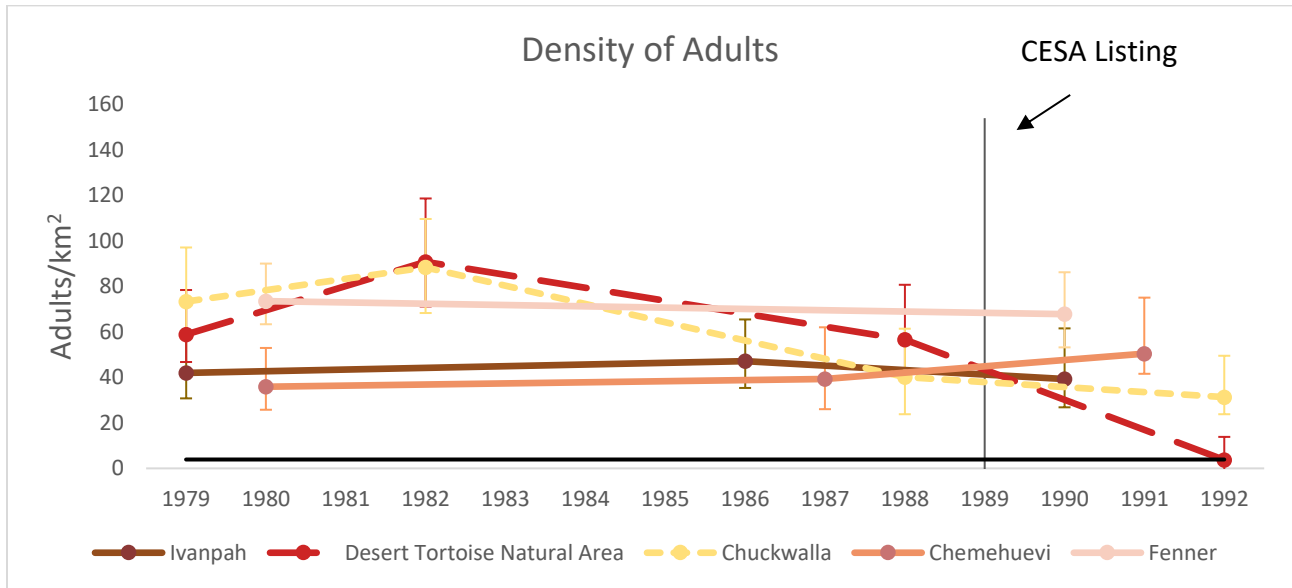
704 The long-term surveys in the TCAs provide robust data on declines in density since 2004.  
705 However, tortoise populations had been in decline for decades previously, and estimates of  
706 densities from before the species was listed under CESA in 1989 are important for  
707 understanding the scale of long-term decline. While there were no large scale or frequent  
708 systematic population monitoring programs in the 20<sup>th</sup> century, multiple regional or short-term  
709 surveys give snapshots of density in certain areas pre and post listing. Collectively, these studies  
710 give a broad picture of the state of tortoise populations in the past several decades.

711 Estimates of tortoise densities in California before the species was listed under CESA can be  
712 found in Berry (1986a):

713 “Berry and Nicholson (1984a) developed a more detailed map of relative  
714 tortoise abundance throughout an area of over 100,000 km<sup>2</sup> using data  
715 from 1,808 strip transects. Transects, which were 2.4 km by 9.1 m,  
716 provided counts of tortoise signs (live individuals, carcasses, scats, cover  
717 sites, tracks, drinking sites, and courtship rings). Counts of signs were  
718 calibrated against counts along transects in areas where tortoise  
719 densities had been estimated by repeated censuses. The map prepared  
720 by this method showed five relative density classes: 0–8, 9–19, 20–39,  
721 40–97, and >97 tortoises/km<sup>2</sup>. Four major tortoise population centers or  
722 crucial habitats with densities of >77 tortoises/km<sup>2</sup> were identified: (1)  
723 Fremont-Stoddard in the western Mojave Desert (4864 km<sup>2</sup>), (2) Ivanpah  
724 in the eastern Mojave Desert (918 km<sup>2</sup>), (3) Fenner-Chemehuevi in the  
725 eastern Mojave and northeastern Colorado deserts (3881 km<sup>2</sup>), and (4)  
726 Chuckwalla (1333 km<sup>2</sup>) in the southern Colorado Desert.”

727  
728 In addition, in the 1970s the BLM established 27 2.6 km<sup>2</sup> (1 mile<sup>2</sup>) survey sites in California  
729 (Berry and Turner 1986). Using mark recapture methods, researchers surveyed the plots over  
730 60-day periods in the spring every 2–10 years (Berry and Medica 1995). Berry (1986a) reports  
731 that of those 27 sites, “eight had estimated densities of  $\leq 8$  tortoises/km<sup>2</sup>, six had 8–39  
732 tortoises/km<sup>2</sup>, and 13 sites supported 42–184 tortoises/km<sup>2</sup>”, though the years those estimates  
733 come from are not reported. Multiple of these sites are located within the current Tortoise  
734 Conservation Areas, with sites in the Ivanpah, Chuckwalla, Fenner, and Chemehuevi TCAs. Using  
735 data reported in Berry and Medica (1995), rough comparisons can be made between the  
736 estimated densities in 1979–1992 and the 2004–2014 surveys. The earlier surveys covered the  
737 whole of the plot and did mark recapture methods to estimate density, while the later USFWS  
738 surveys used line transects. In addition, the BLM density estimates are only for the single plot  
739 per TCA, while the more recent line transects use multiple line transects per TCA to estimate  
740 density across the whole TCA. However, the combined density estimates provide a benchmark  
741 of declines over the past 50 years. The Desert Tortoise Natural Area overlaps with the northern  
742 border of the Fremont-Kramer TCA. Estimates of densities in 1979–1980 vary from 36  
743 adults/km<sup>2</sup> in Chemehuevi to a high of 73 adults/km<sup>2</sup> in Fenner and Chuckwalla (Figure 10). By  
744 the early 1990s, density of adults had not fallen particularly dramatically except in Chuckwalla

745 which had a 57% decline from about 73 adults/km<sup>2</sup> to about 31 adults/km<sup>2</sup>, and the Desert  
 746 Tortoise Natural Area which saw a 93% decline to 3.7 adults/km<sup>2</sup> which is below the density  
 747 needed for population viability (Figure 10). However, on the scale of multiple decades, all the  
 748 surveyed areas experienced very steep declines. From 1979–1980 to 2020–2021, densities of  
 749 adults in the corresponding TCAs fell 93% in Fenner, 96% in Chuckwalla, 89% in Chemehuevi,  
 750 and 93% in Ivanpah (Table 2 and Figures 8, 9,10).



751  
 752 **Figure 10.** Estimated densities of adults/km<sup>2</sup> in plots surveyed 1979–1992 using mark recapture  
 753 methods. The dot represents the midpoint of the density estimates, bars are 95% confidence  
 754 intervals. Black horizontal line represents 3.9 adults/km<sup>2</sup>, the estimated minimum density  
 755 needed for population viability. Redrawn from figures in Berry and Medica (1995).

756 Berry et al. (2020b) continued the work of surveying tortoises at Desert Tortoise Research  
 757 Natural Area in the western Mojave Desert for decades. Part of the site was fenced to keep out  
 758 sheep, vehicles and humans but allow movement of tortoises, and surveys were done both  
 759 inside and outside the fence. In 1979 when they started the surveys, estimated densities of all  
 760 tortoises inside the fence were 103/km<sup>2</sup>, and 79/km<sup>2</sup> outside the fence. In 2002 it had declined  
 761 to 10.2/km<sup>2</sup> inside the fence and 4.17/ km<sup>2</sup> outside the fence. By 2012 densities had increased  
 762 to 15.6/ km<sup>2</sup> inside the fence, and to 4.9/km<sup>2</sup> outside the fence. Counts of tortoises (from which  
 763 densities were estimated) followed an estimated linear decline of 9.1% per year over the 30+  
 764 years of the study.

765 Other studies give rough estimates of historical density in other parts of the range. In the Pinto  
 766 Basin of Joshua Tree National Park in 1991–1996, Freilich et al. (2000) used mark recapture  
 767 methods to resurvey an area that had been surveyed in the 1970s. Their methods were  
 768 designed to estimate abundance rather than density, and since they did not have a well-defined  
 769 effective trapping area, their density estimates are rough. However, they report that in the  
 770 1970s the density estimates were 29–31 adults and juveniles/km<sup>2</sup>, while their estimate for the

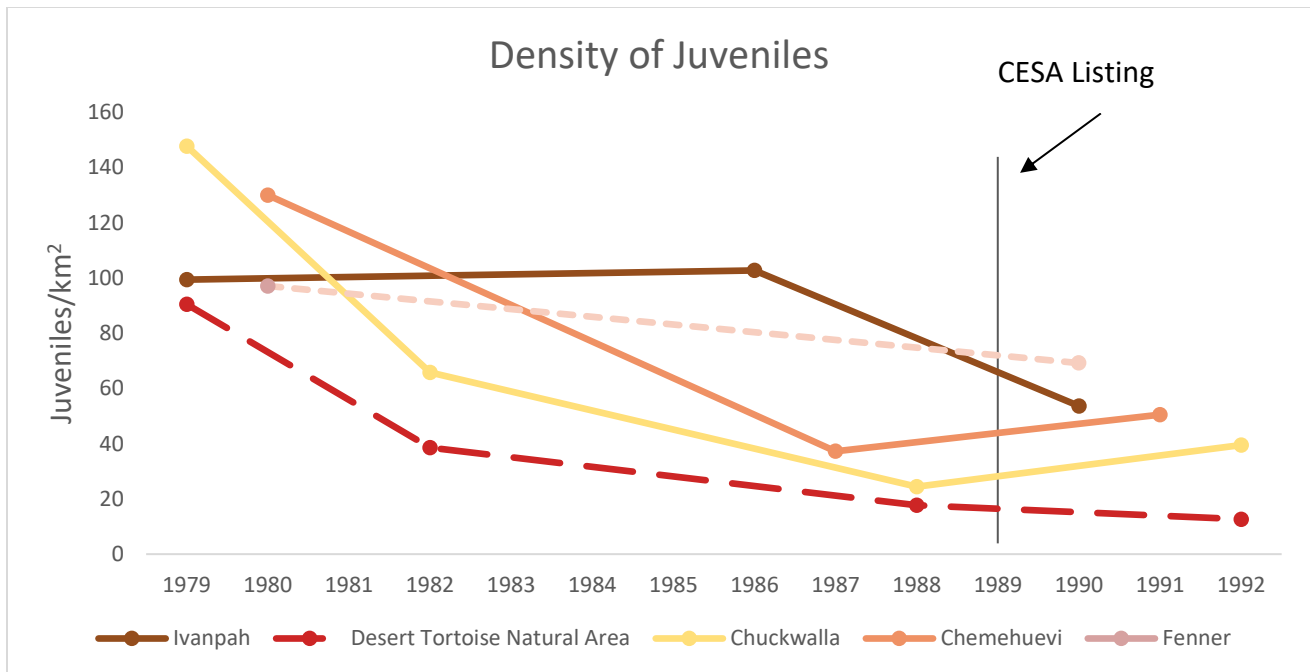
771 early 1990s was 42 adults/km<sup>2</sup>. Lovich et al. (2014) reports that surveys in the Pinto Basin in  
772 1987–1988 estimated densities as high as 77 tortoises/km<sup>2</sup>.

773 Medium-term tracking of densities did occur in four study sites in California at various times  
774 between 1977 and 1985 (Berry et al. 1986). At one site in the western Mojave Desert, Fremont  
775 Peak, sampling occurred three times (1977, 1980, and 1985) over a 9-year period and the  
776 population density declined from 27/km<sup>2</sup> in 1980 to 15/km<sup>2</sup> in 1985 (Berry et al. 1986).  
777 However, at three other sites there were no significant changes in density during those years.  
778 At the Kramer Hills site in the Western Mojave Desert there were an estimated 42 adults/km<sup>2</sup> in  
779 1980 and 44 adults/km<sup>2</sup> in 1982. The Chemehuevi Wash site in the Colorado Desert was  
780 surveyed in 1979 and 1982 and saw a nonsignificant increase from 18 adults/km<sup>2</sup> to 22  
781 adults/km<sup>2</sup>. The Chuckwalla Bench study site also in the Colorado Desert had a non-significant  
782 increase in density from 75 adults/km<sup>2</sup> in 1979 to 87 adults/km<sup>2</sup> in 1982 (Berry et al. 1986), see  
783 Figure 10.

784 Although the density surveys in the 1970s and 1980s do not use the same methodology as later  
785 surveys and only cover small areas, they do give an idea of the range of tortoise densities in the  
786 decades before the start of the surveys in the TCAs, providing context for more recent density  
787 estimates.

#### 788 *Juveniles*

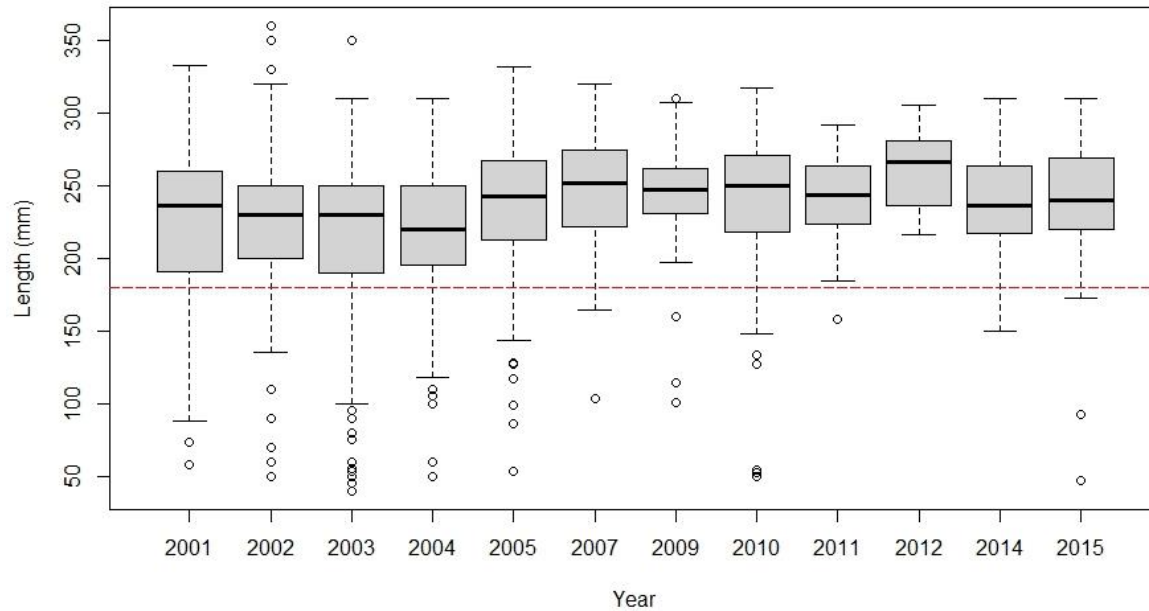
789 Juvenile tortoises are easier to overlook during surveys than adults, and the U.S. Fish and  
790 Wildlife surveys in the TCAs do not report densities of juveniles (but see below). However,  
791 Berry and Medica (1995) report on the density of adults and all tortoises using mark recapture  
792 surveys in BLM plots from 1979 to 1992. From those we can roughly calculate historic density  
793 of juveniles (density of all tortoises minus density of adult tortoises) (Figure 11).



794

795 **Figure 11.** Density of juvenile tortoises in plots in California from 1979 to 1992. Juvenile density  
 796 was calculated by subtracting density of adults from density of all tortoises presented in Berry  
 797 and Medica (1995).

798 Between the late 1970s and early 1990s, the density of juveniles declined roughly 46% in  
 799 Ivanpah, 86% in the Desert Tortoise Natural Area, 73% in Chuckwalla, 62% in Chemehuevi, and  
 800 29% in Fenner (Figure 11). While juvenile tortoises are expected to have low survival rates, this  
 801 long-term loss of juveniles from the landscape is concerning, and there is evidence that it is  
 802 continuing into recent years. In 2014 in the Western Mojave Recovery Unit, the density of adult  
 803 tortoises was 49% of what it had been in 2004, and the proportion of juveniles in the  
 804 population declined by 9% (Allison and McLuckie 2018). In the yearly transect surveys done in  
 805 the TCAs, many fewer tortoises with midline carapace length <180 mm were found in 2007–  
 806 2015 compared to 2001–2005 (Figure 12). In some areas, the youngest tortoises found in  
 807 recent years were at least 30 years old (Holcomb 2022a). Even if conditions quickly improve for  
 808 juveniles, such a long period with little recruitment of juveniles into the population will hinder  
 809 population recovery significantly.



810  
 811 **Figure 12.** Midline carapace length of tortoises surveyed within the Western Mojave Recovery  
 812 Unit Tortoise Conservation Areas, showing a reduction in observations of tortoises smaller than  
 813 180mm after about 2005. Described in Alison and McLuckie (2018), and figure made with  
 814 USFWS unpublished data provided by K. Holcomb and used with permission. The horizontal  
 815 dashed line at 180 mm represents the size over which tortoises are considered to be adults.

816 **3.3 Mortality and Survival Rates**

817 Adult and juvenile survival rates are important demographic factors that can affect whether a  
 818 population is increasing, stable, or declining. Desert tortoises generally have low survival rates  
 819 (i.e., high mortality rates) as hatchlings and juveniles, and relatively high adult survival rates  
 820 (Berry and Murphy 2019). The adult survival rate needed for population stability depends on a  
 821 number of factors, including population reproduction and/or recruitment rates, but the USFWS  
 822 1994 Recovery Plan estimated that an adult survival rate of 98% per year is needed for  
 823 population growth of 0.5% per year. A more recent estimate that incorporated current adult  
 824 densities and juvenile survival rates found that an adult survival rate of 93% per year was  
 825 necessary for desert tortoise population stability (no growth or decline) (Holcomb 2022a).  
 826 Estimates of survival/mortality rates come from a variety of studies within California, most of  
 827 which were quite limited in geographic scale. When comparing survival rates to mortality/death  
 828 rates, a broad rule of thumb is that mortality or death rate  $\approx 1 - (\text{survival rate})$ .

829 Adult tortoises are much easier to survey than juveniles, consequently most of the information  
 830 about survival and mortality in the wild relates to adults. In the late 1970s and early 1980s, a  
 831 study from four sites provided some limited information on annual mortality rates in stable and  
 832 declining populations (Berry et al. 1986). At Fremont Peak in an area that became the Fremont-  
 833 Kramer TCA, densities of adults and subadults declined significantly between 1977 and 1985,  
 834 and the estimated annual mortality rate was 4.5% per year. In contrast, three other sites

835 surveyed during that period that did not see significant declines in density had annual mortality  
836 rates of 2.2–2.9% (Berry et al. 1986). Berry et al. (2020b) estimated survival rates (1979–2012)  
837 of adults and juvenile tortoises inside and outside of the fenced portion of the Desert Tortoise  
838 Research Natural Area in the Western Mojave. As mentioned previously, in 1979 estimated  
839 densities of all tortoises was 103/km<sup>2</sup> inside the fence, and 79/km<sup>2</sup> outside the fence. By 2012  
840 densities had decreased to 15.6/km<sup>2</sup> inside the fence, and to 4.9/km<sup>2</sup> outside the fence. During  
841 those years the population suffered an estimated 87.6% decline. Median annual survival  
842 probability (converted into percentages for ease of comparison) for adults inside and outside of  
843 the fenced area ranged from 79%–83% in 1979–1989, 71%–78% in 1989–2002, and 94%–96% in  
844 2002–2012. These estimates are all well below the necessary survival rate identified in the  
845 USFWS 1994 Recovery Plan to achieve modest population growth. Juveniles had lower survival,  
846 their estimated median annual survival probability was 66%–73% in 1979–1989, 57%–65% in  
847 1989–2002, and 90%–93% in 2002–2012.

848 In Eastern Joshua Tree National Park, tortoises were surveyed intermittently from 1978 to 2012  
849 (Lovich et al. 2014). The authors tested the impact of rainfall on survival, and the best model of  
850 survival was based on the average estimated winter precipitation over the preceding three  
851 winters. They estimated a mean annual (apparent) survival rate of 0.87 (87%). Values below the  
852 mean occurred in 1991, 1997–2004 and 2008, which were years of lower rainfall (Lovich et al.  
853 2014). Estimated survival was above the mean in 2010–2011. It should be noted that other  
854 factors that impact survival, such as predation and disease, were not tested independently.  
855 Instead, it was assumed that these factors would be mediated by rainfall (i.e., tortoises would  
856 be in poorer conditions in drier years and therefore they would be more susceptible to  
857 predation or disease).

858 Between 2002 and 2004, Berry and Keith (2008) evaluated the status of desert tortoise  
859 populations in Red Rock Canyon State Park in Kern County. Previous surveys had occurred in  
860 the 1970s, and density was estimated to be <8 tortoises/km<sup>2</sup>. The death rate over four years  
861 was estimated at 67% for adults and subadults, and densities were between 2.7 and 3.6  
862 tortoises/km<sup>2</sup>.

863 In 2007–2008, Berry et al. (2020c) evaluated the status of a population of tortoises in the El  
864 Paso Mountains close to the Fremont-Kramer Critical Habitat Unit. Estimated density of adults  
865 was 4.8/km<sup>2</sup> and the annual death rate of adults in 2003–2008 was 6.9% (Berry et al. 2020c).  
866 The top causes of known death were mammalian and avian predators, gunshots, and vehicles.  
867 The authors concluded that “the high death rate of adults, low population density, high human  
868 visitor use, and ongoing decline in the adjacent critical habitat unit indicate that a viable  
869 population is unlikely to persist in the study area” (Berry et al. 2020c).

870 Esque et al. (2010) tracked several hundred adult tortoises before and after translocations from  
871 Fort Irwin National Training Center to neighboring public land in the Superior-Cronese Critical  
872 Habitat Unit. They monitored translocated tortoises, tortoises resident at the release sites, and  
873 control tortoises in nearby areas that were not affected by the translocations. In the first year  
874 (2008), 19% of control tortoises, 20% of resident tortoises, and 25% of translocated tortoises



875 died. Most of the mortalities were thought to be due to coyote predation. As a comparison, at a  
 876 different reference site in the Superior-Cronese Critical Habitat Unit, 8.3% of tracked tortoises  
 877 died in 2008. At reference sites in other critical habitat units in California, percent mortality in  
 878 2008 ranged from 0% in Ivanpah and Ord-Rodman to 28–30% in Chemehuevi and Chuckwalla.  
 879 Esque et al. (2010) also showed that mortality can vary greatly year to year in the same site.  
 880 For example, at Soda Mountain outside of the Superior-Cronese Critical Habitat Unit, in 2006 at  
 881 there was no mortality, in 2007 mortality was 17%, and in 2010 it was 43% (Esque et al. 2010).

882 In 2009, Berry et al. (2020a) surveyed about 93 km<sup>2</sup> of BLM land within the eastern Chemehuevi  
 883 Valley, adjacent to the Chemehuevi Critical Habitat Unit. Based on the number of live and dead  
 884 tortoises found, they concluded that the density of adults was 2.0/km<sup>2</sup> (+/- 1.0), and that the  
 885 annual death rate in the four years prior to the survey was 13.1%/year. These data led them to  
 886 conclude that the population was probably nonviable (Berry et al. 2020a).

887 Collectively, these data suggest that adult survival rates in most recently surveyed areas are too  
 888 low to support stable populations and have been below the thresholds established by the  
 889 USFWS 1994 Recovery Plan and by Holcomb (2022a) for some time (Table 3). Although survival  
 890 rates have not been estimated systematically across the tortoise’s range in California, rates  
 891 appear to be particularly low outside of CHUs.

892 **Table 3.** Survival and mortality rates of adult and subadult tortoises in various studies.

Life stage	Survival vs Mortality	Rate	Location	Time scale	Reference
Adults	Median annual survival probability	79%-83%	Desert Tortoise Research Natural Area	1979-1989	Berry et al. 2020b
Adults	Median annual survival probability	71%-78%	Desert Tortoise Research Natural Area	1989-2002	Berry et al. 2020b
Adults	Median annual survival probability	94%-96%	Desert Tortoise Research Natural Area	2002-2012	Berry et al. 2020b
All	Mean annual survival	87%	Eastern Joshua Tree National Park	1978-2012	Lovich et al. 2014
Adults & subadults	Annual mortality	4.5%	Fremont -Kramer TCA	1977-1985	Berry et al. 1986
Adults & subadults	Annual mortality	2.2%-2.9%	Kramer Hills, Chemehuevi, Chuckwalla	1977-1985	Berry et al. 1986
Adults & subadults	Death rate over 4 years	67%	Red Rock Canyon State Park	2002-2004	Berry and Keith 2008
Adults	Annual death rate	6.9%	El Paso Mountains near Fremont-Kramer CHU	2003-2008	Berry et al. 2020c
Adults	Annual mortality	13%	Chemehuevi Valley	2005-2009	Berry et al. 2020a
Adults	Annual mortality	0%	Ivanpah	2006-2008	Esque et al. 2010
Adults	Annual mortality	0%	Ord-Rodman	2006-2008	Esque et al. 2010
Adults	Annual mortality	0%-31%	Chemehuevi	2006-2008	Esque et al. 2010
Adults	Annual mortality	9%-29%	Chuckwalla	2006-2008	Esque et al. 2010
Adults	Annual mortality	0%-44%	Soda Mountain	2006-2008	Esque et al. 2010

893

894 *Juvenile Survival*

895 In long-lived species like the tortoise, if adult survivorship drops, reproductive rates or juvenile  
896 survival would have to increase dramatically to keep populations stable. Analysis by the USFWS  
897 (1994) estimated that “a 10% increase in adult mortality can require a 300% increase in juvenile  
898 survivorship” to maintain a stable population. Many of the threats to adult survival affect  
899 juveniles, making it unlikely that juvenile survivorship can naturally increase to the levels  
900 needed to compensate for the decreasing adult survival documented above.

901 Several factors limit the number of hatchlings that are produced in the wild each year. Females  
902 lay a maximum of about 30 eggs per year, incubation success depends on temperature, and  
903 nest predation is common (Berry and Murphy 2019). After emerging from the egg, survival  
904 rates of wild hatchlings can be low. In the Ivanpah Valley between 2011 and 2014, Tuberville et  
905 al. (2019) compared survival and growth of free ranging hatchlings to those reared in pens  
906 under different rainfall scenarios. Both groups were hatched from eggs laid by wild females and  
907 brought into captivity for the study. Free ranging hatchlings were released into the wild  
908 between 0 and 18 months old. Estimated annual survival rates for the free ranging hatchlings  
909 was 48%–49% compared to 94% of those reared in pens.

910 We do not have much information on historical juvenile survival rates, but the impact of recent  
911 low survival rates can be seen in demographic information. As mentioned previously, in the  
912 yearly surveys performed in the Western Mojave TCAs, many fewer tortoises with midline  
913 carapace length <180 mm were found in 2007–2015 compared to 2001–2005 (Figure 12). One  
914 likely cause of juvenile mortality is raven predation. Holcomb et al. (2021) estimated that  
915 annual survival rates for 1–10-year-old tortoises in 5 CHUs averaged 63% when within 500m of  
916 a raven’s nest, and ~76% when the median distance to a nest was 1.72 km. See section 4.4 for  
917 more detail on predation.

918 One strategy to improve juvenile survival is to raise tortoises in captivity and then release them  
919 once they reach a certain size (referred to as head-starting; for more details see section 9.1). A  
920 study at the Fort Irwin National Training Center on head-started juvenile tortoises (Nagy et al.  
921 2015b) found that in the two years after release, survivorship was 76–79%, but in the third year  
922 survivorship dropped to 53%, resulting in an overall three year survival rate of 32%. Survival  
923 was generally higher amongst tortoises with a carapace length of at least 100 mm (9 years old).  
924 Another study on head-starting found that found no significant difference in the survival rate of  
925 hatchlings released vs those reared indoors for 7 months vs those reared in outdoor pens for 7  
926 months (Daly et al. 2019). Although the head-started tortoises grew quickly, the three groups  
927 combined annual survival after release was 44%, with the odds of survival increasing 51% for  
928 every 100m away from a raven’s nest. They predicted that survival would be near 100% if the  
929 nearest nest was more than 1.6 km away (Daly et al. 2019)

930 Even with head-starting, juvenile survival rates are often lower than the 59% average annual  
 931 juvenile survival rate estimated by Holcomb (2022a) to be necessary for population stability if  
 932 adult annual survival rates are 93% (Table 4). The available information suggests that low  
 933 juvenile survival is one of the major reasons why there have been widespread declines in  
 934 density.

935 **Table 4.** Survival and mortality rates of juvenile tortoises in various studies.

Life stage	Survival vs Mortality	Rate	Location	Time scale	Reference
Juveniles	Median annual survival probability	66%-73%	Desert Tortoise Research Natural Area	1979-1989	Berry et al. 2020b
Juveniles	Median annual survival probability	57%-65%	Desert Tortoise Research Natural Area	1989-2002	Berry et al. 2020b
Juveniles	Median annual survival probability	90%-93%	Desert Tortoise Research Natural Area	2002-2012	Berry et al. 2020b
Head started juveniles	Survivorship after 2 years	76-79%	Fort Irwin	2005-2007	Nagy et al. 2015
Head started juveniles	Survivorship after 3 years	53%-48%	Fort Irwin	2005-2008	Nagy et al. 2015
Wild Hatchlings	Survival rate	49%	Ivanpah Valley	2011-2014	Tuberville et al 2019
Head started juveniles	Annual survival after release	44%	Mojave National Preserve	2015	Daly et al. 2019
Juveniles	Annual survival close to ravens' nest	63%	Mojave Desert	2020	Holcomb et al. 2021
Juveniles	Annual survival far from raven's nest	76%	Mojave Desert	2020	Holcomb et al. 2021

936

937 For species like tortoise with slow growth, delayed maturation, and low reproduction rates  
 938 (Shine 2005), factors that lower adult survival rates can have long-term negative impacts on  
 939 abundance/density. Snapping turtles have similar life history traits as desert tortoises, and in a  
 940 population in Ontario Canada, river otters killed about 50% of the adults over three years in the  
 941 late 1980s (Keevil et al. 2018). Female annual survival rates fell from 94% to 76–86% during  
 942 those years, and the population was reduced by about 40% (Keevil et al. 2018). Twenty-three  
 943 years later, survival rates had returned to early 1980s level, but abundance did not rebound.  
 944 This suggests that even if threats are removed, and survival rates increase, for a long-lived  
 945 species like the desert tortoise, populations may not recover for several decades. The problem  
 946 is magnified if juvenile survival is very low as is seen in multiple survey areas in California.  
 947 Having breeding adults on the landscape is vital for population viability, and low rates of  
 948 juvenile recruitment create an unstable demographic structure that will make it less likely for  
 949 populations to recover and makes them vulnerable to any additional sources of mortality  
 950 (Holcomb 2022b).

951 **4 FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE**

952 Desert tortoise life history traits, including delayed reproductive maturity, relatively low annual  
953 fecundity, and low survival rates of juvenile tortoises cause populations to be vulnerable to a  
954 multitude of threats (Berry et al. 2020b). Their vulnerability is increased because many of the  
955 threats are interactive and amplify each other. For clarity, this document focuses on individual  
956 threats, but also recognizes that many of them are fundamentally intertwined. Many of the  
957 threats described in the initial desert tortoise status review and the USFWS Recovery Plans (U.S.  
958 Fish and Wildlife Service 1994, U.S. Fish and Wildlife Service 2011) continue to affect the  
959 species.

#### 960 **4.1 Habitat Modification and Destruction**

961 Mojave Desert Tortoise range in California occurs on a variety of public and private land  
962 jurisdictions, the top three being BLM (39,251 km<sup>2</sup>), National Park Service (NPS) (17,035 km<sup>2</sup>),  
963 and Department of Defense (DoD) (13,018 km<sup>2</sup>). The type of habitat modification and  
964 destruction permitted on each of these land types varies. BLM land is managed for a wide range  
965 of uses and stakeholders, and permitted activities that may impact tortoises include off-  
966 highway driving, mining, and renewable energy projects. Activities on NPS land are much more  
967 restricted; off-highway driving, mining, and renewable energy projects are not allowed. DoD  
968 land is not generally open to the public and uses range from extremely low impact to high  
969 impact live artillery use. See Figure 5 for more details on land ownership.

970 In the large majority of tortoise habitat, at least some alteration is allowed which can impact  
971 tortoises. Across all states, an estimated 66% of Mojave Desert Tortoise habitat has some  
972 development within 1 km, where development is defined as “urban development, cultivated  
973 agriculture, energy development (e.g., oil and gas well pads, solar energy facilities), surface  
974 mines and quarries, pipelines and transmission lines, and transportation (e.g., roads and  
975 railroads” (Carter et al. 2020). The direct impacts of development include removal of soil and  
976 vegetation, destruction of burrows, and creation of roads and other infrastructure that can kill  
977 tortoises or hinder their movements (Boarman and Sazaki 1996, 2006). An important indirect  
978 impact of development is subsidization of predators (see section 4.4) (Boarman et al. 2006).

979 Tortoises are less likely to occur in areas that have even a low level of development. Carter et  
980 al. (2020) found that “encounter rates of both live and dead Mojave Desert Tortoises combined  
981 decreased significantly with development levels” and that when “10% of the area within 1 km  
982 of that location has been altered by development” (10% development), it was rare to find live  
983 or dead tortoises at a location. The authors estimated that encounter rates for both live and  
984 dead Mojave Desert Tortoises decreased an average of 4% for every 1% increase in the  
985 development index (Carter et al. 2020).

986 In the Western Mojave Recovery Unit (which is wholly within California) 47% of tortoise habitat  
987 has almost no development (<1% within 1 km), and 5% of habitat has >10% development (U.S.  
988 Fish and Wildlife Service 2022a). For the Eastern Mojave Recovery Unit, the proportion of  
989 habitat with <1% development within 1 km is 58%, and 5% is at 10% development. In the  
990 Colorado Desert Recovery Unit, it is 65% and 4% respectively (U.S. Fish and Wildlife Service  
991 2022a). However, those two units extend outside of California (see Figure 6), and it is unclear

992 whether those percentages are representative of the range in California. In their 2022 5-year  
993 review, the USFWS concluded that “space does not appear to be a limiting factor to tortoise  
994 recovery”. However, these categories of development used above do not take into account  
995 unpaved roads and tracks for off-highway vehicles (OHVs) which are allowed on BLM land (see  
996 section 4.2).

997 Driven by a number of forces, the human population in the inland deserts of California has  
998 increased significantly in the past 30 years. Between 1990 and 2022, the number of housing  
999 units increased 58% in Imperial County, 79% in Riverside County, and 37% in San Bernadino  
1000 County (numbers calculated from State of California Department of Finance 2023). Urban or  
1001 suburban development typically expands along the edges of previously impacted habitats which  
1002 generally contain few tortoises. Therefore, we focus discussion on other types of projects that  
1003 are more likely to have large-scale impacts on areas with desert tortoise populations.

#### 1004 *Department of Defense*

1005 The Department of Defense is a major landholder in desert tortoise range. Military bases in  
1006 California deserts include Fort Irwin, Naval Air Weapons Station China Lake, Edwards Air Force  
1007 Base, George Air Force Base, Chocolate Mountain Aerial Gunnery Range, Marine Corps Air  
1008 Ground Combat Center Twentynine Palms, and Marine Corps Logistics Base Barstow. In total,  
1009 these bases encompass over 3 million acres (14.78% of the total tortoise range in California, see  
1010 Figure 4). A wide variety of land uses occur on DoD property, and some of those uses are very  
1011 compatible with desert tortoises while others are not. Training areas are generally high impact  
1012 and tortoises in training designated areas are translocated to other sites. For example,  
1013 according to the USFWS (2022c), the “Department of the Army (Army) expanded training onto  
1014 18,197 acres (73.6 km<sup>2</sup>) of designated critical habitat on the southern area of Fort Irwin that  
1015 had previously been off-limits to training, thus requiring the translocation of approximately 650  
1016 adult desert tortoises. In addition, the Army plans to expand activities onto and displace  
1017 tortoises from up to 62,045 acres (~250 km<sup>2</sup>) of its western training area in the near future,  
1018 which is designated critical habitat and currently off limits to training. The Department of the  
1019 Navy (Navy) expanded training for the Marine Corps Air Ground Combat Center (MCAGCC) at  
1020 Twentynine Palms into approximately 167,982 acres (680 km<sup>2</sup>) of public and private land, which  
1021 required translocating approximately 1,000 adult tortoises.” Around 700 of those tortoises  
1022 were translocated into the Ord-Rodman TCA (see section 9.1 on Translocation).

1023 Along with translocation of tortoises, other strategies used by the DoD to offset the impact of  
1024 converting large areas of habitat into training grounds include acquiring land (making it federal)  
1025 within a CHU, buying out grazing allotments, increased law enforcement in tortoise habitat,  
1026 predator monitoring and targeted control within translocation sites, rehabilitation of closed  
1027 routes, installation of off-highway vehicle barriers and desert tortoise exclusion fencing, and  
1028 constructing perimeter fences to prevent public trespass into tortoise habitat (U.S. Fish and  
1029 Wildlife Service 2022a). For more discussion of efforts to conserve tortoises, see section 5.2  
1030 Current Management Actions.

1031 Given the relatively large amount of DoD land with land use practices that require translocation  
1032 of tortoises, it is of interest whether and how quickly that habitat might become suitable again  
1033 for tortoises if and when the areas are no longer used for training. Recovery from disturbance  
1034 can take a long time in desert ecosystems. This has been documented in soils and vegetation of  
1035 the Desert Training Center which spans parts of southern California, southern Nevada, and  
1036 western Arizona. This area was used for military training exercises in the 1940s and 1960s, and  
1037 40–60 years later the soil in tank tracks remained compacted and rain infiltration rates were  
1038 low (Prose and Wilshire 2000). These soil differences led to increased plant density in the  
1039 tracks, but those plants had restricted growth. In addition, grass species with shallow fibrous  
1040 root systems increased in density in the tracks while species with long tap roots had reduced  
1041 density and cover (Prose and Wilshire 2000). USFWS (1994) estimated that areas where camps,  
1042 roads, and parking lots were built would take “decades or centuries to recover.” Other  
1043 documented direct negative impacts to tortoises on military property include “vandalism,  
1044 predation, mycoplasmosis and shell diseases” with “significantly more tortoises with shell  
1045 disease...found on plots with current and recent military use than on plots with no history of  
1046 military use” (Berry et al. 2006). For more detail on shell disease see section 4.7.

#### 1047 *Renewable Energy Projects*

1048 Renewable energy projects, namely solar farms and wind energy facilities are a major source of  
1049 development in desert tortoise habitat. These facilities are regarded as key to reducing CO<sub>2</sub>  
1050 emissions, and their development has been prioritized on public land (e.g., American  
1051 Reinvestment and Recovery Act 2008; National Energy Policy Act 2005, Infrastructure  
1052 Investment and Jobs Act 2021, Inflation Reduction Act 2022). Unlike urban or suburban  
1053 development, energy projects tend to be sited in mostly undeveloped public land, thus leading  
1054 to the potential degradation and fragmentation of relatively high-quality tortoise habitat  
1055 (Lovich et al. 2011).

1056 The impacts of wind and solar energy facilities generally differ from more typical forms of  
1057 development, primarily due to the diffuse nature of the infrastructure. Data specifically  
1058 evaluating the impacts of renewable energy facilities on desert tortoises remains limited,  
1059 however two studies suggest that tortoise survival rates are relatively high. A study near Palm  
1060 Springs in Riverside County estimated tortoise survival rate within a wind energy facility (WEF)  
1061 and a nearby wilderness area (NWA) using data from 1997–2000 and 2009–2014 (Agha et al.  
1062 2015). They found “long-term tortoise survivorship within the WEF (96.7 %) was significantly  
1063 higher than in the nearby NWA (92.1 %)” (Agha et al. 2015). This counter intuitive result may  
1064 have been due to tortoises at the WEF benefiting from “edge enhancement of vegetation (food  
1065 resources), turbine pads (artificial rain catchments), reduced subsidized predators and low  
1066 traffic.” (Agha et al. 2015).

1067 Lovich et al. (2011) tracked tortoises at a wind energy facility near Palm Springs for six field  
1068 seasons (1997–2000 and 2009–2010). The facility contained turbines, electrical transformers,  
1069 and an extensive network of roads (Lovich et al 2011). Their estimated annual survivorship rate  
1070 of 91.6% (confidence interval 90.5–93.5%) was based only on adult females, which is a much

1071 higher survival rate than has been reported in many areas across the range in California (see  
1072 section 3.3). The authors suggested a few characteristics of the site that might have led to high  
1073 survival rates including very restricted public access and fewer ravens. However, they cautioned  
1074 that without before-and-after studies of the impact of energy facilities, of which there are very  
1075 few, it is hard to draw conclusions about the long-term impacts of energy facilities on desert  
1076 tortoise.

1077 Development of a wind power project results in a variety of disturbances that are classified as  
1078 temporary or permanent. Permanent impacts include land occupied by wind turbine pads,  
1079 access roads, substations, and transmission lines. Temporary direct impacts include temporary  
1080 roads, staging areas, and substation/transmission construction (Denholm et al. 2009). However,  
1081 in desert ecosystems, 'temporary' disturbances may have decades-long impacts if sites are not  
1082 actively rehabilitated. Denholm et al. (2009) collated data on the size of several wind projects in  
1083 California including total size (land associated with the complete wind plant project) and area of  
1084 direct (permanent and temporary) impact. Of the four projects with complete data, direct  
1085 impacts accounted for 1.5–7% of the total area of the project.

1086 Solar power plants have a different design and land use than windfarms. However, similar types  
1087 of impact classifications occur. Direct impacts occur where land is occupied by solar arrays,  
1088 access roads, substations, service buildings, and other infrastructure (Ong et al. 2013). Three  
1089 types of solar power plants were evaluated in one study, and the percentage of total land that  
1090 was directly impacted was between 38% and 100% of the project site (N=12 projects) (Ong et  
1091 al. 2013). The impact of infrastructure to wildlife extends beyond the habitat that is directly  
1092 modified, including fragmentation and barriers to gene flow, effects due to noise, vibration, and  
1093 shadow flicker, electromagnetic field generation, macro- and micro-climate change, predator  
1094 attraction, dust and dust suppressants, and increased fire risk (Lovich and Ennen 2011, 2013). A  
1095 study in southern California compared wind farms with nearby areas and found that species  
1096 richness, evenness, and diversity was lower on the farm sites for reptiles, birds, mammals,  
1097 arachnids, and plants (Keehn and Feldman 2018). Renewable energy facilities are not sited  
1098 within tortoise CHUs, however they can be close enough that the impacts listed above spill over  
1099 into critical habitat (K. Berry USGS, pers. comm 2022).

1100 Renewable energy projects that could potentially cause 'take' of desert tortoises must apply for  
1101 incidental take permits (ITPs) from the Department or from the USFWS depending on  
1102 jurisdiction (see section 5.1 for more detail). Between 2010 and 2021, the Department issued  
1103 ITPs for desert tortoise for 49 renewable energy projects. In 2022, the Department completed  
1104 ITP permitting for six renewable energy projects within San Bernadino and Riverside counties  
1105 that would have a total footprint of about 10,600 acres (43 km<sup>2</sup>). As of October 2022, the  
1106 Department was in the process of reviewing or issuing ITPs for 14 more renewable energy  
1107 projects in Riverside and San Bernadino counties that could potentially have footprints of up to  
1108 20,750 acres (84 km<sup>2</sup>). Not all of these projects are necessarily sited within the recovery units or  
1109 will end up receiving permits from the Department. However, it does show that there is  
1110 increasing demand to use land within the Mojave Desert for renewable energy projects (for  
1111 more information about ITPs, see Section 5.2).

1112 *Cannabis Operations*

1113 Illegal cannabis farms are an emerging threat to tortoises and their habitat in the Mojave  
1114 Desert. Habitat is destroyed to put up greenhouses, and there are potential associated spillover  
1115 effects like chemical leakage into stream beds, trash dumps, and other land disturbances  
1116 beyond the footprint of the greenhouses. In addition, water and trash may attract and increase  
1117 densities of predators like coyotes and ravens, and guard dogs are thought to kill tortoises  
1118 (CDFW unpublished data, Holcomb 2022a, U.S. Fish and Wildlife Service 2022a). In the  
1119 Department’s Region 6, which includes the majority of desert tortoise range, as of 2022 there  
1120 had been 3,065 acres (~12 km<sup>2</sup>) of illegal cannabis cultivation visited by law enforcement.  
1121 However, the Department acknowledges that there are vastly more illegal sites within tortoise  
1122 range for which a law enforcement response has not been possible, therefore these numbers  
1123 likely underestimate the true impacts. The presence of illegal cannabis farms can have  
1124 additional indirect impacts on tortoise conservation. For example, according to USFWS (2022a),  
1125 “illegal cannabis farms have already led to the cessation of raven monitoring and management  
1126 efforts in the Fremont-Kramer Critical Habitat Unit in 2021, with the likelihood that tortoise  
1127 monitoring in the same unit scheduled for 2022 will be cancelled due to safety concerns for  
1128 field workers.”

1129 Legal cannabis cultivation also occurs within the desert tortoise range. Currently in Region 6  
1130 there are 2,394 acres (~9.5 km<sup>2</sup>) of legal cannabis cultivation that have Streambed Alteration  
1131 Agreements. The Department evaluates each development project individually for the purposes  
1132 of the California Environmental Quality Act, and there has not been a robust analysis of the  
1133 cumulative impacts to the species resulting from cannabis development in the area. Due to the  
1134 newness of the threat, the overall impact on tortoises from illegal and legal cultivation has not  
1135 been quantified. However, it a matter of increasing concern, and the current tools of permitting  
1136 and law enforcement resources may not be sufficient to lessen the negative impacts on  
1137 tortoises.

1138 While the long-term impact of habitat modification and destruction resulting from all the land  
1139 use types described above, along with any associated mitigation measures, is not fully known,  
1140 the USFWS (2019a) states the impacts are “unlikely to be positive, despite the numerous  
1141 conservation measures that have been (or will be) implemented as part of the actions.”  
1142 Although there are multiple science-based measures enacted to manage and mitigate threats,  
1143 U.S. Fish and Wildlife Service (2019a) warns that they “have been unable, to date, to determine  
1144 whether the expected benefits of the measures have yet been realized, at least in part because  
1145 of the low reproductive capacity of the desert tortoise. Therefore, the conversion of habitat  
1146 into areas that are unsuitable for this species continues the trend of constricting the desert  
1147 tortoise into a smaller portion of its range”.

1148 Across the entire species range, it has been estimated that 7.4% of modelled tortoise habitat is  
1149 now completely unsuitable for tortoise survival due to development and recent fire (Holcomb  
1150 2022a). Additionally, habitat is degraded in many additional areas as a result of factors such as  
1151 off-highway vehicle use, wildfire, invasive plant species, and increased temperature due to



1152 climate change Therefore, focusing solely on the proportion of direct habitat loss in the desert  
1153 tortoise range may be misleading and create an overly optimistic picture. With more than 90%  
1154 of historical habitat still accessible, tortoise populations have declined severely in the past two  
1155 decades.

#### 1156 **4.2 Vehicle Strikes, Roads, and Fencing**

1157 Development of all types creates roads and other transport corridors that impact tortoises  
1158 directly through vehicle strikes and as barriers to movement. Indirect impacts of transport  
1159 corridors include habitat degradation including the spread of invasive species (Boarman et al.  
1160 1997, Brooks et al. 2005).

1161 Desert tortoises are particularly susceptible to being killed on roads due to their slow rate of  
1162 travel. Human behavior also plays a role. Boarman et al. (1997) anecdotally reported drivers  
1163 intentionally swerving to hit turtles and tortoises. Even if drivers are not intentionally hitting  
1164 tortoises, speeding on all types of roads can lead to unintentional but deadly strikes on  
1165 tortoises (A. Ellsworth pers. comm. Nov 2022). Boarman and Sazaki (1996) estimated a kill rate  
1166 of 1 tortoise per 2.4 km of road per year on Highway 58 in the western Mojave Desert, but  
1167 warned their estimate was likely low because carcasses disappear quickly in the desert (likely  
1168 due to scavenging). Anecdotal evidence from the Mojave Desert Preserve indicates an average  
1169 of 5.3 tortoises are killed per year on the 216 km of paved road in the Preserve. Using 2008-  
1170 2010 data from the Preserve, Hughson and Darby (2013) estimated that 31 female tortoises per  
1171 year killed (on top of natural mortality) would be unsustainable, concluding that road  
1172 mortalities may account for about ~9% of the excess mortality per year (assuming equal sex  
1173 ratios). Juvenile dispersing tortoises are more likely to be killed on roads compared to adults  
1174 (Boarman and Sazaki 1996).

1175 Tortoises are often attracted to roads within their home ranges as places where appropriate  
1176 forage plants grow and rain runoff collects (Boarman et al. 1997). However, impacts from direct  
1177 mortality and increased access for predators near roads can result in the creation of reduced  
1178 occupancy zones along roads, whose width can vary (Boarman et al. 1997). Two-lane paved  
1179 roads in Mojave National Preserve had reduced occupancy up to 400 m away from the road  
1180 (Hughson and Darby 2013). Boarman and Sazaki (1996) studied Highway 58 in California and  
1181 found reduced occupancy up to 800m away. If the roads occur at a sufficient density, these  
1182 zones could impact enough habitat to affect tortoise density across large scales. Although these  
1183 results are only correlative, the TCAs that have road densities above 0.75 km/km<sup>2</sup> all had  
1184 declines in tortoise densities between 2004 and 2014, while TCAs with less dense roads had  
1185 both increases and declines in tortoise density (U.S. Fish and Wildlife Service 2022a).

1186 Keeping tortoises off roads is a conservation priority (U.S. Fish and Wildlife Service 2022a).  
1187 Well-constructed fencing designed to stop tortoises from accessing roads can lead to 93%  
1188 fewer tortoise carcasses along highways as well as reducing road kills of other small vertebrates  
1189 (Boarman and Sazaki 1996). Properly designed culverts under roads facilitate tortoise

1190 movements and help prevent fences from fragmenting tortoise populations (Boarman and  
1191 Sasaki 1996). According to the USFWS (2022c):

1192 “Through 2011 approximately 1,660 km of highway roadside (including both  
1193 sides of roads for those fenced on each side) had tortoise exclusion fencing  
1194 installed to prevent road mortalities. Unfortunately, only approximately 43 km of  
1195 roadside have been fenced in the decade since 2011. Almost 500 km of roadside  
1196 have been identified as priorities for fencing based on our current understanding  
1197 of road-effect zone area, relative habitat potential, and locations of extant  
1198 populations (Holcomb 2019).”

1199 Considerations that can slow or prevent fence building include cost, maintenance, visual  
1200 disruption of the landscape, and loss of habitat during construction. At the October 2022 Desert  
1201 Tortoise Management Oversight Group Meeting, the BLM reported that 3.5 miles of I-40 in the  
1202 Ord-Rodman CHU will be fenced soon, and 5 miles of fence will be built soon in Mojave  
1203 National Preserve. Other strategies to reduce tortoise mortalities on roads such as lowering  
1204 speed limits, installing warning signs, and driver education have not been shown to be  
1205 particularly effective (Hughson and Darby 2013).

1206 Off-highway vehicles

1207 Off-roading is a popular pastime in the California’s deserts. According to the BLM, in 2008 there  
1208 were four times the number of off-highway vehicles in the West than in 1998 (Bisson 2008). In  
1209 Desert Wildlife Management Areas and CHUs, OHVs are legally required to stay on established  
1210 roads and trails, while on the remainder of BLM land they can travel cross-country, although  
1211 local BLM offices can enact further restrictions. OHVs and their associated unpaved trails lead  
1212 to habitat degradation, but the impacts are thought to be generally less severe than paved  
1213 roads.

1214 OHV trails are typically <4m wide with a dirt surface, and are unimproved (i.e., they have never  
1215 been bladed or filled) (Brooks et al. 2005). When the trails are created, it alters soils,  
1216 vegetation, and some types of wildlife may potentially be killed. Tortoises can be run over on  
1217 and off these trails and vehicles can crush burrows, depriving tortoises of refuge from extreme  
1218 temperatures and drought. In areas of very frequent OHV use, multiple routes may merge into  
1219 broad areas devoid of perennial vegetation 10–100 m or more across. These extremely high  
1220 impact areas are rare, however there are large networks of OHV trails across the Mojave Desert  
1221 which collectively can create significant changes to habitat and soils (Brooks et al. 2005). OHV  
1222 trails change water runoff patterns especially on slopes and lead to greater erosion (Brooks et  
1223 al. 2005). In addition, roads of all kinds can serve as pathways for invasive species. Inholding of  
1224 private parcels within BLM land often are set aside for conservation, and OHV trails formally  
1225 stop and restart at the boundaries. However, drivers often trespass across those private  
1226 parcels, creating negative impacts for the tortoises even in areas that are designated as  
1227 protected (A. Ellsworth, CDFW pers. comm. Oct 2022). The ecosystem or landscape-wide  
1228 impact of OHV use can be hard to tease out in areas like the Mojave Desert that have multiple

1229 land uses, and Brooks et al. (2005) warned that “dispersed landscape effects ... should be  
1230 generalized very cautiously”.

1231 The extent of OHV trails in desert tortoise habitat is hard to quantify, however the recent  
1232 expansion of the Spangler, El Mirage, and Johnson Valley off-highway vehicle recreation areas  
1233 under the 2019 John D. Dingell, Jr. Conservation, Management, and Recreation Act opened up  
1234 an additional 60,000 acres (~242 km<sup>2</sup>) of public land to cross country OHV use (U.S. Fish  
1235 and Wildlife Service 2022a). At the October 2022 Desert Tortoise Management Oversight Group  
1236 Meeting, the BLM reported that there is a multi-year restoration project in Fremont-Kramer  
1237 CHU to monitor and restore OHV routes.

### 1238 **4.3 Impacts from Invasive and Non-Native Species**

#### 1239 *Invasive Grasses and Forbs*

1240 Like many of the processes threatening desert tortoise, the impacts of invasive species are  
1241 often tied to and synergistic with other factors such as livestock grazing, drought, and wildfire.  
1242 Fueled in part by nitrogen pollution carried by wind from the Los Angeles Basin which enriches  
1243 desert soils (Fenn et al. 2010), invasive Mediterranean grasses have spread through much of  
1244 the Mojave Desert. These grasses create fuel for wildfires (Drake et al. 2015) and outcompete  
1245 native annual plants (DeFalco et al. 2003). In 1995, 34 plots in the Mojave Desert near Barstow  
1246 had frequencies of occurrence of 17% for *Bromus* and 38% for *Schismus* (both invasive grasses)  
1247 (Brooks 1999). A more recent study sampled 718 plots across the Mojave Desert in 2009–2013  
1248 to investigate invasive grasses (*Bromus* spp. and *Schismus* spp.) and an invasive forb (*Erodium*  
1249 *cictarium*). At least one of the invasive taxa occurred in 91% of the plots with herbaceous cover,  
1250 and two or more of the species co-occurred in 77% (Underwood et al. 2019). Although these  
1251 two methodologies are different, the general trend of increasing cover of invasive grass and  
1252 forb species has occurred broadly across the Mojave Desert.

1253 Berry et al. (2020b) summarized the impacts of invasive grasses on desert tortoise:

1254 “Tortoises avoid plants high in potassium and do not thrive on diets of native or  
1255 non-native grasses. Both juveniles and adults lose mass and are out of nitrogen  
1256 balance when consuming grasses (Barboza 1995a, b; Hazard et al. 2009, 2010;  
1257 Drake et al. 2016). Grasses are high in fiber, contain less digestible energy, and  
1258 little protein (Hazard et al. 2009), causing juveniles to lose phosphorus and  
1259 potentially shell volume (Hazard et al. 2010). Because of numerous human  
1260 activities, invasive, non-native, and fire-prone grasses became established in  
1261 tortoise habitat and now contribute substantially to the biomass of annual plants  
1262 in late winter and spring, the principal feeding time for the tortoise (Brooks and  
1263 Berry 2006, Brooks and Matchett 2006, Brooks et al. 2006, Minnich 2008). These  
1264 grasses compete with native forbs for nutrients (Brooks 2000a). A diet of grasses  
1265 is insufficient in nutrients and leads to water loss during digestion (Hazard et al.  
1266 2009, 2010). In experimental studies, 32–37% of neonates and yearlings did not  
1267 survive on a diet of grasses, whereas individuals in these size groups fed native

1268 forbs or a mix of native forbs and grasses had better body condition, immune  
1269 functions, growth, and survival rates exceeding 95% (Drake et al. 2016).”

1270 In contrast to grasses, the alien forb *Erodium* provided sufficient nitrogen and is of similar  
1271 nutritional quality as a native forb (Nagy et al. 1998), allowing juvenile tortoises fed on forbs to  
1272 gain weight (Hazard et al. 2009).

#### 1273 *Livestock and other grazers*

1274 Grazing by livestock is a major part of the recent history of the desert. Until the 1990 listing of  
1275 the desert tortoise as threatened under the ESA, grazing by livestock was allowed on BLM land  
1276 in tortoise range (Berry et al. 2014). After listing, BLM banned livestock grazing in the CHUs.  
1277 However, grazing is allowed on private inholdings within the CHUs, which are often unfenced.  
1278 The documented impacts of livestock on tortoises include competition for food, trampling to  
1279 death, and causing the collapse of burrows (see Berry and Murphy (2019)). Livestock also  
1280 degrade habitat by creating or expanding trails via trampling which reduces annual cover and  
1281 disrupts the soil surface, thus promoting wind erosion, and compacts the soil which slows  
1282 future growth of annual plants (Webb and Stielstra 1979, Lovich and Bainbridge 1999).  
1283 Livestock increase browsing pressure on the trees and shrubs tortoises require for shade and  
1284 for establishing burrows (Berry et al. 2020a). Artificial watering sites set up for livestock  
1285 concentrate activity of wild and domesticated large herbivores, potentially changing aspects of  
1286 soil nutrients, compaction, seedbanks, and density of invasive species nearby. In a grazing  
1287 allotment on BLM land in the west central Mojave Desert, cover of native plants decreased with  
1288 increasing proximity to water site, while cover of alien (but not necessarily invasive) species  
1289 increased (Brooks et al. 2006). This change in plant composition was observed up to 800m away  
1290 from the watering site. Ninety-six percent of the alien plant cover was made up of three  
1291 species, including the forb *Erodium cicutarium* and the alien grass *Schismus* spp. (Brooks et al.  
1292 2006).

#### 1293 **4.4 Predation**

1294 Predation affects tortoises across age classes, with different species preying on various age  
1295 classes. While there have always been predators that target tortoises, the number of predators  
1296 and their distribution on the landscape has increased in tandem with human development.

1297 The best studied predators of tortoises are ravens and coyotes. These species are generalist  
1298 predators which utilize a variety of habitats including human modified ones. Human presence in  
1299 tortoise habitat provides food resources such as unsecured trash, water, and road-killed  
1300 carcasses, and buildings and other structures that provide shelter (Boarman et al. 2006, Kristan  
1301 and Boarman 2007). These ‘resources bonanzas’ (Kristan and Boarman 2007) allow raven and  
1302 coyote populations to flourish, increasing predation pressure on native prey.

1303 Raven populations have drastically increased in the Mojave Desert since the 20<sup>th</sup> century and  
1304 have become a major predator of juvenile tortoises. This contrasts with population trends for  
1305 many other bird species. Between the early 20<sup>th</sup> century and 2013–16, survey sites in the

1306 Mojave Desert lost 43% of their bird species on average (Iknayan and Beissinger 2018). Ravens  
1307 were the only species to substantially increase across survey sites. The probability that ravens  
1308 would be detected at a survey site was on average 35% in the first half of the 20<sup>th</sup> century and  
1309 76% in 2013–2016 (Iknayan and Beissinger 2018). In 2020, surveys in Fenner, Ivanpah, Fremont-  
1310 Kramer, Ord-Rodman, and Superior-Cronese CHUs found average densities of 0.63 ravens/km<sup>2</sup>  
1311 in Fenner in the east to 2.44 ravens/km<sup>2</sup> in Fremont-Kramer in the west (Holcomb et al. 2021).  
1312 This expansion of raven presence in extent and abundance is due at least in part to increased  
1313 anthropogenic subsidies (Boarman and Berry 1995). Ravens spend their time near these  
1314 subsidies (Boarman and Berry 1995, Boarman et al. 1995, 2006), which is one of the factors that  
1315 leads to higher mortality for tortoises near human infrastructure than in open desert (Berry et  
1316 al. 2006, Esque et al. 2010). As human infrastructure has increased in the Mojave Desert, the  
1317 impact of raven predation on desert tortoise populations has likely increased. Nagy et al.  
1318 (2015b) released 53 tortoises on Fort Irwin National Training Center in 2005, and 78% of the  
1319 mortality of smaller tortoises (carapace 45–80 mm) was due to ravens, while coyotes were a  
1320 major source of mortality for larger (111–175 mm) tortoises (Nagy et al. 2015b). High levels of  
1321 raven predation on juveniles are thought to have led to far fewer juveniles being observed in  
1322 the annual TCA surveys. In an area with a raven density of 2.4/km<sup>2</sup>, the USFWS estimated  
1323 survival of 0–12-year-old tortoises at 51%, which is much lower than in areas without ravens  
1324 (Holcomb 2022b). Distance to the nearest raven nest impacts the survival rates of 0-10 year old  
1325 tortoises. Using decoy tortoises, Holcomb et al. (2021) found that juvenile tortoises on average  
1326 had an annual survival rate of 63% 500m from a raven’s nest, while tortoises 1.72 km away had  
1327 ~76% annual survival rates. They estimated that in areas where there were more than 0.89  
1328 ravens/km<sup>2</sup>, and tortoises were less than 1.72 km from a nest, juvenile mortality would be great  
1329 enough to cause population decline. If these criteria were applied to the Fremont-Kramer CHU,  
1330 raven predation alone would likely have caused “inadequate” recruitment of juvenile tortoises  
1331 across the majority of the CHUs over the past 20 years (Holcomb et al. 2021). Ivanpah and  
1332 Fenner CHUs have fewer anthropogenic subsidies for ravens and therefore lower raven  
1333 densities. However, the densities in those CHUs are high enough that predation pressure  
1334 combined with drought, road mortality and invasive species together permit sustained  
1335 recruitment of juvenile tortoises only in a few places. (Holcomb et al. 2021)

1336 Predation pressure by ravens is not even across the tortoise range. In a study in the El Paso  
1337 Mountains east of Bakersfield between 2008 and 2009, avian predators (mostly ravens)  
1338 accounted for only 2.5% (on plot) and 3.7% (off plot) of observed mortalities (Berry et al.  
1339 2020c).

1340 Coyotes are a major predator of adult tortoises. In a translocation study in the Superior-  
1341 Cronese CHU, 158 tortoises were translocated from Ft. Irwin in 2008. Ten years later, 104 were  
1342 dead, an estimated 60% of which were killed by coyotes (Mack and Berry 2023). Kelly et al.  
1343 (2021) found that coyotes in the Mojave Desert preyed more on adult than juvenile tortoises  
1344 while desert kit foxes focused on juveniles. In an examination of the dead tortoises found in the  
1345 El Paso Mountains east of Bakersfield between 2008 and 2009, 20% of the carcasses found on  
1346 the survey plots and about 52% of those found off plots were killed by mammalian predators  
1347 including coyote, kit fox, and badger (Berry et al. 2020c).

1348 There is also some evidence that canid predators focus more on females than males. In the  
1349 Superior-Cronese CHU in 2008, Esque et al. (2010) found that tortoises suffered high levels of  
1350 mortality (8.3–25% of tracked tortoises died in the year covered by the study), with the  
1351 majority of tortoises found dead having been killed by predators (likely coyotes) and that  
1352 females were more likely to be killed because they were smaller. They also looked at reference  
1353 sites across the Mojave Desert and found that coyote predation on tortoises was strongly  
1354 associated with the size of nearby human populations (Esque et al. 2010).

1355 Other predators of tortoises include fire ants, white-tailed antelope squirrels, bobcats (Nagy et  
1356 al. 2015*a,b*), red-tailed Hawks (Anderson and Berry 2019), rattlesnakes (Berry et al. 2016),  
1357 domestic dogs (Berry and Murphy 2019), and badgers (Smith et al. 2016).

1358 Like many threats facing desert tortoises, predation may be influenced by other factors  
1359 including drought (Esque et al. 2010). The periods of extended drought may exacerbate coyote  
1360 predation pressure due to low rodent and lagomorph numbers and coyotes switching to relying  
1361 more on tortoises for food, however data on small mammal abundances that would provide  
1362 direct evidence of this is lacking (Esque et al. 2010).

#### 1363 **4.5 Climate Change and Drought**

1364 Anthropogenic climate change has led to higher annual average air temperatures in general as  
1365 well as increased volatility of California’s climate. Extreme events like drought and heat waves  
1366 are more frequent, rainfall is increasingly variable, and flow regimes of rivers are changing  
1367 (Bedsworth et al. 2018). These changes have led to observable shifts in species distributions  
1368 and timing of life history events (Office of Environmental Health Hazard Assessment 2018). In  
1369 California, Mojave Desert Tortoises inhabit the relatively cooler high Mojave Desert, and the  
1370 hotter low Sonoran Desert. The western part of the tortoise range in the Mojave Desert gets  
1371 most of its precipitation in the winter with only about 15% from summer monsoons, whereas  
1372 the monsoons account for about 30% of yearly precipitation in the eastern deserts (Hopkins  
1373 2018).

#### 1374 *Impacts of Increased heat*

1375 In the inland deserts of California, daily maximum temperatures warmed by 0.4–0.7°F (0.2–  
1376 0.38°C) when 1976–2005 was compared to a historical base line of 1961–1990 (Hopkins 2018).  
1377 Annual average maximum daily temperatures are projected to rise 5.6–8.8°F (3.1–4.9°C) by  
1378 2100 across the state generally as compared to a historical average from 1976–2005. In the  
1379 already hot inland deserts, maximum daily temperatures are projected to see increases of up to  
1380 8–14°F (4.4–7.7°C) by 2070–2100, depending on the future emission levels of greenhouse gases  
1381 (Hopkins 2018). It is projected that there will up to 141 days a year in the Mojave Desert when  
1382 the temperature exceeds 95°F (35°C), with minimum daily temperatures projected to rise 4–7°F  
1383 (2.2–3.8°C) by 2070–2100 (Hopkins 2018).

1384 Under warming scenarios described above, desert tortoises will have fewer areas where they  
1385 can stay within their physiological limits. As habitat area shrinks, tortoises are already heading

1386 upslope in some areas to escape the heat of the valley bottoms, a distribution known as the  
1387 'toilet bowl effect' (W. Campbell pers. comm. May 2022). This type of movement may become  
1388 more difficult as temperatures increase and suitable upslope areas shrink. Sadoti et al. (2017)  
1389 found that tortoises restrict their movements when it is hotter. While this is not necessarily  
1390 surprising, if there are more days when it is too hot for tortoises to move, they might find it  
1391 harder to move to avoid those hot temperatures and will have limited opportunities to disperse  
1392 or find mates. However, the degree to which increased heat in the summer will shift mating  
1393 season or impact reproductive success is unknown. Increased temperatures will make burrows  
1394 as refugia from the heat more critical. Since only certain types of soils and substrates allow for  
1395 creation of adequately long tunnels, available tunnel sites may become a critical habitat  
1396 concern in the future and should be taken into consideration in conservation efforts (Mack et  
1397 al. 2015).

1398 *Impacts of drought*

1399 Desert tortoises are adapted to drought and heat. However, increasing levels of both are likely  
1400 to cause physiological stress, alter the availability of edible vegetation, and increase the impact  
1401 of predation. Barrows (2011) lists some of the physiological and behavioral impacts of drought:

1402 "Drought conditions result in reduced tortoise activity (Duda et al., 1999) and  
1403 lower metabolic and reproductive rates (Peterson, 1996a; Henen, 1997; Henen et  
1404 al., 1998) although some breeding activity occurs even during periods of water  
1405 stress (Henen, 1997). Despite these behavioral and physiological adaptations,  
1406 during droughts tortoises experience as much as 40% loss of body mass and a 60%  
1407 loss of water volume relative to body mass as well as large variations in blood  
1408 osmolarity (Peterson, 1996b) and can have higher levels of mortality (Turner et al.,  
1409 1984)."

1410 California has undergone extreme drought recently with the 2000–2021 span being the driest in  
1411 the southwestern US in the past 1,200 years (Williams et al. 2022). Although there is significant  
1412 uncertainty regarding projected precipitation changes, current models show that winter  
1413 precipitation is likely to increase in the inland deserts, but the summer monsoon precipitation  
1414 could decrease up to 40% (Hopkins 2018). Precipitation events are likely to be more intense and  
1415 at the same time soils are predicted to be drier, leading to more flash flooding (Hopkins 2018).  
1416 The projected warmer and periodically drier conditions during the 21<sup>st</sup> century may increase  
1417 the risk for more severe drought (Hopkins 2018).

1418 Long-term drought has caused die offs of perennial plants in desert tortoise habitat, likely  
1419 driven by lack of winter rain (McAuliffe and Hamerlynck 2010). Die offs were extensive but not  
1420 homogenous, and soil conditions likely played a role (McAuliffe and Hamerlynck 2010).  
1421 Tortoises are selective herbivores that will feed from a wide variety of available plants if  
1422 necessary but primarily focus their observed foraging effort on a small set of species, many of  
1423 which are so rare on the landscape they were not detected during plant surveys (Jennings and  
1424 Berry 2015). Given predictions that winters may become wetter but summers drier (Hopkins

1425 2018), the impacts of future droughts on the vegetation that tortoises rely on is unclear. Some  
1426 invasive species of *Bromus* grasses are successful in disturbed habitats, and their presence in  
1427 desert habitat has helped alter the fire cycle (Brooks 1999, Bradley et al. 2016). However,  
1428 germination, growth, and reproduction are limited by temperature and rainfall which makes it  
1429 difficult to predict the relative success of invasive grasses vs. native forbs under predicted  
1430 climate changes (Bradley et al. 2016). It is possible that tortoises will also face increased  
1431 nutritional stress if preferred plants die off and more nutrient poor grasses like *Bromus* remain  
1432 available.

1433 Lovich et al. (2014) used surveys in Joshua Tree NP from 1979 to 2012 to estimate the impact  
1434 of persistent and recurrent drought on tortoise survival. Estimated population size decreased  
1435 dramatically from 1996 to 2012, with high survival in 1978–1996, and lower survival in 1997–  
1436 2002. The lower survival rates were concurrent to persistent drought, and estimated survival  
1437 rates were best explained by winter precipitation. Being in a national park, tortoises in Joshua  
1438 Tree should be sheltered from many anthropogenic impacts including large scale habitat  
1439 modification and degradation and direct killing by humans. In addition, in 2012, many of the  
1440 dead tortoises showed signs consistent with death by dehydration and starvation. Therefore,  
1441 the authors concluded the decline was likely the result of reduced survival rates due to drought  
1442 (Lovich et al. 2014). Other populations of desert tortoises have also shown a negative impact of  
1443 drought on survival and abundance. Populations in Arizona of *G. agassizii* and *G. morafkai* were  
1444 surveyed multiple times between 1990 and 2017 and experienced very low survival (30% in the  
1445 Black Mountains and 34% in the Hualapai Mountains) during a drought, which led to a drop in  
1446 adult abundances of about 50% (U.S. Fish and Wildlife Service 2022a).

1447 Another potential source of indirect stress from increasing drought comes from predators.  
1448 Under drought conditions, the rodents and lagomorphs that coyotes regularly prey on tend to  
1449 be depleted, and it is likely that this leads to increased predation pressure on tortoises (Esque  
1450 et al. 2010, Nagy et al. 2015b). Ravens particularly target juvenile tortoises, but since they are  
1451 heavily subsidized by human activities, drought may have less of an impact on their predation  
1452 behavior.

1453 A major question is how much desert tortoise habitat will become unsuitable in the future due  
1454 to heat and drought. Species have shifted altitude and/or latitude as climate has changed  
1455 (Vanderwal et al. 2013, Wolf et al. 2016), but species that are not nimble dispersers may have  
1456 trouble accessing new areas, and those areas may not contain the full suite of conditions  
1457 necessary for survival. However, within current habitats, local refugia may persist in future  
1458 climatic conditions and allow species to persist. Barrows et al. (2016) evaluated potential  
1459 habitat refugia on US Marine Corps Air Ground Combat Center (MCAGCC) at Twentynine Palms  
1460 and found that 33% of the study area (283,900 ha) supported desert tortoise habitat at the  
1461 time. With a simulated 1°C (1.8°F) of warming, the amount of habitat shrunk by 25%, with  
1462 remaining habitat occurring at higher elevation. Under a simulated 3°C warming, habitat area  
1463 shrunk by 56% (to 127,650 ha). Of the remaining available habitat, 91% overlapped with current  
1464 tortoise habitat, suggesting that climate refugia would be relatively easy for tortoises to access.  
1465 However, it should be noted that while Barrows et al. (2016) considered 3°C (5.4°F) to be an



1466 end of century level of warming, California’s 4<sup>th</sup> Climate Change Assessment from 2018 predicts  
1467 that level of warming to occur in the inland deserts by 2039 (Bedsworth et al. 2018). In Joshua  
1468 Tree National Park, desert tortoises are found in both the Mojave and Sonoran desert portions.  
1469 Modelling by Barrows (2011) predicts that under 2°C (3.6°F) of warming with 50 mm decrease  
1470 in precipitation, habitat area will decrease by about 88% in the Sonoran Desert portion and by  
1471 about 66% in the Mojave Desert portion.

#### 1472 **4.6 Fire**

1473 Desert tortoise habitat historically experienced few fires due to low plant productivity and  
1474 sparse fuel loads, and those that did occur tended to burn in a patchy mosaic pattern (Esque et  
1475 al. 2003). Consequently, desert tortoise are not well adapted to fire, although use of burrows  
1476 can prevent mass casualties in fires (Esque et al. 2003). The expansion of invasive plants  
1477 (primarily grasses like *Bromus*) has increased fuel loads in the Mojave Desert (Brooks 1999), and  
1478 fire frequency in the California portion of the Mojave Desert increased between 1980 and 1995  
1479 (Brooks and Esque 2002). However, longer term studies looking at fires in 1980–2004 (Brooks  
1480 and Matchett 2006) and 1992–2011 (Hegeman et al. 2014) in the Mojave Desert show no clear  
1481 increase in numbers of fires or acres burned per year, though 2005 stood out since “the  
1482 amount of area burned in the Mojave Desert was 385,357 ha (952,238 acres) (M. Brooks  
1483 unpublished data), representing 132% of the total area that burned during the previous 25  
1484 years (Brooks and Matchett 2006). However, those time series do not include the 2020 Dome  
1485 Fire in Mojave National Preserve which burned 43,273 acres (175 km<sup>2</sup>) of higher elevation  
1486 tortoise habitat (U.S. Fish and Wildlife Service 2022a). Fire-caused tortoise death is summarized  
1487 in Berry and Murphy (2019):

1488 “Woodbury and Hardy (1948) reported deaths of about 14 tortoises from a fire  
1489 covering ca. 5.2 km<sup>2</sup> on part of the Beaver Dam Slope south of Bunkerville in 1942.  
1490 In a post-fire study, Lovich et al. (2011c) described a fire in the western Sonoran  
1491 Desert that killed an adult female tortoise and injured five other adult tortoises.  
1492 Nussear et al. (2012) reported that three of 30 tortoises died from fire during a  
1493 comparative study of translocated and resident tortoises. In the Red Cliffs Desert  
1494 Reserve and critical habitat in Utah, 687 tortoises died in 2005 in a fire that  
1495 burned ca. 23% of the approximately 251 km<sup>2</sup> habitat (A. McLuckie, pers. comm.).  
1496 Drake et al. (2012) described a tortoise recovering from burns three years post-  
1497 fire.”

1498 The effects of wildfire on vegetation can negatively impact tortoises. A study in the low  
1499 elevation Mojave Desert shrubland found that invasive *Bromus* cover increased after one fire  
1500 but did not continue increasing after additional fires (Brooks 2012). However, native vegetation  
1501 cover decreased with multiple fires, with percentage cover dropping from about 25% to about  
1502 1% when fire frequency increased from one every ten years to three every ten years. Given the  
1503 poor nutritional content of *Bromus*, increasing fire frequency threatens tortoises’ ability to find  
1504 sufficient and adequate food. Tortoises tend to remain in same areas after fire (Lovich et al.

1505 2018), foraging for annuals in the burned areas, while using the cover of perennial shrubs only  
1506 found in unburned areas (Drake et al. 2015).

1507 The effects of a changing climate on wildfire size and frequency in desert tortoise habitat are  
1508 uncertain. Increased winter rain could promote biomass growth that dries out in the hotter  
1509 summers and increases fuel load (Tagestad et al. 2016). Alternately, the predicted increase in  
1510 drought like conditions may keep fuel loads low. Another variable is the cause of ignitions. In  
1511 the past 40 years, human caused fires were more prevalent in areas with high visitation levels  
1512 such as low to mid elevation and desert montane zones, while lightning caused fires were more  
1513 common in the central and eastern areas that get summer monsoons (Brooks and Matchett  
1514 2006). There are widespread campaigns and regulations aimed at reducing the chances that  
1515 visitors will cause fires in the desert, and the efficacy of these campaigns may influence fire  
1516 frequency and spatial distribution in the future. Overall, Hopkins (2018) suggests that strong  
1517 temporal and spatial variability in precipitation and fuel load across the desert makes long-term  
1518 and widespread trends in fire regime hard to predict.

#### 1519 **4.7 Disease and Parasites**

1520 Desert tortoises are susceptible to a variety of diseases, some of which are likely to have caused  
1521 or contributed to population declines. Upper respiratory tract disease (URTD) has been cited as  
1522 a cause of population declines in desert tortoise and was a reason for listing under the ESA in  
1523 1990 (U.S. Fish and Wildlife Service 1990).

1524 The disease can be caused by the bacteria *Mycoplasma agassizii* and *Mycoplasma testudineum*,  
1525 while herpesviruses can cause similar symptoms (Johnson et al. 2005, Jacobson et al. 2014). The  
1526 disease presents as lesions in the nasal cavity and inflammation of mucosa of the upper  
1527 respiratory tract, mucal discharge from the nares, damaged nasal scales due to chronic mucal  
1528 discharge, wheezing breath, swollen and watery eyes, and extreme lethargy (Jacobson et al.  
1529 1995, 2014, Johnson et al. 2005, Sandmeier et al. 2013). Tortoises that do not show clinical  
1530 signs of infection can still serve as a reservoir for the disease and likely can transmit it to  
1531 healthy tortoises (Jacobson et al. 1995). Transmission is most likely through direct contact that  
1532 happens during courtship, mating, and fighting, and aerosol transmission is not likely (U.S. Fish  
1533 and Wildlife Service 1990, Jacobson et al. 2014). The disease both directly kills tortoises and can  
1534 interfere with their sense of smell and therefore their ability to forage for food and can  
1535 potentially negatively affect their reproductive fitness (Germano et al. 2014, Jacobson et al.  
1536 2014). Sandmeier et al. (2013) found evidence that longer and colder winters correlated  
1537 positively with the proportion of tortoises exhibiting URTD, possibly because time spent  
1538 underground depresses the tortoise immune system or allows the bacteria to flourish.

1539 Outbreaks of the disease occurred in the Desert Tortoise Natural Area in Kern County in 1989  
1540 when 627 dead tortoises were recovered during a survey, and 43% of 468 live tortoises had  
1541 signs of the disease (Jacobson et al. 1991). The population declined by 90% between 1979 and  
1542 1992 (Berry and Medica 1995). In 1990–1995, Christopher et al. (2003) sampled tortoises in  
1543 three sites in the Mojave Desert:

1544 “Of 108 tortoises, 68.5% had clinical signs of upper respiratory tract disease  
1545 consistent with mycoplasmosis at least once during the study period. In addition,  
1546 48.1% developed moderate to severe shell lesions consistent with cutaneous  
1547 dyskeratosis. Ulcerated or plaque-like oral lesions were noted on single occasions  
1548 in 23% of tortoises at Goffs and 6% of tortoises at Ivanpah. Tortoises with oral  
1549 lesions were significantly more likely than tortoises without lesions to have  
1550 positive nasal cultures for *Mycoplasma agassizii* ( $P=0.001$ ) and to be dehydrated  
1551 ( $P=0.0007$ )” (Christopher et al. 2003).

1552 More recent studies have found much lower prevalence of URTD. In the central Mojave Desert  
1553 in 2005–2008, Berry et al. (2015) found only 1.49% of sampled tortoises were antibody positive,  
1554 and a study in a similar area in 1997–2003 found 2.2% antibody positivity rate.

1555 It is thought that the high prevalence of the disease in wild populations in the 1970s–1990s was  
1556 due in part from infected captive tortoises being released into the wild. A number of factors are  
1557 correlated with outbreaks of the disease, mainly factors that increase physiological stress in  
1558 tortoises such as drought, heavy metal pollution, and human disturbance (Jacobson et al. 2014).  
1559 Berry et al. (2015) pointed out that many of the stressors that increase tortoise vulnerability to  
1560 disease, especially drought and proximity to human populations, are increasing in desert  
1561 tortoise range. However, there have not been any large outbreaks documented in California  
1562 recently, and in the Desert Tortoise Natural Area the disease has “evolved from an acute,  
1563 epizootic disease with high mortality to a chronic endemic disease with variable morbidity, low  
1564 mortality” (Jacobson et al. 2014). Reflecting the decreased level of threat currently posed by the  
1565 disease, in their 2022 5-year review the USFWS stated that “direct disease management of wild  
1566 tortoise populations is less important (other than in translocations of tortoises between  
1567 populations) than managing factors that affect their habitat and its capacity to support healthy  
1568 tortoises” (U.S. Fish and Wildlife Service 2022a).

1569 Being captured by humans for research and/or translocation can stress tortoises and make  
1570 them more susceptible to URTD. Therefore, official handling protocols have strict guidelines in  
1571 place to minimize stress as much as possible (U.S. Fish and Wildlife Service 2020b, a). In  
1572 addition, translocating sick individuals runs the risk of spreading URTD, so translocation  
1573 protocols involve health assessments and quarantine to minimize disease transfer between  
1574 populations (U.S. Fish and Wildlife Service 2020b). However, disease can be transferred by  
1575 tortoises naturally dispersing, and reservoirs of the disease in populations outside of California  
1576 should be considered in discussions of connectivity (Burgess et al. 2021).

1577 Shell diseases like cutaneous dyskeratosis also affect tortoises and present as “abnormal  
1578 conformation and loss of normal integrity of the horny layer (scute) of the shell and cutaneous  
1579 scales. Deep shell defects may expose dermal bone” (Homer et al. 2001). Shell lesions were  
1580 associated with high mortality rates of desert tortoises in Chuckwalla Bench in 1982–1988  
1581 (Figures 10 and 11, Jacobson et al. 1994). In 1979, 56% of the tortoises surveyed had shell  
1582 lesions. The proportion of effected tortoises increased to 65% in 1982, to 90% in 1988, and  
1583 remained high in 1990 at 87%. During those years the density of all tortoises (adults and

1584 juveniles) fell from 221/km<sup>2</sup> to 71/km<sup>2</sup>, a 68% decline (Berry and Medica 1995). While the  
1585 declines in population cannot be definitively tied to shell lesions, they could be a sign of a  
1586 deficiency disease or toxicosis (Jacobson et al. 1994). There has been very little reported on  
1587 shell disease in wild tortoises in California since the mid-1990s.

#### 1588 **4.8 Overexploitation**

1589 Under the California Fish and Game Code, desert tortoises have had some legal protection from  
1590 take or collection since 1961 (Fish & G. Code, § 5000). However, vandalism (gunshots) and  
1591 collecting for pets were listed as reasons for population declines in the USFWS's 1990 decision  
1592 to list the desert tortoise as threatened (U.S. Fish and Wildlife Service 1990). Before tortoises  
1593 were listed, Berry (1986b) found that percentage of tortoise deaths from gunshots in California  
1594 deserts (1972–1982) ranged from a low of 1.8% at Chuckwalla Bench to a high of 28.9% in the  
1595 Fremont Valley. Overall, 14.3% of carcasses found had evidence of gunshots, with the areas  
1596 with the highest percentage in the Western Mojave. In a 2008–2009 study in the El Paso  
1597 Mountains in Kern County, 6 of 67 carcasses had evidence of gunshots (Berry et al. 2020c).  
1598 Direct take of tortoises has been illegal since the species was listed under the ESA and CESA,  
1599 however shooting of tortoises still occurs. Berry and Murphy (2019) reported gunshot deaths  
1600 subsequent to listing in Fort Irwin National Training Center (1997-2003), Red Rock State Park  
1601 (2002-2004), and the Desert Research Natural Area (2011).

1602 Despite legal protection, Berry et al. (1996) (reported in Berry and Murphy (2019)) estimated  
1603 that more than 2,000 tortoises were removed from four study areas over a 10-year period from  
1604 the mid-1980s to the mid-1990s. It is likely some tortoises are still being taken from the wild,  
1605 with those near roads most vulnerable. A study in the Sonoran Desert of Arizona in 2008–2009  
1606 placed decoy tortoises on roads and found 1.4% of drivers stopped and tried to collect the  
1607 decoy by placing it in their vehicle. Drivers were more likely to notice the tortoises on  
1608 maintained gravel roads compared to paved roads or unmaintained gravel roads. However,  
1609 road type did not influence the probability a driver would try to collect the tortoise  
1610 (Grandmaison and Frary 2012).

#### 1611 **4.9 Other Human-related Activities**

##### 1612 *Mining and pollution*

1613 Although Spanish colonizers panned for gold in the Chocolate Mountains in the late 1700s,  
1614 commercial mining in California deserts began in the 1800s. Prospectors and miners dug shafts  
1615 to extract gold, tungsten, silver, copper, and other valuable materials (Shumway et al. 1980).  
1616 Some of these shafts remain open and unfenced, and tortoises can fall in and become trapped  
1617 (Berry and Murphy 2019). Mining also leaves behind pollutants of various types including  
1618 mercury, arsenic, and lead that impact soil and plants (including those favored by tortoises) up  
1619 to 15 km from mining sites (Chaffee and Berry 2006). These pollutants can enter tortoises via  
1620 breathing, ingestion of impacted plants, or absorption through skin, and there is some concern  
1621 that exposure to these toxins may make tortoises more susceptible to disease (Berry et al.  
1622 2015, Berry and Murphy 2019). Tortoises collected from the Kelly Rand Ming District northeast

1623 of California City and from Edwards Airforce Base had bioaccumulated arsenic in their shell  
1624 plates compared to tortoises from areas with minimal land disturbance (Foster et al. 2009).  
1625 However, Cohn et al. (2021) analyzed the blood of tortoises in the Ivanpah Valley and found  
1626 that heavy metal levels in the blood were generally low (0%–7%), heavy metal levels in the soil  
1627 did not exceed soil health guidelines, and there was no relationship between metal  
1628 concentrations and body health or disease prevalence suggesting that tortoises were not  
1629 negatively impacted by mining pollution in that area.

#### 1630 *Deliberate Releases*

1631 Based on public comments received by the Department, well-meaning individuals may release  
1632 captive tortoises, believing it will help wild populations. People may also release animals they  
1633 no longer wish to keep as pets. The deliberate release of captive tortoises presents several  
1634 issues. Captive tortoises can have high prevalence of respiratory diseases which could be  
1635 passed on to wild tortoises if they are released (Berry et al. 2015). Releasing animals of  
1636 unknown genetic origin, or even different species like *G. morfaka* or the Texas tortoise (*G.*  
1637 *berlandieri*), could result in hybridization with wild *G. agassizii* (U. S. Fish and Wildlife Service  
1638 1994). The release of diseased captive tortoises was a large enough concern to be mentioned as  
1639 reason for population declines in the 1994 Recovery Plan (U. S. Fish and Wildlife Service 1994),  
1640 but we lack robust recent data on the current prevalence of releases and their effects. A public  
1641 education campaign highlighting the downsides to freeing captive tortoises may help address  
1642 this threat. Translocations of captive tortoises into the wild are also discussed in section 9.1.

#### 1643 **4.10 Vulnerability of Small Populations**

1644 Desert tortoises occupy a large range in California, and even at very low densities, populations  
1645 in conservation areas can still number in the thousands. However, the various factors  
1646 described above have nonetheless led to dramatic declines in density and abundance across the  
1647 surveyed critical habitat units (Figure 7, Tables 2 and 5. The most recent estimates of  
1648 abundance in the Tortoise Conservation Areas are from 2014. In 2014, tortoise density in all the  
1649 TCAs except Chocolate Mountain and Fenner was below the estimated 3.9 tortoises per km<sup>2</sup>  
1650 needed for population viability (Table 2). Estimated abundances ranged from 1,241 in the Pinto  
1651 Mountains TCA to 10,469 individuals in Chemehuevi TCA (Table 5). Although these estimates  
1652 remain in the thousands, most of these areas encompass hundreds to thousands of square kilometers  
1653 (see Table 1).

1654 **Table 5.** Estimated abundance in the Tortoise Conservation Areas within California  
 1655 in 2014. Reported in U.S. Fish and Wildlife Service (2022a) using data from Allison  
 1656 and McLuckie (2018).

<b>Recovery Unit</b>	<b>Tortoise Conservation Area</b>	<b>Estimated Abundance in 2014</b>
Western Mojave	Fremont-Kramer	6,196
	Ord-Rodman	3,064
	Superior-Cronese	7,398
Eastern Mojave	Ivanpah	5,578
Colorado Desert	Chocolate Mountain	5,146
	Chuckwalla	9,304
	Chemehuevi	10,469
	Fenner	8,517
	Pinto Mountains	1,241
	Joshua Tree	4,319

1657

1658 Since 2014, estimated densities have declined in all the TCAs in the Western Mojave,  
 1659 Chuckwalla, and dramatically in the Chocolate Mountains. Ivanpah and Pinto Mountains TCAs  
 1660 have increased in density since 2014 but are still below the 3.9 adults/km<sup>2</sup> threshold.  
 1661 Chemehuevi and Fenner have both increased in density since 2014 and are above the viability  
 1662 threshold, while Joshua Tree has increased slightly in density and was at the 3.9 adults/km<sup>2</sup>  
 1663 threshold in 2020. We do not have estimated abundances that are based on these most recent  
 1664 density estimates, and the 2014 abundance estimates are based on amount of potential habitat  
 1665 in Nussear et al. (2009). Given all of the factors mentioned in the previous sections, it is likely  
 1666 that some suitable habitat has been lost since then due to destruction and degradation,  
 1667 meaning that in the TCAs where densities have gone up, abundances may not have increased  
 1668 concordantly. Systematic surveys of populations are not conducted outside of the TCAs, but  
 1669 Berry et al. (2020a, c) concluded densities and survival rates in the El Paso Mountains and the  
 1670 Chemehuevi Valley were so low that the populations were unviable.

1671 Desert tortoise populations are currently vulnerable to demographic pressures that are likely to  
 1672 exacerbate declining trends if not addressed. Foremost is the lack of recruitment. Low  
 1673 reproductive output and high predation pressure on juveniles has led to a worrying lack of  
 1674 young tortoises (Figure 12). Even with thousands of adults in a population, if sufficient juvenile  
 1675 tortoises are not surviving to breeding age, the population will decline without interventions  
 1676 like head-starting.

1677 The threshold density for population viability of 3.9 adults/km<sup>2</sup> assumes equal sex ratios in the  
 1678 population (U.S. Fish and Wildlife Service 2011). Unequal sex ratios are thought to lower  
 1679 effective population size which in small populations with limited connectivity could exacerbate  
 1680 inbreeding (Frankham 1995). Unfortunately, there are no published data on sex ratios in the 17  
 1681 TCAs (Berry and Murphy 2019), and the recent data we have are from very limited short term  
 1682 sampling efforts elsewhere. Berry and Keith (2008) surveyed a ~4 km<sup>2</sup> plot in Red Rock Canyon

1683 State Park, and in 2004 they found three males and one adult female. Five subadult or adult  
1684 females and four subadult or adult males had died 2–4 years previously, and the authors point  
1685 out that if those animals had survived, the sex ratio of the population would have been much  
1686 more balanced. In a 1 mi<sup>2</sup> study plot in Joshua Tree NP, “Sex ratios, defined as the number of  
1687 live males divided by the number of females, ranged from unity, to male biased (5:1), to female  
1688 biased (0.22:1) across years with no trend in any one direction” (Lovich et al. 2014). As  
1689 mentioned in the section on life history, the sex of the hatchling is heavily influenced by  
1690 incubation temperature. As temperatures rise and heat extremes become more common due  
1691 to anthropogenic climate change, it is likely that sex ratios at hatching will skew to be more  
1692 female dominated, however the degree to which this will impact adult sex ratios is unknown.  
1693 Increased reporting of the sex ratios during surveys in the TCAs would illuminate the severity of  
1694 this issue and allow detection the predicted skew toward females if it were to occur.

## 1695 **5 EXISTING MANAGEMENT**

### 1696 **5.1 Regulatory Status and Legal Protections**

#### 1697 *Federal*

#### 1698 *Federal Endangered Species Act*

1699 In August 1989, the USFWS listed the Mojave population of desert tortoise as endangered on  
1700 an interim basis. Eight months later in April 1990, it issued a final rule to list it as threatened  
1701 (U.S. Fish and Wildlife Service 1990). In July 2002, the USFWS received a petition to reclassify  
1702 the species from threatened to endangered. In 2017, the USFWS announced a 90-day finding  
1703 that the petition did not present substantial scientific or commercial information indicating that  
1704 reclassifying the Mojave population of the desert tortoise may be warranted, and no status  
1705 review was initiated in response to the petition. The USFWS has published status reviews in  
1706 2010 and 2022, both recommending that the threatened status be retained (U.S. Fish and  
1707 Wildlife Service 2010, U.S. Fish and Wildlife Service 2022a). The 2022 status review uses much  
1708 of the same data presented here and acknowledges that “the status of the Mojave Desert  
1709 Tortoise had not improved by 2014 and most threats to the species persist at or above 2010–  
1710 2011 levels. These conditions portend further status deterioration in the absence of concerted  
1711 efforts by land managers to meaningfully reduce predator subsidies, vehicle-caused tortoise  
1712 mortalities, and invasive annual plants in important tortoise habitats” (U.S. Fish and Wildlife  
1713 Service 2022a). The recommendation to retain the threatened status was based on finding  
1714 about a dozen *G. agassizii* in Arizona, east of the Colorado River and outside the boundaries of  
1715 the recovery units, recognition that the range-wide population of tortoises is in the hundreds of  
1716 thousands, and optimism that conservation actions will eventually result in population  
1717 improvements (U.S. Fish and Wildlife Service 2022a).

#### 1718 *National Environmental Policy Act*

1719 The National Environmental Policy Act (NEPA) requires federal agencies to assess the  
1720 environmental effects of their proposed actions prior to making certain decisions. Using the  
1721 NEPA process, agencies evaluate the environmental and related social and economic effects of

1722 their proposed actions. Agencies also provide opportunities for public review and comment on  
1723 those evaluations. Title I of NEPA contains a Declaration of National Environmental Policy. This  
1724 policy requires the federal government to use all practicable means to create and maintain  
1725 conditions under which man and nature can exist in productive harmony. Section 102 in Title I  
1726 of the Act requires federal agencies to incorporate environmental considerations in their  
1727 planning and decision-making through a systematic interdisciplinary approach. Specifically, all  
1728 federal agencies are to prepare detailed statements assessing the environmental impact of and  
1729 alternatives to major federal actions significantly affecting the environment. These statements  
1730 are commonly referred to as Environmental Impact Statements and Environmental  
1731 Assessments.

### 1732 **5.1.2 State**

#### 1733 California Law/Fish and Game Code

1734 California law has long included protections for Mojave Desert Tortoise. In 1939, California  
1735 state law prohibited purchase or sale of the species. In 1961, and additional law was passed to  
1736 prohibit shooting, harming, or possessing the species (Fish & G. Code, § 5000). In 1972, the Fish  
1737 and Game Code was amended to allow possession of tortoises as long as the tortoise was  
1738 legally acquired (Fish & G. Code, § 5001).

#### 1739 California Endangered Species Act

1740 On August 3, 1989, the Commission listed the desert tortoise as a threatened species under  
1741 CESA. CESA prohibits the import, export, take, possession, purchase, or sale of Mojave Desert  
1742 Tortoise, or any part or product of Mojave Desert Tortoise, except as otherwise provided by the  
1743 Fish and Game Code, such as through a permit or agreement issued by the Department under  
1744 the authority of the Fish and Game Code (Fish & G. Code, § 2080 *et seq.*). For example, the  
1745 Department may issue permits that authorize the incidental take of listed and candidate species  
1746 if the take is incidental to an otherwise lawful activity, the impacts of the authorized take are  
1747 minimized and fully mitigated, the activity will not jeopardize the continued existence of the  
1748 species, and other conditions are met (Fish & G. Code, §§ 2081, subd. (b).). The Department  
1749 may also authorize incidental take through voluntary local programs and safe harbor  
1750 agreements (Fish & G. Code, §§ 2086 and 2089.2 *et. seq.*) and for scientific, educational, or  
1751 management purposes (Fish & G. Code, § 2081, subd. (a).). If the species is listed under both  
1752 the federal ESA and CESA, a project that has received a federal incidental take statement or  
1753 incidental take permit that is consistent with CESA can receive a consistency determination (CD)  
1754 from the Department (Fish & G. Code, § 2080.1.).

1755 Given the predominance of federal land in desert tortoise range, it should be noted that  
1756 federal agencies undertaking federal projects on federal land are usually not subject to CESA  
1757 and instead must typically consult with the USFWS to “ensure that actions they fund, authorize,  
1758 permit, or otherwise carry out will not jeopardize the continued existence of any listed species  
1759 or adversely modify designated critical habitats” (U.S. Fish and Wildlife Service 2022). However,  
1760 non-federal entities working on federal lands are subject to CESA. For example, timber



1761 companies with permission to harvest timber on U.S. Forest Service lands must comply with  
1762 both federal and state wildlife laws.

1763 In 2000 and 2005, the Department prepared summary status reports describing the status of  
1764 desert tortoise as declining (California Department of Fish and Wildlife 2000, California  
1765 Department of Fish and Wildlife 2005). These reports summarize the status of all species listed  
1766 as endangered, threatened, or candidate under CESA (Fish and G. Code § 2079), and are made  
1767 available to the public on the Department’s website. The 2005 report described the desert  
1768 tortoise as severely threatened by population losses and further stated that tortoise  
1769 populations were extremely low in some areas and may not have been viable (California  
1770 Department of Fish and Wildlife 2005).

1771 California Environmental Quality Act

1772 State and local agencies must conduct environmental review under the California  
1773 Environmental Quality Act (CEQA) for discretionary projects proposed to be carried out or  
1774 approved by the public agency unless the agency properly determines the project is exempt  
1775 from CEQA (Pub. Resources Code, § 21080). If a project has the potential to substantially  
1776 reduce the habitat, decrease the number, or restrict the range of any rare, threatened, or  
1777 endangered species, the lead agency must make a finding that the project will have a significant  
1778 effect on the environment and prepare an environmental impact report (EIR) or mitigated  
1779 negative declaration as appropriate before proceeding with or approving the project (Cal. Code  
1780 Regs., tit. 14, §§ 15065(a)(1), 15070, and 15380.). An agency cannot approve or carry out any  
1781 project for which the EIR identifies one or more significant effects on the environment unless it  
1782 makes one or more of the following findings: (1) changes have been required in or incorporated  
1783 into the project that avoid the significant environmental effects or mitigate them to a less than  
1784 significant level; (2) those changes are in the responsibility and jurisdiction of another agency  
1785 and have been, or can and should be, adopted by that other agency; or (3) specific economic,  
1786 legal, social, technological, or other considerations make infeasible the mitigation measures or  
1787 alternatives identified in the environmental impact report (Pub. Resources Code, § 21081; Cal.  
1788 Code Regs., tit. 14, §§ 15091 and 15093.). For (3), the agency must adopt a statement of  
1789 overriding considerations finding that the overriding benefits of the project outweigh the  
1790 significant effects on the environment. CEQA establishes a duty for public agencies to avoid or  
1791 minimize such significant negative effects where feasible (Cal. Code regs., tit. 14, § 15021.).  
1792 Impacts to Mojave Desert Tortoise, as a CESA-threatened species, must be identified,  
1793 evaluated, disclosed, and mitigated or justified under the Biological Resources section of an  
1794 environmental document prepared pursuant to CEQA.

1795 *Nonregulatory Status*

1796 Natural Heritage Program Ranking and IUCN Red List

1797 Natural heritage ranking does not provide any regulatory protections but is often considered  
1798 during the CEQA process (Hammerson, G.A. et al. 2008). All Natural Heritage Programs, such as  
1799 the CNDDDB, use the same ranking methodology originally developed by The Nature  
1800 Conservancy and now maintained by NatureServe. This ranking methodology consists of a

1801 global rank describing the rank for a given taxon over its entire distribution, and a state rank  
1802 describing the rank for the taxon over its state distribution. Both global and state ranks reflect a  
1803 combination of rarity, threat, and trend factors. The ranking methodology uses a standardized  
1804 calculator that uses available information to assign a numeric score or range of scores to the  
1805 taxon, with lower scores indicating that a taxon is more vulnerable to extinction, and higher  
1806 scores indicating that a taxon is more stable (Faber-Langendoen et al. 2012). The rank  
1807 calculation process begins with an initial rank score based on rarity and threats, with rarity  
1808 (multiplied by 0.7) factored more heavily into the calculator than threats (multiplied by 0.3).  
1809 The combined rarity and threat rank is then either raised or lowered based on trends. When  
1810 there is a negative trend, the rank score is lowered, and when there is a positive trend the rank  
1811 score is raised. Short-term trends are factored more heavily into the calculator than long-term  
1812 trends. International Union for Conservation of Nature (IUCN) and NatureServe assess  
1813 extinction risk for species using a time period of 10 years or 3 generations, whichever is longer,  
1814 up to a maximum of 100 years (Faber-Langendoen et al. 2012).

1815 Mojave Desert Tortoise has been assigned a global rank of G3 indicating the species is  
1816 “vulnerable and at moderate risk of extinction or collapse due to a fairly restricted range,  
1817 relatively few populations or occurrences, recent and widespread declines, threats, or other  
1818 factors”. This species has been assigned a state rank of S2 indicating the species is locally  
1819 imperiled and “at high risk of extirpation in the jurisdiction due to restricted range, few  
1820 populations or occurrences, steep declines, severe threats, or other factors”. The factors cited  
1821 for this rank include widespread habitat loss, degradation, and fragmentation, and human-  
1822 associated factors that cause mortality (NatureServe 2022).

1823 The IUCN Red List provided a global scope assessment of Mojave Desert Tortoise in October  
1824 2021 (Berry et al. 2021) resulting in a designation of critically endangered. This Red List  
1825 category represents the highest risk of extinction and is assigned when a taxon has been  
1826 evaluated against the ranking criteria and is not yet designated Extinct in the Wild, but qualifies  
1827 above endangered, vulnerable, and near threatened. The species was originally assessed as  
1828 vulnerable in 1996 and its designation has steadily increased in severity (Berry and Murphy  
1829 2019).

## 1830 **5.2 Management Efforts**

1831 Due to its large range and the decades since it was formally protected under the ESA and CESA,  
1832 a diverse suite of government and other entities are involved in land ownership and  
1833 management within the range of Mojave Desert Tortoise (Table 6). The majority of land is  
1834 managed by federal agencies, but the range also includes a substantial portion of private lands.  
1835 The BLM is responsible for managing nearly 11,000 km<sup>2</sup> of Mojave Desert Tortoise critical  
1836 habitat and is the largest landowner within the species range. The NPS is responsible for the  
1837 next largest section of the range, most of which is congressionally designated Wilderness Areas  
1838 where motorized vehicles are prohibited. Private lands and DoD lands comprise most of the  
1839 remaining land ownership within the species range.

1840 **Table 6.** Land ownership within the entire range of Mojave Desert Tortoise and within  
 1841 designated critical habitat.

<b>Land Management Entity</b>	<b>Landownership in Species Range (Km<sup>2</sup>)</b>	<b>Percent of Landownership in Species Range (%)</b>	<b>Landownership in Critical Habitat (Km<sup>2</sup>)</b>	<b>Percent of Landownership in Critical Habitat (%)</b>
United States Bureau of Land Management	37,960	42.5	10,917	56.6
United States National Park Service	18,418	20.6	3,702	19.2
Private Lands	15,147	17	1,730	9.0
United States Department of Defense	13,018	14.6	2,270	11.8
State of California	2,018	2.3	485	2.5
Cities, Counties, Non-Profits, Special Districts	995	1.1	114	0.6
Other Public or Private Lands	391	0.4	30	0.2
Other Federal	79	0.1	19	0.1
United States Bureau of Indian Affairs	689	0.8	NA	NA
United States Forest Service	242	0.3	NA	NA
United States Bureau of Reclamation	181	0.2	NA	NA
United States Fish and Wildlife Service	89	0.1	NA	NA

1842

1843 *Partnerships and Working Groups*

1844 The Desert Tortoise Management Oversight Group (MOG), formed in 1994, is comprised of  
 1845 senior managers from USFWS, BLM, state transportation agencies, state wildlife agencies,  
 1846 county governments, and non-governmental organizations (NGOs) that work in the tortoise  
 1847 range in Arizona, Nevada, and California. This group identifies regional recovery priorities,  
 1848 addresses issues common to multiple agencies, and shares information and updates about  
 1849 tortoise status and their recovery activities.

1850 The Recovery and Sustainment Partnership (RASP) is comprised of DoD and Department of  
 1851 Interior agencies and is intended to provide increased flexibility for the use of land for military  
 1852 operations (i.e., make it easier to conduct training in areas with tortoise populations) in return  
 1853 for developing recovery initiatives. Under this partnership, agencies contribute to a pooled  
 1854 funding source to implement recovery actions such as raven management in California. Pooled  
 1855 funding and the Memorandum of Understanding between RASP partners allows for increased  
 1856 flexibility and reduced regulatory hurdles for implementation of broad, regional scale recovery  
 1857 actions.

1858 The California Desert Conservation Act (Fish & G. Code, § 1450 et seq.) became effective on  
 1859 January 1, 2022, and establishes a California Desert Conservation Program within the California  
 1860 Wildlife Conservation Board with the goals of protecting habitat in California’s Mojave and  
 1861 Colorado deserts by planning and implementing land acquisition and restoration projects. The  
 1862 California Desert Conservation Program could result in increased conservation or restoration of  
 1863 Mojave Desert Tortoise habitat in California.

1864 *United States Fish and Wildlife Service*

1865 The USFWS has developed and revised range-wide Recovery Plans for Mojave Desert Tortoise  
1866 that encourage collaboration, identify research priorities, and encourage management actions  
1867 for the benefit of the species. In 1994, the USFWS published the first Recovery Plan and  
1868 designated more than 25,000 km<sup>2</sup> of critical habitat, most of which is in California (U.S. Fish and  
1869 Wildlife Service 1994). The plan identified Desert Wildlife Management Areas and included  
1870 management recommendations such as landscape-level management and monitoring, public  
1871 education, and habitat protection (U.S. Fish and Wildlife Service 1994). In 2008 and 2011, the  
1872 USFWS published revisions to the Recovery Plan which identified research priorities and  
1873 recovery actions, including facilitation of recovery partnerships, protection of existing  
1874 populations and habitat, supplementing populations, and implementing adaptive management  
1875 (U.S. Fish and Wildlife Service 2011). In 2010, the USFWS published its first 5-year review for  
1876 Mojave Desert Tortoise across its multi-state range, in which they assigned a recovery priority  
1877 number indicating that the species faces a moderate degree of threat, has a low potential for  
1878 recovery, and faces conflict with construction or other development projects or other forms of  
1879 economic activity. The USFWS recommended no change in status from threatened to  
1880 endangered, in part because implementation of the 2008 Revised Recovery Plan was expected  
1881 to resolve key uncertainties and improve recovery potential. In 2022, the USFWS published  
1882 another 5-year review reporting the continuing declines in density in all of the California  
1883 Tortoise Conservation Areas except Joshua Tree in 2004–2014 (see Table 2), but also  
1884 recommended no change in the listing status of the Mojave Desert Tortoise (U.S. Fish and  
1885 Wildlife Service 2022a). For more detail see section 5.1.

1886 As part of the revised 2011 Recovery Plan, Recovery Implementation Teams were developed,  
1887 which are “composed of representatives from government agencies and non-profit  
1888 organizations. Participants in these teams prepare proposals for recovery actions, seek funding  
1889 to support the proposals, and assist with implementation when funding becomes available”  
1890 (Berry and Murphy 2019). Recovery Implementation Teams have focused on restoration of  
1891 habitat burned and/or denuded by livestock, trash management to subsidize predators,  
1892 invasive plant control, roadway fencing, and other conservation and management actions  
1893 (Berry and Murphy 2019).

1894 *Bureau of Land Management*

1895 The 2016 Desert Renewable Energy and Conversation Plan (DRECP) Land Use Plan Amendment  
1896 to the California Desert Conservation Act Plan of 1980 guides management of 10 million acres  
1897 (~40,469 km<sup>2</sup>) of BLM lands, some of which is Mojave Desert Tortoise habitat. The entire DRECP  
1898 Plan Area covers approximately 22.5 million acres (~91,054 km<sup>2</sup>) of federal and non-federal  
1899 land. Phase I of the DRECP focused on the BLM lands and was released as a Land Use Plan  
1900 Amendment (LUPA). Phase II will focus on county-level planning designed to work in  
1901 conjunction with the LUPA. Along with many other agencies and stakeholders, the Department  
1902 was involved in the development of the DRECP but is not a signatory to the 2016 LUPA.

1903 Under the DRECP, 11,290 acres (~46 km<sup>2</sup>) of modeled desert tortoise habitat would eventually  
1904 be developed for renewable energy, with a streamlined permit review process (Bureau of Land  
1905 Management 2016). The LUPA contains numerous conservation and management actions,  
1906 including establishment of a cumulative limit (no more than 1%) on ground-disturbing activities  
1907 within BLM-owned portions of TCAs and mapped linkages. The plan amendment further  
1908 prohibits long-term habitat removal in high density tortoise areas (more than five tortoises at  
1909 least 160 mm carapace length per square mile, or more than 35 individuals in total), but gives  
1910 an exception for transmission projects. Outside of the development focus areas intended for  
1911 renewable energy, the plan amendment includes actions that are more protective of desert  
1912 tortoises than direction contained in the previous land use plan (U.S. Fish and Wildlife Service  
1913 2022a).

1914 *National Park Service*

1915 Management of the Mojave Desert Tortoise on NPS lands is guided by the NPS Organic Act of  
1916 1916, the ESA of 1973, the Wilderness Act of 1964, the 2006 NPS Management Policies, and  
1917 each unit's General Management Plan (GMP), Superintendent's compendiums, and Resource  
1918 Stewardship Strategies. Broad conservation actions are outlined in GMPs and specific closures  
1919 and updates to prohibited actions are contained in the Superintendent's compendium.  
1920 Examples include prohibitions on use of Unmanned Aircraft Systems (drones), limits on use of  
1921 artificial lights to view wildlife, requirements for food storage and trash management, and  
1922 commitments for restoration of disturbed areas and/or mitigation of direct vegetation impacts.

1923 In desert tortoise range, the NPS administers Joshua Tree National Park, Death Valley National  
1924 Park, and Mojave National Preserve. The majority of lands across these three units are  
1925 congressionally designated Wilderness, including nearly 50% of lands in Mojave National  
1926 Preserve, approximately 85% of lands in Joshua Tree National Park, and roughly 93% of lands in  
1927 Death Valley National Park. The Wilderness Act of 1964 is intended to preserve places "where  
1928 the earth and its community of life are untrammelled by man, where man himself is a visitor  
1929 who does not remain" (Wilderness Act section 2, subd. I). Most notably, use of offroad vehicles  
1930 and motorized equipment is prohibited in Wilderness areas.

1931 The NPS Organic Act of 1916 (39 Stat. 535, 16 U.S.C. 1, as amended), states that the NPS "shall  
1932 promote and regulate the use of the Federal areas known as national parks, monuments, and  
1933 reservations...to conserve the scenery and the national and historic objects and the wildlife  
1934 therein and to provide for the enjoyment of the same in such manner and by such means as will  
1935 leave them unimpaired for the enjoyment of future generations." The NPS Management  
1936 Policies indicate that Parks will "meet its obligations under the National Park Service Organic  
1937 Act and the Act to both pro-actively conserve listed species and prevent detrimental effects on  
1938 these species." This includes working with other agencies and partners to implement  
1939 management programs which inventory, monitor, restore, and maintain listed species habitats.  
1940 The Mojave Desert Inventory & Monitoring Network of the NPS regularly implements  
1941 monitoring programs at all three NPS units focused on desert spring riparian vegetation and

1942 water quality as well as upland vegetation and soil characteristics that might influence the  
1943 survival of Mojave Desert Tortoise.

1944 *United States Department of Defense*

1945 The Sikes Act was established in 1960 to ensure conservation and protection of natural  
1946 resources used by the DoD. The U.S. Congress amended the Sikes Act in 1997 requiring the DoD  
1947 to develop and implement Integrated Natural Resources Management Plans (INRMPs). These  
1948 plans outline how each military installation will manage its significant natural resources  
1949 holistically while maintaining military readiness. Since these lands are often protected from  
1950 access and use by the general public, they may contain some of the more significant remaining  
1951 large tracts of habitat and play important roles for species conservation and habitat  
1952 connectivity.

1953 Under the ESA, the DoD is responsible for managing and protecting the threatened and  
1954 endangered species found on its installations. DoD is required to consult with the USFWS and  
1955 National Oceanic and Atmospheric Association (NOAA) Fisheries to manage their threatened  
1956 and endangered species efforts (Dalsimer 2016).

1957 DoD facilities within the Mojave Desert Tortoise range include Naval Air Weapons Station China  
1958 Lake, Edwards Air Force Base, Fort Irwin, the Marine Corps Air Ground Combat Center, and the  
1959 Chocolate Mountain Aerial Gunnery Range. DoD is an active collaborator in the MOG and RASP  
1960 partnerships and contributes funding to many recovery actions. Unlike most other federal land,  
1961 tortoise habitat under DoD jurisdiction is “subject to more dramatic changes in management or  
1962 use than other Federal lands depending on the changing national security situation” (U.S. Fish  
1963 and Wildlife Service 2011). This means that large tracts of desert tortoise habitat can relatively  
1964 quickly be converted to uses that are incompatible with desert tortoise, requiring translocation  
1965 of large number of tortoises (see section 4.1 for more details). To offset these losses of tortoise  
1966 habitat, the DoD undertakes a variety of actions such as purchasing land in critical habitat units,  
1967 increasing law enforcement, predator control and monitoring, rehabilitation of closed roads,  
1968 and installation of fencing.

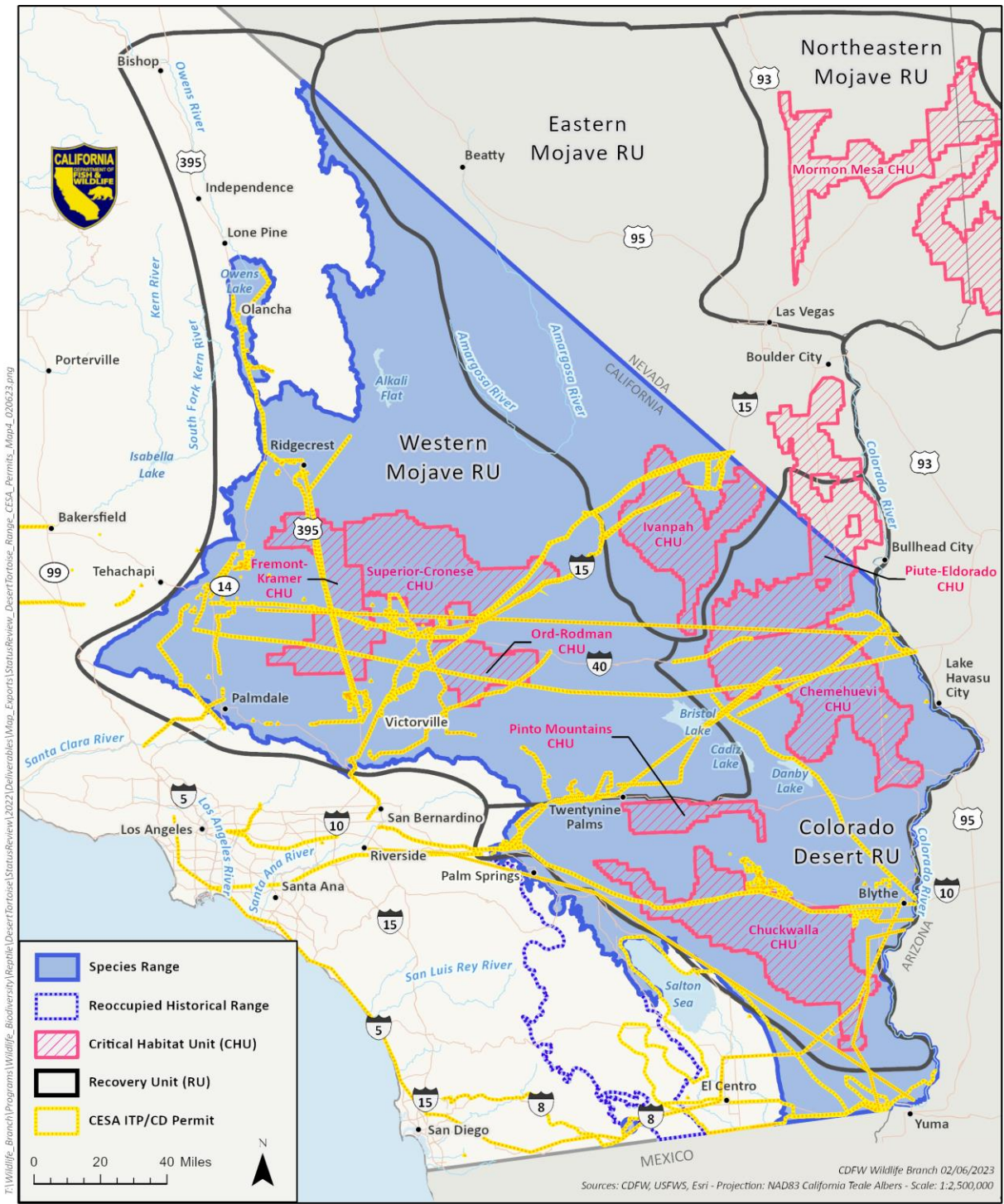
1969 *California Department of Fish and Wildlife*

1970 CESA prohibits the unauthorized take of desert tortoise, but the Department may permit take  
1971 that is incidental to otherwise lawful activities if the impacts of the take are minimized and fully  
1972 mitigated. These permits are commonly called incidental take permits.

1973 The Department is required to determine what qualifies as "full mitigation" for each permit on  
1974 a case-by-case basis. As a practical matter, perpetual protection and management of habitat  
1975 mitigation lands has often been the type of mitigation required. In addition, projects may have  
1976 to implement a variety of measures to minimize take of tortoises including but not limited to  
1977 surveying and monitoring for their presence, fencing to keep tortoises out of the project site,  
1978 relocating of nests to safe offsite locations, translocating tortoises on the project site, and  
1979 managing ravens on the site.

1980 Since 1989, CDFW has issued 192 ITPs and 49 CDs covering incidental take of Mojave Desert  
1981 Tortoise; the most common project types include renewable energy, transportation, and utility  
1982 infrastructure (for locations of permitted projects see Figure 13). The Department's records are  
1983 not complete; however, at minimum these permits authorize 62,131 acres (~250 km<sup>2</sup>) of  
1984 permanent impacts and 14,672 acres (~59 km<sup>2</sup>) of temporary impacts (based on data available  
1985 about temporary acres from 36% of ITPs and 79% of ITPs for permanent impacts). The ratio at  
1986 which projects have to protect and manage mitigation habitat varies on a project-by-project  
1987 basis, however projects sited in federally designated Critical Habitat are generally mitigated at a  
1988 5:1 ratio and other habitats at around a 3:1 ratio depending on quality. Permit holders have  
1989 multiple options when choosing mitigation lands but must typically provide for permanent  
1990 protection and perpetual management of habitat for the listed species either on the project site  
1991 or at another location approved by the Department. This requires transfer of fee-title and/or  
1992 recordation of a conservation easement, to which the Department must be at least a third-  
1993 party beneficiary, funding of short-term management practices and a long-term management  
1994 endowment, and monitoring to ensure compliance with the conservation easement.  
1995 Alternatively, permittees may purchase credits at conservation and mitigation banks.

1996 The desert tortoise is addressed in several Natural Community Conservation Plans (NCCPs) and  
1997 Habitat Conservation Plans (HCPs) in California, including the West Mojave Plan, the Coachella  
1998 Valley Multi Species Habitat Conservation Plan (MSHCP), and the California Energy  
1999 Commission's Habitat and Species Protection Research Project. The Coachella Valley MSHCP  
2000 area supports a small, but significant population of desert tortoise in Riverside County (CDFW  
2001 2005). This MSHCP includes all federally designated critical habitat within the plan area as part  
2002 of the Desert Tortoise and Linkage Conservation Area.



2004  
2005  
2006  
2007  
2008

**Figure 13.** Map of Incident Take Permits (ITPs) and Consistency Determinations (CD) in the general area of Mojave Desert Tortoise range in California. The linear permit areas are for energy transmission lines, pipelines, fiber optic lines, and other linear features. Other types of projects are represented as polygons.



2009 **6 SUMMARY OF LISTING FACTORS**

2010 The preceding sections of this status review describe the best scientific information available to  
2011 the Department, with respect to the key factors identified in the regulations. This section  
2012 considers the significance of any threat to the continued existence of Mojave Desert Tortoise  
2013 for each of the factors.

2014 **6.1 Present or Threatened Modification or Destruction of Habitat**

2015 Like many species, habitat loss and degradation are major concerns for desert tortoise.  
2016 Tortoises are sensitive to habitat alteration by development and an estimated 66% of Mojave  
2017 Desert Tortoise habitat has some development within 1 km (Carter et al. 2020). The direct  
2018 impacts of development include removal of soil and vegetation, destruction of burrows, and  
2019 creation of roads and other infrastructure that can kill tortoises or hinder their movements  
2020 (Boarman and Sasaki 1996, 2006). Large amounts of desert tortoise habitat are open to  
2021 renewable energy development, off road driving, or is under DoD jurisdiction and could be used  
2022 for training or associated infrastructure development. For example, in the past 10 years, a net  
2023 of ~150,000 acres of the ~3,000,000 acres (~607 km<sup>2</sup> of ~12,140 km<sup>2</sup>) of viable desert tortoise  
2024 habitat under DoD jurisdiction have been eliminated (U.S. Fish and Wildlife Service 2022a).

2025 Tortoises are less likely to utilize areas that have even a low level of development. Carter et al.  
2026 (2020) found that “encounter rates for both live and dead Mojave desert tortoises combined  
2027 decreased significantly with increased development levels” and that when “10% of the area  
2028 within 1 km of that location has been altered by development”, it was rare to find live or dead  
2029 tortoises at that location. To date, models show that only 5% of Mojave Desert Tortoise habitat  
2030 falls into that category (Carter et al. 2020). However, as the demands for housing and  
2031 renewable energy facilities increase in the desert, it is likely that the amount of development  
2032 within or near tortoise habitat will continue to increase.

2033 Currently there are about 62,000 acres (about 250 km<sup>2</sup>) permitted to be permanently impacted  
2034 by renewable energy projects within desert tortoise range in California. Wind and solar farms  
2035 alter the habitat in permanent and temporary ways (though some alterations considered to be  
2036 temporary can have impacts lasting decades in the desert. Studies of the impacts of wind farms  
2037 on tortoises indicate that tortoises can survive on some farm sites, and that in some cases their  
2038 survivorship may be higher on farms than in surrounding areas. However, such studies are few  
2039 and the impacts of wind and solar farms on tortoises remain uncertain. Roads and OHV routes  
2040 are a direct threat to tortoises through roadkill, as well as habitat degradation and  
2041 fragmentation. The proliferation of such features in desert tortoise habitat adversely impacts  
2042 tortoises, especially since the installation of exclusion fencing has been limited over the past  
2043 decade. Other factors that degrade habitat include increasing temperatures and potential  
2044 drought frequency, which are expected to reduce the ability of current habitat areas to support  
2045 tortoise populations in the future.

2046 Invasive grasses have caused widespread impacts to desert tortoise habitat. These grasses,  
2047 mostly *Bromus* and *Schismus* species, are outcompeting native grasses and forbs that tortoises

2048 preferentially eat. The invasive grasses lack sufficient levels of the nutrients that tortoises need  
2049 to survive and consuming them leads to increased water loss. The impact seems especially  
2050 acute on juvenile tortoises and is likely being a factor in the low survival rates for juveniles seen  
2051 in some areas. The grasses also intensify the fire cycle which in turn decreases the amount of  
2052 native vegetation that is an important food source for tortoises.

2053 Loss of habitat is traditionally considered to be one of the major drivers of species declines  
2054 worldwide. However, direct loss of habitat may be less of an issue for desert tortoises than  
2055 habitat degradation. Although current estimates indicate more than 90% of historical habitat  
2056 still available (only 7.4% of modelled habitat is currently considered completely unsuitable  
2057 (Holcomb 2022a)), tortoise populations have declined severely in the past two decades. Habitat  
2058 degradation through road construction and off-vehicle vehicle use, fire, invasive species  
2059 outcompeting native plants, and increasing temperatures due to climate change have likely  
2060 reduced the quality of much of the remaining habitat. Therefore, focusing solely on the  
2061 proportion of habitat loss in the desert tortoise range as a means of measuring population  
2062 impacts may be misleading and create an overly optimistic picture.

## 2063 **6.2 Overexploitation**

2064 People still shoot and collect desert tortoises but seemingly not at the frequencies seen in the  
2065 late 20<sup>th</sup> century. This may have to do with changing human behavior patterns or because there  
2066 are simply fewer tortoises on the landscape for humans to encounter. Overexploitation is not  
2067 currently considered a major threat to Mojave Desert Tortoise.

## 2068 **6.3 Predation**

2069 Predation, especially by ravens and coyotes, is a significant factor in desert tortoise population  
2070 decline. Ravens (and to lesser extent coyotes) are subsidized by the infrastructure, water, and  
2071 food around human development, and their populations have dramatically increased in recent  
2072 decades. Ravens preferentially target juvenile tortoises, and since clutch sizes are low and  
2073 tortoises can take 12–20 years to become sexually mature, decreased juvenile survival is likely  
2074 an important factor in many areas with declining tortoise densities. Given the slow life history  
2075 traits of tortoises, lower juvenile survival will be a long-term issue for the population, impacting  
2076 populations for decades. Coyotes can kill older tortoises, and in some areas are a significant  
2077 cause of death meaning that even in the unlikely scenario where the threat from ravens is  
2078 eliminated quickly, predation could remain an issue and recovery is unlikely to be swift.

## 2079 **6.4 Competition**

2080 There is some direct competition with livestock for food however there is not much recent data  
2081 on the severity of the impacts specifically in California. In a recent paper on anthropogenic  
2082 stressors to desert tortoises, livestock grazing is listed as a threat in Nevada but not California  
2083 (Tuma et al. 2016).

## 2084 **6.5 Disease**

2085 Upper respiratory tract disease has been cited as a cause of population declines in desert  
2086 tortoise and was a reason for listing under the ESA in 1990. It is thought that its high prevalence  
2087 in wild populations in the 1970s through 1990s was due in part to infected captive tortoises  
2088 being released into the wild. Drought, heavy metal pollution, and human disturbance increase  
2089 physiological stress in tortoises and are correlated with outbreaks of the disease (Jacobson et  
2090 al. 2014). Berry et al. (2015) points out that many of the stressors that increase tortoise  
2091 vulnerability to disease, especially drought and proximity to human populations, are increasing  
2092 in desert tortoise range. However, there have not been any large outbreaks causing mortality  
2093 documented in California since the 1990s. There is not currently significant concern about the  
2094 disease in wild populations, although great care still needs to be taken during translocations to  
2095 prevent any accidental spread.

## 2096 **6.6 Other Natural Occurrences or Human-related Activities**

### 2097 *Climate Change*

2098 Climate change is a major threat which will also intensify other threats. The predicted increase  
2099 in heat and periodically drier conditions increase the chances drought in California through the  
2100 end of the century will increase the amount of time tortoises experience physiological stress,  
2101 decrease the amount of suitable habitat, and likely negatively alter the vegetation they rely on.  
2102 Climate change in general is causing governments to invest in the expansion of wind and solar  
2103 farms, and the number of proposed renewable energy projects in desert tortoise habitat are  
2104 increasing. The DoD considers climate change a major threat to global stability (U.S.  
2105 Department of Defense 2021) and predicts that global climate change will intensify political  
2106 unrest worldwide. This makes it possible that training activity in the many military bases in  
2107 desert tortoise habitat will increase in the future, converting more land from suitable tortoise  
2108 habitat to training areas, and requiring large scale translocations of resident tortoise as  
2109 mitigation.

### 2110 *Fire*

2111 Desert tortoise habitat historically experienced few fires due to low plant productivity and  
2112 sparse fuel loads, and those that did ignite generally burned at low severity in a patchy mosaic  
2113 pattern. Consequently, desert tortoise and the vegetation they rely on are not well adapted to  
2114 fire. Tortoises have some direct protection from fire as they spend much of their time  
2115 underground. The expansion of invasive plants (primarily invasive *Bromus* species) has  
2116 increased fuel loads, though over the long-term fires have not become more common in the  
2117 desert. Fire directly causes some tortoise death and further changes the vegetative community  
2118 making it more difficult for tortoises to find nutritious foods.

### 2119 *Mining*

2120 Mining has a long legacy in desert tortoise habitat. Some mining shafts remain open and  
2121 unfenced, and tortoises can fall in and get trapped inside. Mining leaves behind pollutants of  
2122 various types including mercury, arsenic, and lead that impact soil and plants (including those  
2123 favored by tortoises) up to 15 km from mining sites. Tortoises can absorb the pollutants via  
2124 breathing, eating impacted plants, or absorption through skin, and exposure to these toxins  
2125 may make tortoises more susceptible to disease. Though there is evidence pollution from

2126 mining has negative impacts on tortoise health, it does not appear to be a major threat to  
2127 tortoise populations.

## 2128 **6.7 Summary of Key Findings**

2129 Historical and current conservation efforts have not proven sufficient to halt the population  
2130 declines of desert tortoise. The most robust estimates of densities come from annual  
2131 systematic surveys done in the Tortoise Conservation Areas, which include the Critical Habitat  
2132 Units and contiguous areas with potential tortoise habitat and compatible management. These  
2133 surveys began in 2004 and cover large areas of the best tortoise habitat. Taken as a whole,  
2134 these surveys provide strong evidence that most tortoise populations in California have  
2135 declined rapidly over the past two decades. Estimated rates of annual decline in density in the  
2136 TCAs for 2004–2014 were between 3.3% and 10.8% per year, which is unsustainable for most  
2137 species, but especially for such a long-lived and slow-reproducing species as the desert tortoise.  
2138 Sixty percent of the TCAs currently have densities below 3.9 adult tortoises/km<sup>2</sup> which is the  
2139 density considered necessary for population viability, while another 30% are at the threshold.  
2140 Only one TCA currently has density above the 3.9/km<sup>2</sup> population viability threshold. While we  
2141 do not have estimates of density in all the TCAs prior to the desert tortoise being listed as  
2142 threatened, densities in the early 1980s in select TCAs varied between 35 and 90 adults/km<sup>2</sup>,  
2143 and between 35 and 70 adults/km<sup>2</sup> when they were listed as threatened under CESA in 1989. It  
2144 is estimated that densities of adults in certain TCAs fell between 89% and 97% from the early  
2145 1980s to 2020–2021. Since the late 1970s, the number of juveniles detected on surveys has also  
2146 fallen sharply, to the point that in recent surveys in the Western Mojave almost no juveniles  
2147 were found. Overall, the population data available from the last 20 years continue to  
2148 document tortoise declines in most sampled areas populations in in many TCAs, which  
2149 represent much of the best habitat, are no longer considered viable.

2150 Due to the slow components of tortoise life history, if past and current management is  
2151 successful at mitigating threats and adverse impacts to tortoises, it would still take at least 25  
2152 years of positive population growth to reach the USFWS Recovery Criteria (U.S. Fish and  
2153 Wildlife Service 2022a). For example, in the USFWS 1994 Recovery Plan they estimate that  
2154 when adult survivorship is 98%, population growth would be less than 0.5% per year, and would  
2155 take 140 years to double in size. Annual survival rates for both adults and juveniles in many  
2156 areas are much lower than 98%, making population stability, let alone growth, unlikely.  
2157 Collectively, the available data show that despite 30 years of state and federal protection, in the  
2158 critical habitat units (which are considered to be the best tortoise habitat), most tortoise  
2159 populations have continued to decline and do not show consistent signs of recovery. In most  
2160 regularly surveyed areas, tortoise densities are below the thresholds considered to represent  
2161 population viability.

2162 The dramatic declines in Mojave Desert Tortoise populations have likely resulted from the  
2163 extensive number and interconnected nature of the threats facing tortoises in California. The  
2164 important threats fall in two categories, those that directly kill adults and juveniles, and  
2165 changes in habitat suitability that make it less likely to support healthy populations.

2166 Particularly in long-lived species that are slow to reproduce, decreased survival has long lasting  
2167 impacts on the population and can alter demographic patterns for decades. Predation pressure  
2168 from ravens and coyotes reduce the survival of juvenile and adult tortoises respectively.  
2169 Increasing development removes or reduces habitat suitability and creates roads and increased  
2170 traffic that can endanger tortoises. Extensive networks of trails for off-highway vehicles on  
2171 public lands increase the chance that tortoises will be run over even in areas without paved  
2172 roads. Well-designed fences and culverts can help prevent tortoises and other wildlife being  
2173 killed by vehicles along major roads, but many primary roads remain unfenced and little fencing  
2174 has been built since 2011.

2175 Habitat modification and destruction reduces the amount of habitat that can support tortoises  
2176 in the long-term. Development in the desert will likely continue and possibly speed up given  
2177 California's need for housing and renewable energy (Office of Governor Gavin Newsom 2021).  
2178 The Department of Defense is a large landowner in desert tortoise range and frequently  
2179 expands the areas that it uses for training, requiring translocation of hundreds of tortoises.  
2180 Large scale tortoise translocations do not tend to have high survival rates. It is hard to predict  
2181 the amount of land the DoD will convert into training areas in the future, but given the  
2182 increases of the federal defense budget over the past 20 years (Wikipedia 2023), military  
2183 training needs are not likely to decrease.

2184 Additional factors have direct and indirect impacts on tortoises and their habitat. Climate  
2185 change, which is likely to make desert tortoise range hotter and drier, will increase tortoise  
2186 physiological stress and change activity patterns. The nutritious native plants tortoises  
2187 preferably feed on are being outcompeted by nutritionally poor invasive grasses, which can  
2188 lower tortoise survival rates. Fires fueled by invasive grasses are becoming more common,  
2189 which decreases the amount of native vegetation available for tortoises to feed on.

2190 Some threats appear to be declining. Upper respiratory tract diseases were a major concern  
2191 when tortoises were listed as threatened. Encouragingly, the prevalence of diseased tortoises is  
2192 lower than in previous decades, and it does not currently appear to be an acute threat to wild  
2193 populations. The prevalence of gunshot deaths also decreased in the past several decades, but  
2194 it is unclear if this is due to change in human behavior or simply reflects a lower tortoise  
2195 encounter rate due to declining tortoise density.

2196 There is still a large amount of available habitat and even at low densities, in 2014 there were  
2197 estimated to be more than 61,000 adult tortoises within the TCAs. However, that is a decrease  
2198 from an estimated ~310,000 adults in 2004, and as densities have continued to fall since 2014,  
2199 current abundance is likely lower than 60,000 adult tortoises, and in 60% of the TCAs the  
2200 populations are below the densities needed for viability. Given that there are multiple  
2201 interacting threats that are reducing the amount and quality of viable habitat and lowering  
2202 survival rates of adults and juveniles, the available information suggests that tortoise  
2203 populations will continue to decline for the foreseeable future. However, several of the major  
2204 threats like raven predation on juveniles and the lack of fencing on highways can be minimized  
2205 with the appropriate resources and policy changes. Implementing these actions where

2206 appropriate to improve survival in the short term is critical to give desert tortoises the  
2207 resilience to be able to weather longer term habitat and climactic effects.

2208 **7 PROTECTION AFFORDED BY LISTING**

2209 It is the policy of the state to conserve, protect, restore and enhance any endangered or any  
2210 threatened species and its habitat (Fish & G. Code, § 2052). If listed as an endangered rather  
2211 than a threatened species pursuant to CESA, unauthorized “take” of Mojave Desert Tortoise will  
2212 remain prohibited and its conservation, protection, and enhancement will remain a statewide  
2213 priority. As the Mojave Desert Tortoise is already listed as threatened, public agency  
2214 environmental review is required under the California Environmental Quality Act (CEQA) and its  
2215 federal counterpart, the National Environmental Policy Act (NEPA). There are no changes in  
2216 legal protections under CESA for species changed from threatened to endangered.

2217 However, if the status of the Mojave Desert Tortoise is changed to endangered under CESA, it  
2218 may increase the likelihood that state and federal land and resource management agencies will  
2219 prioritize and allocate more funds towards protection and recovery actions. The federal and  
2220 state listings of the desert tortoise as threatened stimulated a great deal of interest and funding  
2221 in addressing basic questions about the species, with expanded research into status and  
2222 distribution of populations, ecology, genetics, and diseases, as well as collaborations to  
2223 minimize conflict among the many users of desert tortoise habitats. It also triggered the  
2224 creation of a federal Recovery Plan and the numerous conservation and management measures  
2225 outlined in the Existing Management Section. However, funding for species recovery and  
2226 management is limited, and there is a growing list of threatened and endangered species.  
2227 Therefore, while a status change pursuant to CESA will highlight the urgency of tortoise  
2228 conservation needs, the management effects of such a change are uncertain.

2229 **8 RECOMMENDATION FOR THE COMMISSION**

2230 CESA requires the Department to prepare this report regarding the status of Mojave Desert  
2231 Tortoise in California based upon the best scientific information available to the Department  
2232 (Fish & G. Code, § 2074.6). CESA also requires the Department to indicate in this status review  
2233 whether the petitioned action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, §  
2234 670.1, subd. (f)). Based on the criteria described above, the best scientific information available  
2235 to the Department indicates that Mojave Desert Tortoise is in serious danger of becoming  
2236 extinct in California due to one or more causes including present or threatened degradation  
2237 and loss of habitat, predation, and other natural occurrences and human-related activities.

2238 The Department recommends that the Commission find the petitioned action to change the  
2239 status of Mojave Desert Tortoise from threatened to endangered to be warranted.

2240 **9 MANAGEMENT RECOMMENDATIONS**

2241 CESA directs the Department to include in its status review recommended management  
2242 activities and other recommendations for recovery of Mojave Desert Tortoise (Fish & G. Code, §

2243 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).). The USFWS created a Recovery Plan for  
2244 desert tortoise in 1994 which was revised in 2011. This is currently the most comprehensive  
2245 framework of actions needed to recover the desert tortoise, and many of the recommendations  
2246 are still very relevant. For our recommendations we borrow heavily from the framework in the  
2247 2011 revised Recovery Plan, include examples of recent progress, and point out specific areas  
2248 where the Department could engage more. We also focus on specific actions like translocation  
2249 and head-starting that have been in use for multiple years to examine what evidence there is  
2250 that they have been effective.

## 2251 **9.1 Actions**

2252 This document is not a Recovery Plan; however, it is useful to identify the conservation goals  
2253 that the management recommendations are meant to achieve.

2254 In brief, the USFWS Recovery Plan includes the following objectives:

- 2255 1. Maintain self-sustaining populations of desert tortoises within each Recovery Unit into the  
2256 future.
  - 2257 – Criteria: Rates of population change ( $\lambda$ ) for desert tortoises are increasing (i.e.,  $\lambda > 1$ )  
2258 over at least 25 years (a single tortoise generation)
- 2259 2. Maintain well-distributed populations of desert tortoises throughout each recovery unit.
  - 2260 – Criteria: Distribution of desert tortoises throughout each tortoise conservation area  
2261 is increasing over at least 25 years (i.e.,  $\psi$  [occupancy]  $> 0$ )
- 2262 3. Ensure that habitat within each recovery unit is protected and managed to support long-  
2263 term viability of desert tortoise populations.

2264 The major elements of the USFWS Recovery Plan strategy to achieve these objectives are:

- 2265 1. Develop, support, and build partnerships to facilitate recovery.
- 2266 2. Protect existing populations and habitat, instituting habitat restoration where  
2267 necessary.
- 2268 3. Augment depleted populations in a strategic manner.
- 2269 4. Monitor progress toward recovery.
- 2270 5. Conduct applied research and modeling in support of recovery efforts within a strategic  
2271 framework.
- 2272 6. Implement a formal adaptive management program.

2273 For each of the strategies in the Recovery Plan, the USFWS includes specific measures to  
2274 contribute to those strategies. We do not list all of these specific measures here, but instead  
2275 discuss the strategies and measures that are most relevant and important to recovery in  
2276 California and highlight those which the Department may have a role in implementing.

### 2277 ***1. Develop, support, and build partnerships to facilitate recovery.***

2278 There are multiple existing partnerships to facilitate recovery of desert tortoise (see section 5.2  
2279 Management Efforts). The Department could become more active in the MOG, participate in  
2280 Recovery Implementation Teams, and strengthen maintain relationships with state and federal  
2281 agencies to collaboratively address priorities such as highway fencing and translocation.

2282 **2. Protect existing populations and habitat, instituting habitat restoration where necessary.**

2283 Here we focus on the issues most relevant to California.

2284 *a. Conserve intact desert tortoise habitat*

2285 The majority of land (63.1%) in the tortoise range is under stewardship of the BLM or the NPS  
2286 and receives some level of protection (see Table 6). Future habitat conservation efforts should  
2287 consider how habitat suitability will change in the coming decades under predicted climate  
2288 change and ways in which habitat can be restored and made more resilient and/or habitat  
2289 degradation can be ameliorated.

2290

2291 *b. Secure lands/habitat for conservation.*

2292 Projects that will potentially result in incidental take of tortoises may apply for an ITP from the  
2293 Department. As a condition of the ITP, the Department must require any impacts to the desert  
2294 tortoise to be fully mitigated. This requirement is most often met through the perpetual  
2295 protection and management of off-site habitat. CDFW should continue to focus on securing  
2296 high quality habitats through the ITP process and through other means (e.g., facilitating  
2297 recovery land acquisitions through grants, facilitating conservation easement, etc.). The USFWS  
2298 also issues take authorizations that ask for mitigation in the form of land protection. For more  
2299 detail see section 5.2 Management Efforts.

2300 As mentioned previously, “the Army acquired approximately 100,000 acres (~405 km<sup>2</sup>) of  
2301 nonfederal land within the Superior-Cronese Critical Habitat Unit for conservation management  
2302 of desert tortoises. It also purchased the base property of three cattle allotments on which the  
2303 Bureau subsequently re-allotted the forage to wildlife” (U.S. Fish and Wildlife Service 2022a).

2304 *c. Connect functional habitat*

2305 Low genetic differentiation among desert tortoise populations in California (Hagerty and Tracy  
2306 2010) suggests that historically there were few barriers to movements and mixing, aside from  
2307 large mountain ranges and other significant climatic or vegetative barriers. However, this is  
2308 effectively no longer the case, and instead there is what is more accurately described as a  
2309 metapopulation (Berry and Murphy 2019, Desert Tortoise Council 2022) where habitat patches  
2310 are separated by roads, housing, agriculture, industry, energy projects, and military activities.

2311 The strategy outlined in the 1994 Recovery Plan suggests that habitat patches of at least 2590  
2312 km<sup>2</sup> (1,000 mi<sup>2</sup>) are needed in each recovery unit to “contain a viable population of desert  
2313 tortoises that is relatively resistant to extinction processes” (U.S. Fish and Wildlife Service  
2314 1994). Multiple TCAs are smaller than 2,590 km<sup>2</sup>, therefore protecting corridors between TCAs  
2315 so that tortoises can disperse is key for conservation of metapopulations. Tortoises within  
2316 isolated patches are at higher risk of extirpation due to the usual risks to small populations—



2317 stochastic catastrophes like drought and fire, reduction in genetic variation, and potential  
2318 associated losses of fitness (Boarman et al. 1997, Berry and Murphy 2019, U.S. Fish and Wildlife  
2319 Service 2022a). While many of the patches share the same threats, given the differences in land  
2320 use and management across the desert tortoise’s range, individual patches should be managed  
2321 to minimize the most severe threats for that patch. The USFWS (2019a) points out that the  
2322 current fragmented nature of desert tortoise habitat (e.g., urban and agricultural development,  
2323 highways, freeways, military training areas) will make “recolonization of extirpated areas  
2324 difficult, if not impossible.”

2325 Land is not equally protected across CHUs, creating potential barriers between areas of  
2326 functional habitat. We recommend focusing the compensatory habitat purchases and other  
2327 types of land acquisitions on connecting functional habitat. The BLM is acquiring several  
2328 thousand acres of checkerboard inholding in Chuckwalla Critical Habitat Unit which will improve  
2329 connectivity to Joshua Tree National Park.

2330 *d. Fence, restrict, designate, close roads and routes*

2331 In order for functional habitat to be connected, tortoises need to be able to move and not be  
2332 isolated in patches. A major action to achieve this is to erect tortoise fencing and crossings  
2333 along roads.

2334 Erecting tortoise exclusion fencing along major roadways and funneling them into well designed  
2335 crossings is a key recovery action. There are 500 kms (~310 mi) of road identified as priority for  
2336 fencing (U.S. Fish and Wildlife Service 2022a). Currently, the regulations on highway fencing  
2337 have made it extremely difficult and expensive to install tortoise fencing and are a major reason  
2338 that there was very little tortoise exclusion fencing installed between 2011 and 2022. Under  
2339 current practice, when an applicant applies for an ITP for a road project that includes tortoise  
2340 exclusion fencing and culverts for crossing, the area of land inside of the fence including the  
2341 median between lanes of traffic is considered to be habitat that is impacted and the impacts  
2342 need to be fully mitigated through land acquisition. The costs of procuring land adds substantial  
2343 costs to fencing projects, to the point that much needed fencing is not getting built. To speed  
2344 up the building of fences, the Department can work with CalTrans and other agencies to reduce  
2345 cost and administrative burden of building tortoise exclusion fencing. Having more flexibility in  
2346 the measures that are used to fully mitigate the impacts of road projects will help speed up  
2347 progress on recovery actions. At the moment there are some fencing projects in process,  
2348 including the first phase of a BLM effort to build 3.5 miles of fencing along I-40 in the Rod-  
2349 Ordman Critical Habitat Unit. In the Mojave National Preserve there is a road rebuilding project  
2350 that includes 5 miles of tortoise fencing.

2351  
2352 In addition to fencing paved roads, we recommend closing and restoring unauthorized OHV  
2353 routes in CHUs.

2354  
2355 *e. Minimize excessive predation on tortoises*

2356 Implementing multiple actions simultaneously is necessary to slow the expansion of predator  
2357 populations. The DoD and the USFWS have active programs to reduce anthropogenic subsidies

2358 to ravens and coyotes by securing trash and water sources and reducing the number of nesting  
2359 and roosting sites created by infrastructure. The USFWS has a program to reduce raven  
2360 populations via egg oiling with a goal of no raven nests in areas that are a priority for tortoise  
2361 recruitment (K. Holcomb, USFWS Raven Management in CA. MOG April 16 2022).

2362

2363 *f. Restore desert tortoise habitat*

2364 Restore closed OHV trails, and work to reduce non-native invasive grasses from desert tortoise  
2365 habitat. Areas degraded by off road vehicles in Fremont Kramer Critical Habitat Unit are being  
2366 restored by the BLM and Marine Corps Air Ground Combat Center Twentynine Palms is  
2367 restoring habitat as part of implementing RASP.

2368

2369 *g. Minimize factors contributing to disease (particularly upper respiratory tract disease)*

2370 Continue to discourage the release of pet tortoises into the wild. Monitor and quarantine  
2371 translocated tortoises to make sure they are not diseased before relocation following  
2372 recommendations in U.S. Fish and Wildlife Service (2020b).

2373

2374 *h. Establish/continue environmental education programs*

2375 Environmental education is a preventative action that has been shown to effectively change  
2376 learned behavior and can be used to reduce stakeholder conflict before it happens (Hungerford  
2377 and Volk 1990). An educated public is more likely to be aware of the consequences they can  
2378 have on desert tortoises and to be more willing to take responsibility for their actions than  
2379 those with less knowledge (Vaske and Donnelly 2007). Aggressive and widespread efforts in  
2380 museums, hunting clubs, and in BLM and NPS visitor centers and interpretive sites are needed  
2381 to inform the public about the status of the desert tortoise and its recovery needs (U.S. Fish and  
2382 Wildlife Service 2011).

2383 Interpretive kiosks or visitor centers should be used to disseminate information about the  
2384 desert tortoise and the need for regulated access and use of habitat. Education programs  
2385 should include such subjects as husbandry and adoption programs for captive tortoises, the  
2386 importance of discouraging unauthorized breeding of desert tortoises in captivity, and the  
2387 illegality under State laws of releasing captive tortoises into wildlands. Education efforts should  
2388 be focused on groups that use the desert on a regular basis, such as rock-hounds and off-  
2389 highway vehicle enthusiasts. Additional educational tools include public service  
2390 announcements, news releases, informational videos, brochures and newsletters, websites, and  
2391 volunteer opportunities (U.S. Fish and Wildlife Service 2011).

2392 *i. Increase law enforcement.*

2393 Increase efforts to enforce rules banning off-roading by OHVs in Desert Wildlife Management  
2394 Areas and CHUs.

2395

2396 **3. Augment Depleted Populations through a Strategic Program**

2397 Population augmentation is currently accomplished through two types of projects,  
2398 translocation and head-starting. Translocation involves moving tortoises from a site where they

2399 would be harmed and into an appropriate recipient site. Head-starting is a strategy to reduce  
2400 predation mortality on juvenile tortoises by hatching and rearing juveniles in captivity until they  
2401 are large enough to avoid most predators.

2402 *a. Translocation*

2403 Proposed projects that could result in incidental take of tortoises may apply for an ITP. As part  
2404 of the minimization measures, tortoises in the project area are translocated to pre-approved  
2405 recipient sites.

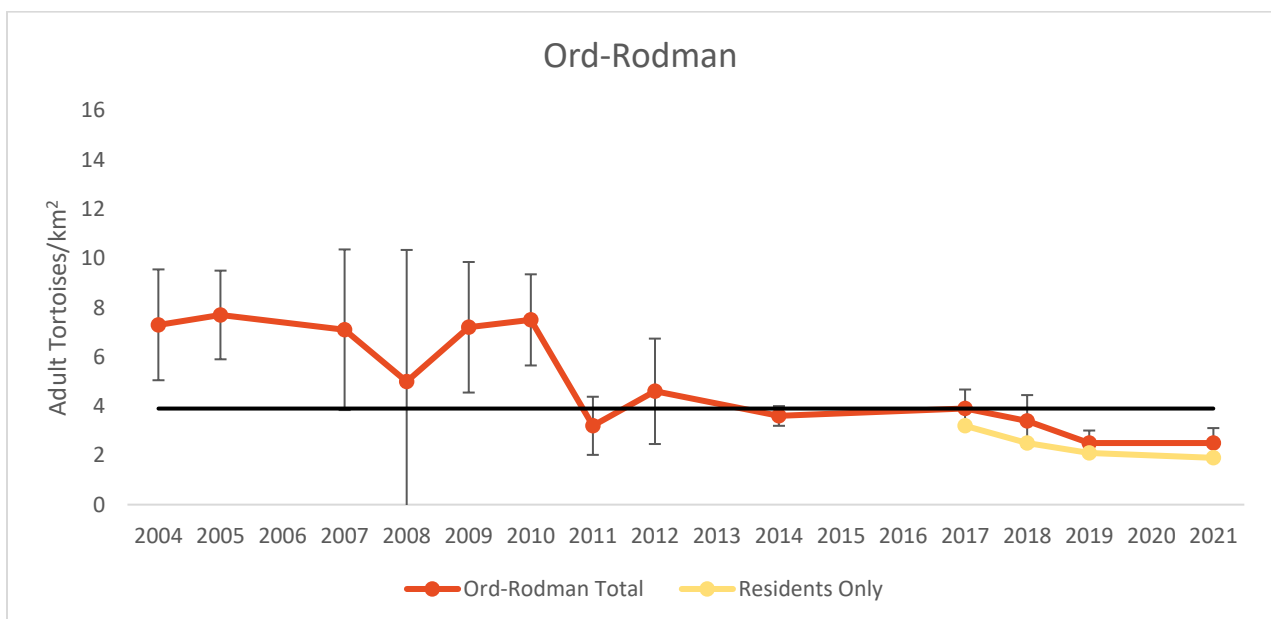
2406 There are a number of considerations that need to be taken into account when tortoises are  
2407 translocated as laid out in the USFWS Plan Development Guidelines (U.S. Fish and Wildlife  
2408 Service 2020b). Major concerns include the habitat suitability of potential translocation sites  
2409 and the possibility of disease transfer from transplants to resident tortoises. The Department  
2410 requires that ITP holders monitor any tortoises translocated, and has teams carefully examine  
2411 recipient sites for soil and vegetation communities that are suitable for all life stages of tortoise,  
2412 evaluate the presence and abundance of predators, and make sure there are sufficient burrows  
2413 of appropriate size so that translocated tortoises can quickly find shelter. Most of the tortoises  
2414 translocated under ITPs granted by the Department are placed within 4 miles of the donor site  
2415 and the number of tortoises translocated for any project is usually less than 50. Due to the  
2416 consistent efforts to find suitable recipient sites, deaths from translocation via dehydration or  
2417 predation are rare (CDFW unpublished data, W. Campbell pers comm Jan 2023). However  
2418 longer-term success of those translocations is not known.

2419 However, there is evidence that larger scale translocations are not very successful. This is likely  
2420 because it is much more difficult to find recipient sites that are suitable for larger numbers of  
2421 tortoises. If donor sites are chosen because resident populations are depleted or have low  
2422 densities, they may not have the capacity to maintain higher densities of tortoises in general  
2423 and might not be able to support large numbers of translocated animals (U.S. Fish and Wildlife  
2424 Service 2011). For example, sites with a depleted population due to habitat modification or  
2425 degradation may currently be at a low carrying capacity and not be able to support many  
2426 transplants because the site lacks sufficient food or burrows to support more individuals, or it  
2427 simply is too hot. In the spring of 2008, 570 tortoises (184 females, 293 males, 93 juveniles)  
2428 were translocated from the southern edge of Fort Irwin National Training Center to neighboring  
2429 public land in the Superior-Cronese Critical Habitat Unit. Esque et al. (2010) tracked the survival  
2430 of the translocated tortoises and within a year, 25% of them died. In the same translocation  
2431 event, (Mulder et al. 2017) found that the males that survived were not fathering hatchlings.  
2432 Even though translocated males made up 46% of the males they genotyped in the population,  
2433 all hatchlings that could be assigned fathers were sired by resident males. A different study  
2434 examined drivers of survival when 158 adult tortoises were translocated from Ft. Irwin to  
2435 release sites 7.36–42.54 km from their home sites (Mack and Berry 2023). The tortoises were  
2436 tracked for 10 years. Thirty-nine percent died in the first year, more than 50% were dead by the  
2437 end of the third year, and after 10 years about 66% were confirmed dead and another 15%  
2438 missing. Most of the dead tortoises were killed by coyotes. After 10 years, survival was highest  
2439 in the site closest to the site they had been taken from, and across the study males were more

2440 likely to survive. Low survival is not limited to the translocated tortoises; in the same time  
2441 period the density of resident tortoises also declined. Supplementation of the resident  
2442 population by translocated individuals does not appear to stabilize populations, as explained by  
2443 (Mack and Berry (2023):

2444 “In 2004–2005, prior to translocation, the USFWS (2015) estimated densities of  
2445 resident adult tortoises at 6.4 adults/km<sup>2</sup> for the Superior-Cronese critical habitat  
2446 unit where the translocation later occurred. In contrast, densities of adults on  
2447 release plots at the time of release were approximately 40/plot or 15.5/km<sup>2</sup>,  
2448 more than two times that of the surrounding resident population. Several decades  
2449 ago, habitat may have supported ≥15 adult tortoises/km<sup>2</sup> in the region (USFWS  
2450 1994, Berry and Murphy 2019). Declines in abundance occurred prior to, during,  
2451 and after the release; the USFWS (2015) reported a 61.5% decline in adult  
2452 tortoises in the Superior-Cronese critical habitat unit between 2004 and 2014 to  
2453 2.4 adults/km<sup>2</sup>, despite additions of several hundred tortoises from the NTC  
2454 translocation project in 2008. By 2017, the density of adults had declined further  
2455 to 1.7 adults/km<sup>2</sup> (USFWS 2018).”

2456 Further evidence that translation has not necessarily increased the recipient populations in  
2457 California comes from Ord-Rodman Critical Habitat Unit. In 2014, the estimated density of  
2458 tortoises in Ord-Rodman was 3.6 adults/km<sup>2</sup> with an estimated abundance of about 3000 adults  
2459 (Tables 2 and 5). Between 2017 and 2019, 724 adult tortoises were translocated into the Ord-  
2460 Rodman TCA due to expansion at 29 Palms Marine Corps Air Gunnery Command Center. From  
2461 2017 on, the surveys kept track of the densities of all adults and of residents adults only (Figure  
2462 14) (U.S. Fish and Wildlife Service 2018, 2019b, 2020a, 2022c, b). Although the initial influx of a  
2463 large number of translocated adults pushed the population back up to 3.9 adults/km<sup>2</sup> in 2017,  
2464 in subsequent years the density of residents and all adults fell and has stayed below the  
2465 threshold for population viability since.



2466

2467 **Figure 14.** Estimated densities of adult tortoises ( $\geq 180$  mm carapace length) in the Ord-  
2468 Rodman TCA in the Western Mojave Recovery Unit 2004–2021. Black horizontal line represents  
2469  $3.9$  adults/ $\text{km}^2$ , the estimated minimum density needed for population viability. Error bars are  
2470 standard errors calculated from reported coefficients of variation. The Residents Only density is  
2471 for adults that were not translocated, the Ord-Rodman Total is the density of residents plus the  
2472 translocated tortoises starting in 2017.

2473 Nor has translocation been successful just across the Nevada border from the Ivanpah Critical  
2474 Habitat Unit. As Scott et al. (2020) reported:

2475 “In 1996, the 100- $\text{km}^2$  Large-Scale Translocation Site (LSTS) was established. The  
2476 LSTS is located in the Ivanpah Valley near Jean, Nevada, within the natural range  
2477 of the tortoise, and is surrounded by either a tortoise-barrier fence or relatively  
2478 inhospitable mountains....Between 1997 and 2014,  $\sim 9,105$  tortoises ( $\sim 50.2\%$  of  
2479 which were adults) of unknown provenance were translocated to the LSTS, where  
2480 they intermingled with an estimated 1450 adult local tortoises that were natural  
2481 residents at the site. Most native and translocated tortoises in the LSTS have since  
2482 died, consistent with steep declines in neighboring populations and likely  
2483 furthered by high post-translocation densities and less comprehensive health  
2484 screening during the first decade of the translocation program. However, roughly  
2485 350 adults were estimated by line-distance surveys to be alive in 2015”

2486 The failure of these large and long-term translocations to either keep translocated tortoises  
2487 alive or the resident population stable suggests translocation may often not be an effective  
2488 management strategy. The majority of the tortoises translocated into LSTS came from captivity  
2489 and were likely not well adapted to surviving in the wild, which is likely a factor in their high  
2490 death rates. Most official translocations in California involve moving wild tortoises from a  
2491 project site to a nearby area, and so may not face the same difficulties in survival that releasing  
2492 captive tortoises appear to create. However, the evidence from Ord-Rodman suggests that  
2493 even an addition of large numbers of new adults to a nearby area can slow but does not  
2494 prevent population declines. The low survival rates of translocated adults and the lack of  
2495 genetic integration of males suggest that large scale translocation may not provide much  
2496 recorded benefit to recipient populations and does not necessarily remove the translocated  
2497 tortoises from harm’s way. Thus, identification of the reasons for the depleted population in  
2498 the recipient site is important to ensure translocation is conducted in a manner appropriate to  
2499 facilitate survival, and to prevent its failure as a minimization measure.

2500 An additional consideration is how far to translocate individuals. When tortoises must be  
2501 translocated from large tracts of land such as on military bases, translocating individuals close  
2502 to their home ranges is not feasible. Long distance translocation involves potential mixing of  
2503 genetic subunits and possible maladaptation to the environment, and investigations into the  
2504 genetic makeup of the source and recipient populations can help managers make appropriate  
2505 decisions (Weeks et al. 2011). Averill-Murray and Hagerty (2014) used microsatellite loci and  
2506 concluded that “releasing tortoises at recipient sites within a straight-line distance of 200 km

2507 from the source population would most conservatively maintain historic genetic population  
2508 structure.” However more recent work by Sánchez-Ramírez et al. (2018) using Single Nucleotide  
2509 Polymorphisms (SNPs) suggests that there are three genetic subunits within the  
2510 Western Mojave Recovery Unit and translocating them at distances of 200 km away could mix  
2511 individuals from different genetic units.

2512 Given the long-term decline of tortoise populations, understanding the population impacts of  
2513 translocation across the state is critical. ITP holders monitor translocated tortoises for 5 years  
2514 and submit reports to the Department. These data should be organized and analyzed in order  
2515 to understand long-term survival rates of translocated individuals and the impacts of potential  
2516 population fragmentation (see section 9.3). Increased collaboration should occur between  
2517 agencies that perform translocations to understand the landscape and population impacts of  
2518 short- and long-range translocations and coordinate research on disease dynamics, recruitment  
2519 rates, and gene flow (U.S. Fish and Wildlife Service 2020b).

2520 *b. Head starting*

2521 Head-starting is a strategy to try to circumvent the high mortality of juvenile tortoises in the  
2522 wild (see sections on Survival and Predation). Population modeling suggests that increased  
2523 juvenile survival can improve population growth rates and is a factor managers can manipulate  
2524 relatively easily (Berry and Murphy 2019). Eggs are hatched in captivity and juveniles are reared  
2525 until they reach a certain size and then released. There is some evidence that this strategy  
2526 appears to be effective at least in the short term (Nagy et al. 2015a,b, Tuberville et al. 2019),  
2527 however, mortality is high for juveniles smaller than 100 mm in length. When Daly et al. (2019)  
2528 monitored head started tortoises after release in the Mojave National preserve, annual survival  
2529 was 44% and short-term survival was better if tortoises were more than 1.6 km from a raven’s  
2530 nest. Daly et al. (2019) points out that by itself, head-starting is unlikely to lead to population  
2531 recovery if larger issues such as raven density and habitat degradation are not addressed. Nagy  
2532 et al. (2015a) recommends not releasing head-started tortoises until they are over 100 mm,  
2533 which requires keeping them in captivity for about 9 years and is a considerable investment of  
2534 time and resources. There is currently a head-starting program at the Ivanpah Desert Tortoise  
2535 Head-starting Facility in Mojave National Preserve, a joint project between the University of  
2536 Georgia and UC Davis. They have produced more than 675 hatchlings, released 324 which have  
2537 been radio-tracked following release, with another approximately 275 for upcoming releases  
2538 (Tuberville 2022). Another head-start program is on Edwards Air Force Base and involves San  
2539 Diego Zoo, the U.S. Geological Survey, Cadiz Inc., and the BLM (San Diego Zoo Wildlife Alliance  
2540 2018).

2541 **7. Monitor progress toward recovery.**

2542 The USFWS does yearly surveys of the Tortoise Conservation Areas which are used to generate  
2543 estimates of density, abundance, and annual rates of change. The results of this monitoring are  
2544 summarized in section 3.2 Trends in Density and Abundance. Along with the data and estimates  
2545 that are currently published in the report, making sex ratio data public would help stakeholders  
2546 better understand demographic trends, especially as they are influenced by climate change.

2547 The USFWS (2011) has more detailed recommendations on how to monitor populations on the  
2548 scale of recovery units.

2549 The Department collects a variety of data on tortoises from holders of ITPs and Scientific  
2550 Collecting Permits. Improving the capacity of the Department to summarize and analyze these  
2551 data to identify the cumulative impacts of permitted projects on tortoise populations will help  
2552 expand the geographic scope of monitoring and is key to developing criteria for decisions on  
2553 potential limits to take for desert tortoise. Sharing this information with other state and federal  
2554 agencies through the MOG will help bring a broader and more comprehensive understanding of  
2555 the state of tortoise populations in California. In addition, the Department should continue to  
2556 engage with the USFWS and other partners to address high priority monitoring needs through  
2557 the Cooperative Endangered Species Conservation Fund (Traditional Section 6) Grant Program  
2558 See sections 9.2 and 9.3 for more detail.

2559 ***5. Conduct applied research and modeling in support of recovery efforts within a strategic***  
2560 ***framework.***

2561 The 2011 USFWS Revised Recovery Plan includes many specific research and modeling actions  
2562 that are needed to address recovery of desert tortoise. Funding for continued long term  
2563 monitoring at sites outside of TCAs such as the Desert Tortoise Natural Area would expand our  
2564 understanding long term trends in areas with different types of management. The Department  
2565 should continue to engage with the USFWS and other partners to address high priority research  
2566 needs through the Cooperative Endangered Species Conservation Fund (Traditional Section 6)  
2567 Grant Program and other funding opportunities.

2568 ***6. Implement a formal adaptive management program.***

2569 The USFWS Recovery Plan includes steps to

- 2570 1. Revise and continue the development of a recovery decision support system.
- 2571 2. Develop and revise recovery action plans.
- 2572 3. Amend land use plans, habitat management plans, and other plans as needed to  
2573 implement recovery actions.
- 2574 4. Incorporate scientific advice for recovery through the Science Advisory Committee.

2575

2576 The Department has authority to develop and implement non-regulatory Recovery Plans and  
2577 recovery criteria for CESA-listed species with the goal of improving the status of species and  
2578 managing threats to the point where CESA listing may no longer be appropriate or necessary.  
2579 The Department should consider whether adoption of the federal Recovery Plan, potentially  
2580 with amendments, is warranted.

2581 **9.2 Regulations and Policy**

2582 Due to the number of interacting threats facing the desert tortoise, there is an opportunity to  
2583 be more flexible with what is considered appropriate mitigation for ITPs. Acquiring land is an

2584 important measure, but it only addresses a few of the recovery actions for the desert tortoise.  
2585 The Department should consider all available actions that meet the “fully mitigated” standard  
2586 for offsetting project impacts. All measures that support and improve populations should be  
2587 considered as mitigation, including installing tortoise fencing along highways, habitat  
2588 enhancement, management and control of raven populations, and measures that improve  
2589 connectivity. Focusing on land acquisition at the expense of other measures could result the  
2590 protection of high-quality habitat but limited reductions in broader factors causing direct  
2591 mortality or restricting movement between protected areas.

2592 Another useful step would be to review the ITPs issued and the implementation of mitigation  
2593 measures since CESA listing and assess their impact on tortoise populations in general. Section  
2594 2081 c) states “No permit shall be issued ...if issuance of the permit would jeopardize the  
2595 continued existence of the species.” Given the long-term decline of desert tortoise populations,  
2596 the Department should include evaluations of the success of mitigation measures as a part of  
2597 assessments of the cumulative impacts that inform the Department’s decisions about issuing  
2598 permits. See section on Capacity Building below.

### 2599 **9.3 Capacity Building CDFW**

#### 2600 *a) Personnel*

2601 For these Management Recommendations to be most consistently implemented and  
2602 successful, staffing and/or funding capacity that can be devoted to developing, supporting, and  
2603 building partnerships to facilitate recovery of the Mojave Desert Tortoise is needed. Adequate  
2604 staffing facilitates internal coordination, continuity of institutional knowledge, and coordination  
2605 with other agencies and organizations to address the most important issues. If CDFW had  
2606 staffing dedicated to tortoise recovery, there could be a primary point of contact for desert  
2607 tortoise permitting and better coordinate collaborate internally and externally with those  
2608 working on tortoise conservation and management.

#### 2609 *b) Upgrading Systems*

2610 Currently, much of the CDFW review and issuing of ITPs for Mojave Desert Tortoise is done on a  
2611 project-by-project basis, with some take permitted through Natural Community Conservation  
2612 Plans and Habitat Conservation Plans like the Coachella Valley Multi Species Habitat  
2613 Conservation Plan. Projects that apply for ITPs are required to collect data and submit  
2614 compliance reports to the Department. If a project is required to translocate tortoises, they  
2615 need to be monitored for five years and data reported to the Department. There is currently no  
2616 central location for those types of data and reports at the Department. Much of the old data,  
2617 reports, and information is in paper form and is stored in various Department offices and is  
2618 functionally inaccessible. Data on project locations, recipient sites, release points, disease  
2619 testing locations with test results, and mitigation lands need to be stored digitally and made  
2620 available in compliance with relevant CDFW scientific data policies. Without a central repository  
2621 for data and platforms where it can be accessed and used by staff it is difficult to understand  
2622 the scope and extent of impacts of development on tortoises. Consequently, the Department  
2623 does not have a complete view of how many acres have been impacted, or the amount and



2624 location of habitat that has been conserved as mitigation and the success of that mitigation.  
2625 However, a permitting system is currently in development that is intended to centralize and  
2626 streamline the issuing of ITPs and other permits that will make it easier for the Department to  
2627 make informed decisions on future incidental take permits and jeopardy determinations.

2628

## 2629 LITERATURE CITED

2630 The following sources were used during the preparation of this Status Review report:

2631 Agha, M., J. E. Lovich, J. R. Ennen, B. Augustine, T. R. Arundel, M. O. Murphy, K. Meyer-Wilkins,  
2632 C. Bjurlin, D. Delaney, J. Briggs, M. Austin, S. v. Madrak, and S. J. Price. 2015. Turbines and  
2633 terrestrial vertebrates: variation in tortoise survivorship between a wind energy facility and an  
2634 adjacent undisturbed wildland area in the desert Southwest (USA). *Environmental Management*  
2635 56:332–341.

2636 Allison, L. J., and A. M. McLuckie. 2018. Population trends in Mojave desert tortoises (*Gopherus*  
2637 *agassizii*). *Herpetological Conservation and Biology* 13:433–452.

2638 Andersen, M. C., J. M. Watts, J. E. Freilich, S. R. Yool, G. I. Wakefield, J. F. McCauley, and P. B.  
2639 Fahnestock. 2000. Regression-tree modeling of desert tortoise habitat in the central Mojave  
2640 Desert. *Ecological Applications* 10:890–900.

2641 Anderson, K. M., and K. H. Berry. 2019. *Gopherus agassizi* (Agassiz's Desert Tortoise) predation.  
2642 *Herpetological Review* 50.

2643 Averill-Murray, R. C., and B. E. Hagerty. 2014. Translocation relative to spatial genetic structure  
2644 of the Mojave desert tortoise, *Gopherus agassizii*. *Chelonian Conservation and Biology* 13:35–  
2645 41.

2646 Barrows, C. W. 2011. Sensitivity to climate change for two reptiles at the Mojave-Sonoran  
2647 Desert interface. *Journal of Arid Environments* 75:629–635.

2648 Barrows, C. W., B. T. Henen, and A. E. Karl. 2016. Identifying climate refugia: a framework to  
2649 inform conservation strategies for Agassiz's desert tortoise in a warmer future. *Chelonian*  
2650 *Conservation and Biology* 15:2–11.

2651 Bedsworth, L., D. Cayan, F. Guido, L. Fisher, and S. Ziaja. 2018. California's Fourth Climate  
2652 Change Assessment Statewide Summary Report. California's Fourth Climate Change  
2653 Assessment.

2654 Berry, Kristin H. 1986a. Desert tortoise (*Gopherus agassizii*) research in California, 1976-1985.  
2655 *Herpetologica* 42:62–67.

- 2656 Berry, Kristin H. 1986b. Incidence of gunshot deaths in desert tortoise populations in California.  
2657 Wildlife Society Bulletin 14:127–132.
- 2658 Berry, K. H., L. J. Allison, A. M. McLuckie, M. Vaughn, and Murphy R.W. 2021. *Gopherus*  
2659 *agassizii*, Mojave Desert Tortoise. The IUCN Red List of Threatened Species.
- 2660 Berry, K. H., T. Y. Bailey, and K. M. Anderson. 2006. Attributes of desert tortoise populations at  
2661 the National Training Center, Central Mojave Desert, California, USA. Journal of Arid  
2662 Environments 67:165–191.
- 2663 Berry, K. H., A. A. Coble, J. L. Yee, J. S. Mack, W. M. Perry, K. M. Anderson, and M. B. Brown.  
2664 2015. Distance to human populations influences epidemiology of respiratory disease in desert  
2665 tortoises. Journal of Wildlife Management 79:122–136.
- 2666 Berry, K. H., and K. Keith. 2008. Status of the desert tortoise in Red Rock Canyon State Park.  
2667 California Fish and Game 94:98–118.
- 2668 Berry, K. H., L. M. Lyren, J. L. Yee, and T. Y. Bailey. 2014. Protection benefits desert tortoise  
2669 (*Gopherus agassizii*) abundance: The influence of three management strategies on a threatened  
2670 species. Herpetological Monographs 28:66–92.
- 2671 Berry, K. H., and P. Medica. 1995. Desert tortoise in the Mojave and Colorado deserts. Pages  
2672 135–137 in E. T. LaRoe, editor. Our Living Resources: A Report to the Nation on the Distribution,  
2673 Abundance, and Health of U.S. Plants, Animals, and Ecosystems. U.S. Department of the  
2674 Interior, Washington D.C.
- 2675 Berry, K. H., and R. W. Murphy. 2019. *Gopherus agassizii* (Cooper 1861) – Mojave Desert  
2676 Tortoise. Chelonian Research Monographs 5.
- 2677 Berry, K. H., L. Nicholson, S. Juarez, and A. P. Woodman. 1986. Changes in Desert Tortoise  
2678 populations at four study sites in California. Pages 60–80 in. Desert Tortoise Council  
2679 Proceedings of the 1986 Symposium.
- 2680 Berry, K. H., T. A. Shields, and E. R. Jacobson. 2016. *Gopherus agassizii* (Agassiz’s Desert Tortoise)  
2681 probable rattlesnake envenomation. Herpetological Review 47:652–653.
- 2682 Berry, K. H., and F. B. Turner. 1986. Spring activities and habits of juvenile desert tortoises,  
2683 *Gopherus agassizii*, in California. Copeia 1986:1010–1012.
- 2684 Berry, K. H., J. L. Yee, and L. M. Lyren. 2020a. Feral burros and other influences on desert  
2685 tortoise presence in the Western Sonoran Desert. Herpetologica 76:403–413.
- 2686 Berry, K. H., J. L. Yee, T. A. Shields, and L. Stockton. 2020b. The catastrophic decline of tortoises  
2687 at a fenced Natural Area. Wildlife Monographs 205:1–53.

- 2688 Berry, K. H., J. Yee, L. Lyren, and J. S. Mack. 2020c. An uncertain future for a population of  
2689 desert tortoises experiencing human impacts. *Herpetologica* 76:1–11.
- 2690 Bisson, H. 2008. Off-Highway vehicle management on public lands. Washington D.C.
- 2691 Bjurlin, C. D., and J. A. Bissonette. 2004. Survival during early life stages of the desert tortoise  
2692 (*Gopherus agassizii*) in the south-central Mojave desert. *Journal of Herpetology* 38:527–535.
- 2693 Boarman, W. I., and K. Berry. 1995. Common Ravens in the southwestern United States, 1968–  
2694 92. Pages 73–75 in E. T. Laroe, editor. *Our living resources: a report to the nation on the*  
2695 *distribution, abundance, and health of U.S. plants, animals, and ecosystems*. U.S. Department  
2696 of the Interior, National Biological Survey, Washington DC, USA.
- 2697 Boarman, W. I., R. J. Camp, F. Collins, M. Hagan, and W. Deal. 1995. Raven abundance at  
2698 anthropogenic resources in the Western Mojave Desert, California National Biological Service  
2699 Riverside, California.
- 2700 Boarman, W. I., M. A. Patten, R. J. Camp, and S. J. Collis. 2006. Ecology of a population of  
2701 subsidized predators: Common ravens in the central Mojave Desert, California. *Journal of Arid*  
2702 *Environments* 67:248–261.
- 2703 Boarman, W. I., and M. Sazaki. 1996. Highway mortality in desert tortoises and small  
2704 vertebrates: success of barrier fences and culverts. Orlando, FL, USA.
- 2705 Boarman, W., and M. Sazaki. 2006. A highway's road-effect zone for desert tortoises (*Gopherus*  
2706 *agassizii*). *Journal of Arid Environments* 94–101.
- 2707 Boarman, W., M. Sazaki, and B. Jennings. 1997. The effect of roads, barrier fences, and culverts  
2708 on desert tortoise populations in California, USA. Pages 54–58 in. *Proceedings: Conservation,*  
2709 *Restoration, and Management of Tortoises and Turtles — An International Conference*.
- 2710 Bradley, B. A., C. A. Curtis, and J. C. Chambers. 2016. *Bromus* response to climate and projected  
2711 changes with climate change. Pages 257–274 in. *Exotic brome-grasses in arid and semiarid*  
2712 *ecosystems of the western US*.
- 2713 Brattstrom, B. H. 1965. Body temperatures of reptiles. *American Midland Naturalist* 73:376.
- 2714 Brooks, M. 1999. Alien annual grasses and fire in the Mojave Desert. *Madroño* 46:13–19.
- 2715 Brooks, M. L. 2012. Effects of high fire frequency in creosote bush scrub vegetation of the  
2716 Mojave Desert. *International Journal of Wildland Fire* 21:61–68.
- 2717 Brooks, M. L., and T. C. Esque. 2002. Alien annual plants and wildfire in desert tortoise habitat:  
2718 status, ecological effects, and management. *Chelonian Conservation and Biology* 4:330–340.

- 2719 Brooks, M. L., B. Lair, F. Station, and N. S. St. 2005. Ecological effects of vehicular routes in a  
2720 desert ecosystem. *Conservation Biology*.
- 2721 Brooks, M. L., and J. R. Matchett. 2006. Spatial and temporal patterns of wildfires in the Mojave  
2722 Desert, 1980-2004. *Journal of Arid Environments* 67:148–164.
- 2723 Brooks, M. L., J. R. Matchett, and K. H. Berry. 2006. Effects of livestock watering sites on alien  
2724 and native plants in the Mojave Desert, USA. *Journal of Arid Environments* 67:125–147.
- 2725 Bureau of Land Management. 2016. Land Use Plan Amendment, Desert Renewable Energy  
2726 Conservation Plan.
- 2727 Burgess, T. L., J. Braun, C. L. Witte, N. Lamberski, K. J. Field, L. J. Allison, R. C. Averill-Murray, K.  
2728 Kristina Drake, K. E. Nussear, T. C. Esque, and B. A. Rideout. 2021. Assessment of disease risk  
2729 associated with potential removal of anthropogenic barriers to Mojave desert tortoise  
2730 (*Gopherus agassizii*) population connectivity. *Journal of Wildlife Diseases* 57:579–589.
- 2731 California Department of Fish and Wildlife. 2000. The Status of Rare, Threatened, and  
2732 Endangered Animals and Plants of California 2000.
- 2733 California Department of Fish and Wildlife. 2005. The Status of Rare, Threatened, and  
2734 Endangered Plants and Animals of California 2000-2004.
- 2735 California Department of Fish and Wildlife. 2014. CWHR version 9.0 personal computer  
2736 program. California Interagency Wildlife Task Group, Sacramento, CA, USA.
- 2737 Carter, S. K., K. E. Nussear, T. C. Esque, I. I. F. Leinwand, E. Masters, R. D. Inman, N. B. Carr, and  
2738 L. J. Allison. 2020. Quantifying development to inform management of Mojave and Sonoran  
2739 desert tortoise habitat in the American southwest. *Endangered Species Research* 42:167–184.
- 2740 Chaffee, M. A., and K. H. Berry. 2006. Abundance and distribution of selected elements in soils,  
2741 stream sediments, and selected forage plants from desert tortoise habitats in the Mojave and  
2742 Colorado deserts, USA. *Journal of Arid Environments* 67:35–87.
- 2743 Christopher, M. M., K. H. Berry, B. T. Henen, and K. A. Nagy. 2003. Clinical disease and  
2744 laboratory abnormalities in free-ranging desert tortoises in California (1990-1995). *Journal of*  
2745 *Wildlife Diseases* 39:35–56.
- 2746 Cohn, B., B. Wallace, C. Grouios, B. Dickson, R. Scherer, A. Kissel, M. E. Gray, and T. G. Jackson.  
2747 2021. Heavy metal concentrations in Mojave desert tortoises (*Gopherus agassizii*) related to a  
2748 mitigation translocation project, Ivanpah Valley, California, USA. *Herpetological Conservation*  
2749 *and Biology* 16:128–141.
- 2750 Curtin, A. J., G. R. Zug, and J. R. Spotila. 2009. Longevity and growth strategies of the desert  
2751 tortoise (*Gopherus agassizii*) in two American deserts. *Journal of Arid Environments* 73:463–  
2752 471.

- 2753 Dalsimer, A. 2016. Threatened and Endangered Species on DoD Lands. DoD Natural Resources.
- 2754 Daly, J. A., K. A. Buhlmann, B. D. Todd, C. T. Moore, J. M. Peaden, and T. D. Tuberville. 2019.  
2755 Survival and movements of head-started Mojave desert tortoises. *Journal of Wildlife*  
2756 *Management* 83:1700–1710.
- 2757 Davy, C. M., T. Edwards, A. Lathrop, M. Bratton, M. Hagan, B. Henen, K. A. Nagy, J. Stone, L. S.  
2758 Hillard, and R. W. Murphy. 2011. Polyandry and multiple paternities in the threatened Agassiz’s  
2759 desert tortoise, *Gopherus agassizii*. *Conservation Genetics* 12:1313–1322.
- 2760 DeFalco, L. A., D. R. Bryla, V. Smith-Longozo, and R. S. Nowak. 2003. Are Mojave Desert annual  
2761 species equal? Resource acquisition and allocation for the invasive grass *Bromus madritensis*  
2762 subsp. *rubens* (*Poaceae*) and two native species. *American Journal of Botany* 90:1045–1053.
- 2763 Denholm, P., M. Hand, J. Maddalena, and S. Ong. 2009. Land-use requirements of modern wind  
2764 power plants in the United States. National Renewable Energy Laboratory.
- 2765 Desert Tortoise Council. 2022. Response by the Desert Tortoise Council to California  
2766 Department of Fish and Wildlife’s May 27, 2022 Notification of Status Review for Mojave Desert  
2767 Tortoise under the California Endangered Species Act.
- 2768 Drake, K. K., L. Bowen, K. E. Nussear, T. C. Esque, A. J. Berger, N. A. Custer, S. C. Waters, J. D.  
2769 Johnson, A. K. Miles, and R. L. Lewison. 2016. Negative impacts of invasive plants on  
2770 conservation of sensitive desert wildlife. *Ecosphere* 7.
- 2771 Drake, K. K., T. C. Esque, K. E. Nussear, L. A. Defalco, S. J. Scoles-Sciulla, A. T. Modlin, and P. A.  
2772 Medica. 2015. Desert tortoise use of burned habitat in the Eastern Mojave desert. *Journal of*  
2773 *Wildlife Management* 79:618–629.
- 2774 Esque, T. C., K. E. Nussear, K. K. Drake, A. D. Walde, K. H. Berry, R. C. Averill-Murray, A. P.  
2775 Woodman, W. I. Boarman, P. A. Medica, J. Mack, and J. S. Heaton. 2010. Effects of subsidized  
2776 predators, resource variability, and human population density on desert tortoise populations in  
2777 the Mojave Desert, USA. *Endangered Species Research* 12:167–177.
- 2778 Esque, T. C., C. R. Schwalbe, L. A. Defalco, R. B. Duncan, and T. J. Hughes. 2003. Effects of desert  
2779 wildfires on desert tortoise (*Gopherus agassizii*) and other small vertebrates. *Southwestern*  
2780 *Naturalist* 48:103–111.
- 2781 Faber-Langendoen, D., J. Nichols, L. Master, K. Snow, A. Tomaino, R. Bittman, G. Hammerson, B.  
2782 Heidel, L. Ramsay, A. Teucher, and B. Young. 2012. NatureServe conservation status  
2783 assessments: methodology for assigning ranks. NatureServe, Arlington, VA.
- 2784 Fenn, M. E., E. B. Allen, S. B. Weiss, S. Jovan, L. H. Geiser, G. S. Tonnesen, R. F. Johnson, L. E.  
2785 Rao, B. S. Gimeno, F. Yuan, T. Meixner, and A. Bytnerowicz. 2010. Nitrogen critical loads and  
2786 management alternatives for N-impacted ecosystems in California. *Journal of Environmental*  
2787 *Management* 91:2404–2423.

- 2788 Frankham, R. 1995. Effective population size/adult population size ratios in wildlife: A review.  
2789 Genetics Research 89:491–503.
- 2790 Freilich, J. E., K. P. Burnham, C. M. Collins, and C. A. Garry. 2000. Factors affecting population  
2791 assessments of desert tortoises. Conservation Biology 14:1479–1489.
- 2792 Germano, J., V. E. van Zerr, T. C. Esque, K. E. Nussear, and N. Lamberski. 2014. Impacts of upper  
2793 respiratory tract disease on olfactory behavior of the Mojave desert tortoise. Journal of Wildlife  
2794 Diseases 50:354–358.
- 2795 Grandmaison, D. D., and V. J. Frary. 2012. Estimating the probability of illegal desert tortoise  
2796 collection in the Sonoran Desert. Journal of Wildlife Management 76:262–268.
- 2797 Hagerty, B. E., and C. R. Tracy. 2010. Defining population structure for the Mojave desert  
2798 tortoise. Conservation Genetics 11:1795–1807.
- 2799 Hammerson, G.A., D. Schweitzer, L. Master, and J. Cordeiro. 2008. Ranking species occurrences-  
2800 a generic approach. NatureServe.
- 2801 Harless, M. L., A. D. Walde, D. K. Delaney, L. L. Pater, and W. K. Hayes. 2009. Home range,  
2802 spatial overlap, and burrow use of the desert tortoise in the West Mojave desert. Copeia 378–  
2803 389.
- 2804 Hazard, L. C., D. R. Shemanski, and K. A. Nagy. 2009. Nutritional quality of natural foods of  
2805 juvenile desert tortoises (*Gopherus agassizii*): Energy, nitrogen, and fiber digestibility. Journal of  
2806 Herpetology 43:38–48.
- 2807 Hegeman, E. E., B. G. Dickson, and L. J. Zachmann. 2014. Probabilistic models of fire occurrence  
2808 across National Park Service units within the Mojave Desert Network, USA. Landscape Ecology  
2809 29:1587–1600.
- 2810 Holcomb, K. L. 2022a. Status Review of the Mojave Desert Tortoise (2012-2022). Desert  
2811 Tortoise Management Oversight Group Meeting October 11, 2022.
- 2812 Holcomb, K. L. 2022b. Fall 2022 Raven Management Update. Desert Tortoise Management  
2813 Oversight Group Meeting October 11, 2022.
- 2814 Holcomb, K. L., P. S. Coates, B. S. Prochazka, T. Shields, and I. Boarman, William. 2021. A desert  
2815 tortoise – common raven viable conflict threshold. Human–Wildlife Interactions 15:405–421.
- 2816 Homer, B. L., C. Li, K. H. Berry, N. D. Denslow, E. R. Jacobson, R. H. Sawyer, and J. E. Williams.  
2817 2001. Soluble scute proteins of healthy and ill desert tortoises (*Gopherus agassizii*). American  
2818 Journal of Veterinary Research 62:104–110.
- 2819 Hopkins, Francesca. 2018. Inland Deserts Summary Report. California’s Fourth Climate Change  
2820 Assessment.

- 2821 Hughson, D. L., and N. Darby. 2013. Desert tortoise road mortality in Mojave National Preserve,  
2822 California. *California Fish and Game* 99:222–232.
- 2823 Hungerford, H. R., and T. L. Volk. 1990. Changing learner behavior through environmental  
2824 education. *Journal of Environmental Education* 21:8–21.
- 2825 Iknayan, K. J., and S. R. Beissinger. 2018. Collapse of a desert bird community over the past  
2826 century driven by climate change. *Proceedings of the National Academy of Sciences of the*  
2827 *United States of America* 115:8597–8602.
- 2828 Jacobson, E. R., M. B. Brown, I. M. Schumacher, B. R. Collins, R. K. Harris, and P. A. Klein. 1995.  
2829 Mycoplasmosis and the desert tortoise (*Gopherus agassizii*) in Las Vegas Valley, Nevada.  
2830 *Chelonian Conservation and Biology* 1:279–284.
- 2831 Jacobson, E. R., M. B. Brown, L. D. Wendland, D. R. Brown, P. A. Klein, M. M. Christopher, and K.  
2832 H. Berry. 2014. *Mycoplasmosis* and upper respiratory tract disease of tortoises: A review and  
2833 update. *Veterinary Journal* 201:257–264.
- 2834 Jacobson, E. R., C. H. Gardiner, M. B. Brown, H. P. Adams, J. M. Gaskin, J. L. Lapointe, R. K.  
2835 Harris, and C. Reggiardo. 1991. Chronic upper respiratory tract disease of free-ranging desert  
2836 tortoises (*Xerobates agassizii*). *Journal of Wildlife Diseases* 27.
- 2837 Jacobson, E. R., T. J. Wronski, J. Schumacher, C. Reggiardo, and K. H. Berry. 1994. Cutaneous  
2838 Dyskeratosis in free-ranging desert tortoises, *Gopherus agassizii*, in the Colorado Desert of  
2839 southern California. *Journal of Zoo and Wildlife Medicine* 25:68–81.
- 2840 Jennings, W. B., and K. H. Berry. 2015. Desert tortoises (*Gopherus agassizii*) are selective  
2841 herbivores that track the flowering phenology of their preferred food plants. *PLoS ONE* 10.
- 2842 Johnson, A. J., A. P. Pessier, J. F. X. Wellehan, R. Brown, and E. R. Jacobson. 2005. Identification  
2843 of a novel herpesvirus from a California desert tortoise (*Gopherus agassizii*). *Veterinary*  
2844 *Microbiology* 111:107–116.
- 2845 Keehn, J. E., and C. R. Feldman. 2018. Disturbance affects biotic community composition at  
2846 desert wind farms. *Wildlife Research* 45:383–396.
- 2847 Keevil, M. G., R. J. Brooks, and J. D. Litzgus. 2018. Post-catastrophe patterns of abundance and  
2848 survival reveal no evidence of population recovery in a long-lived animal. *Ecosphere* 9.
- 2849 Kelly, E. C., B. L. Cypher, and T. L. Westall. 2021. Predation on desert tortoises (*Gopherus*  
2850 *agassizii*) by desert canids. *Journal of Arid Environments* 189.
- 2851 Kristan, W. B., and W. I. Boarman. 2007. Effects of anthropogenic developments on common  
2852 Raven nesting biology in the west Mojave Desert. *Ecological Applications* 17:1703–1713.

- 2853 Lovich, J., M. Agha, J. R. Ennen, T. R. Arundel, and M. Austin. 2018. Agassiz's desert tortoise  
 2854 (*Gopherus agassizii*) activity areas are little changed after wind turbine-induced fires in  
 2855 California. *International Journal of Wildland Fire* 27:851–856.
- 2856 Lovich, J. E., and D. Bainbridge. 1999. Anthropogenic degradation of the southern California  
 2857 desert ecosystem and prospects for natural recovery and restoration. *Environmental*  
 2858 *Management* 24:309–326.
- 2859 Lovich, J. E., and J. R. Ennen. 2011. Wildlife conservation and solar energy development in the  
 2860 desert southwest. *BioScience* 61.
- 2861 Lovich, J. E., and J. R. Ennen. 2013. Assessing the state of knowledge of utility-scale wind energy  
 2862 development and operation on non-volant terrestrial and marine wildlife. *Applied Energy*  
 2863 103:52–60.
- 2864 Lovich, J. E., C. B. Yackulic, J. Freilich, M. Agha, M. Austin, K. P. Meyer, T. R. Arundel, J. Hansen,  
 2865 M. S. Vamstad, and S. A. Root. 2014. Climatic variation and tortoise survival: Has a desert  
 2866 species met its match? *Biological Conservation* 169:214–224.
- 2867 Lovich, J., J. Ennen, S. Madrak, K. Meyer, C. Loughran, C. Bjurlin, T. Arundel, W. Turner, C. Jones,  
 2868 and G. Groenendaal. 2011. Effects of wind energy production on growth, demography and  
 2869 survivorship of a desert tortoise (*Gopherus agassizii*) population in southern California with.  
 2870 *Herpetological Conservation and Biology* 6:161–174.
- 2871 Mack, J. S., and K. H. Berry. 2023. Drivers of survival of translocated tortoises. *Journal of*  
 2872 *Wildlife Management* 1–27.
- 2873 Mack, J. S., K. H. Berry, D. M. Miller, and A. S. Carlson. 2015. Factors affecting the thermal  
 2874 environment of Agassiz's desert tortoise (*Gopherus agassizii*) cover sites in the central Mojave  
 2875 desert during periods of temperature extremes. *Journal of Herpetology* 49:405–414.
- 2876 Manning, J. A. 2018. Genetic origins and population status of desert tortoises in Anza-Borrego  
 2877 Desert State Park, California: Initial steps towards population monitoring. Borrego Springs, CA,  
 2878 USA.
- 2879 McAuliffe, J. R., and E. P. Hamerlynck. 2010. Perennial plant mortality in the Sonoran and  
 2880 Mojave deserts in response to severe, multi-year drought. *Journal of Arid Environments*  
 2881 74:885–896.
- 2882 Mulder, K. P., A. D. Walde, W. I. Boarman, A. P. Woodman, E. K. Latch, and R. C. Fleischer. 2017.  
 2883 No paternal genetic integration in desert tortoises (*Gopherus agassizii*) following translocation  
 2884 into an existing population. *Biological Conservation* 210:318–324.
- 2885 Nagy, K. A., S. Hillard, S. Dickson, and D. J. Morafka. 2015a. Effects of artificial rain on  
 2886 survivorship, body condition, and growth of head-started desert tortoises (*Gopherus agassizii*)  
 2887 released to the open desert. *Herpetological Conservation and Biology* 10:535–549.



- 2888 Nagy, K. A., S. Hillard, M. W. Tuma, and D. J. Morafka. 2015*b*. Head-started desert tortoises  
 2889 (*Gopherus agassizii*): Movements, survivorship and mortality causes following their release.  
 2890 Herpetological Conservation and Biology 10:203–215.
- 2891 Nagy, K. A., B. T. Henen, and D. B. Vyas. 1998. Nutritional quality of native and introduced food  
 2892 plants of wild desert tortoises. Journal of Herpetology 32:260–267.
- 2893 Nussear, K. E., T. C. Esque, R. D. Inman, L. Gass, K. a Thomas, C. S. A. Wallace, J. B. Blainey, D. M.  
 2894 Miller, and R. H. Webb. 2009. Modeling habitat of the desert tortoise (*Gopherus agassizii*) in the  
 2895 Mojave and parts of the Sonoran Deserts of California, Nevada, Utah, and Arizona. US  
 2896 Geological Survey open-file report. Volume 1102.
- 2897 Nussear, K. E., C. R. Tracy, P. A. Medica, D. S. Wilson, R. W. Marlow, and P. S. Corn. 2012.  
 2898 Translocation as a conservation tool for Agassiz’s desert tortoises: Survivorship, reproduction,  
 2899 and movements. Journal of Wildlife Management 76:1341–1353.
- 2900 O’Connor, M. P., L. C. Zimmerman, D. E. Ruby, S. J. Bulova, and J. R. Spotila. 1994. Home range  
 2901 size and movements by desert tortoises, *Gopherus agassizii*, in the eastern Mojave Desert.  
 2902 Herpetological Monographs 8:60–71.
- 2903 Office of Environmental Health Hazard Assessment. 2018. Indicators of Climate Change in  
 2904 California.
- 2905 Office of Governor Gavin Newsom. 2021. Governor Newsom Signs Historic Legislation to Boost  
 2906 California’s Housing Supply and Fight the Housing Crisis | California Governor.  
 2907 <[https://www.gov.ca.gov/2021/09/16/governor-newsom-signs-historic-legislation-to-boost-](https://www.gov.ca.gov/2021/09/16/governor-newsom-signs-historic-legislation-to-boost-californias-housing-supply-and-fight-the-housing-crisis/)  
 2908 [californias-housing-supply-and-fight-the-housing-crisis/](https://www.gov.ca.gov/2021/09/16/governor-newsom-signs-historic-legislation-to-boost-californias-housing-supply-and-fight-the-housing-crisis/)>. Accessed 8 Feb 2023.
- 2909 Oftedal, O., S. Hillard, and D. Morafka. 2002. Selective Spring Foraging by Juvenile Desert  
 2910 Tortoises (*Gopherus agassizii*) in the Mojave Desert: Evidence of an Adaptive Nutritional  
 2911 Strategy. Chelonian Conservation and Biology 4:341–352.
- 2912 Ong, S., C. Campbell, P. Denholm, R. Margolis, and G. Heath. 2013. Land-use requirements for  
 2913 solar power plants in the United States (No. NREL/TP-6A20-56290).
- 2914 Peterson, C. C. 1996. Ecological energetics of the desert tortoise (*Gopherus agassizii*): Effects of  
 2915 rainfall and drought. Ecology 77:1831–1844.
- 2916 Prose, D. v, and H. G. Wilshire. 2000. The lasting effects of tank maneuvers on desert soils and  
 2917 intershrub flora. Open-File Report OF 00-512.
- 2918 Rostal, D. C., J. Grumbles, V. A. Lance, and J. R. Spotila. 2002. Chronology of sex determination  
 2919 in the Desert Tortoise (*Gopherus agassizii*). Chelonian Conservation and Biology 4:313–318.

- 2920 Sadoti, G., M. E. Gray, M. L. Farnsworth, and B. G. Dickson. 2017. Discriminating patterns and  
 2921 drivers of multiscale movement in herpetofauna: The dynamic and changing environment of  
 2922 the Mojave desert tortoise. *Ecology and Evolution* 7:7010–7022.
- 2923 San Diego Zoo Wildlife Alliance. 2018. Head-starting Program for California Desert Tortoises  
 2924 Begins. <[2946 Tagestad, J., M. Brooks, V. Cullinan, J. Downs, and R. McKinley. 2016. Precipitation regime  
 2947 classification for the Mojave Desert: Implications for fire occurrence. \*Journal of Arid\*  
 2948 \*Environments\* 124:388–397.

2949 Tracy, C. R., R. Averill-Murray, W. I. Boarman, D. Delehanty, J. Heaton, E. McCoy, D. Morafka, N.  
 2950 Nussear, B. Hagerty, and P. Medica. 2004. Desert tortoise recovery plan assessment. Desert  
 2951 Tortoise Recovery Plan Assessment Committee for the U.S. Fish and Wildlife Service.

2952 Tuberville, T. D. 2022. Progress Update, Desert Tortoise Management Oversight Group.](https://stories.sandiegozoo.org/2018/07/03/head-starting-program-for-california-desert-tortoises-begins/#:~:text=Radio tracking of more than 30 female tortoises,returned to the wild into their original territory.>.>.</p>
<p>2927 Sánchez-Ramírez, S., Y. Rico, K. H. Berry, T. Edwards, A. E. Karl, B. T. Henen, and R. W. Murphy.<br/>
  2928 2018. Landscape limits gene flow and drives population structure in Agassiz’s desert tortoise<br/>
  2929 (<i>Gopherus agassizii</i>). <i>Scientific Reports</i> 8.</p>
<p>2930 Sandmeier, F. C., C. R. Tracy, B. E. Hagerty, S. Dupré, H. Mohammadpour, and K. Hunter. 2013.<br/>
  2931 Mycoplasmal upper respiratory tract disease across the range of the threatened Mojave Desert<br/>
  2932 tortoise: Associations with thermal regime and natural antibodies. <i>EcoHealth</i> 10:63–71.</p>
<p>2933 Scott, P. A., L. J. Allison, K. J. Field, R. C. Averill-Murray, and H. B. Shaffer. 2020. Individual<br/>
  2934 heterozygosity predicts translocation success in threatened desert tortoises. <i>Science</i> 370:1086–<br/>
  2935 1098.</p>
<p>2936 Shine, R. 2005. Life-history evolution in reptiles. <i>Annual Review of Ecology, Evolution, and</i><br/>
  2937 <i>Systematics</i> 36:23–46.</p>
<p>2938 Shumway, G., L. Vredenburg, and R. Hartill. 1980. Desert Fever: An Overview of Mining History<br/>
  2939 of the California Desert Conservation Area.</p>
<p>2940 Smith, A. L., S. R. Puffer, J. E. Lovich, L. A. Tennant, T. R. Arundel, M. S. Vamstad, and K. D.<br/>
  2941 Brundige. 2016. A potential predator-prey interaction of an American badger and an Agassiz’s<br/>
  2942 desert tortoise with a review of badger predation on turtles. <i>California Fish and Game</i> 102:131–<br/>
  2943 144.</p>
<p>2944 State of California Department of Finance. 2023. Demographics | Department of Finance.<br/>
  2945 <<a href=)

- 2953 Tuberville, T. D., K. A. Buhlmann, R. Sollmann, M. G. Nafus, J. M. Peaden, J. A. Daly, and B. D.  
2954 Todd. 2019. Effects of short-term, outdoor head-starting on growth and survival in the Mojave  
2955 desert tortoise (*Gopherus agassizii*). *Herpetological Conservation and Biology* 14:171–184.
- 2956 Tuma, M. W., C. Millington, N. Schumaker, and P. Burnett. 2016. Modeling Agassiz’s desert  
2957 tortoise population response to anthropogenic stressors. *Journal of Wildlife Management*  
2958 80:414–429.
- 2959 Turner, F. B., P. Hayden, B. L. Burge, and J. B. Roberson. 1986. Egg production by the desert  
2960 tortoise (*Gopherus agassizii*) in California. *Herpetologica* 42:93–104.
- 2961 U. S. Fish and Wildlife Service. 1994. Desert Tortoise (Mojave population) Recovery Plan.  
2962 Portland, Oregon.
- 2963 U. S. Fish and Wildlife Service. 2010. Mojave population of the desert tortoise (*Gopherus*  
2964 *agassizii*): 5-year review: summary and evaluation. Reno, Nevada.
- 2965 U. S. Fish and Wildlife Service. 2022. ESA Section 7 Consultation.
- 2966 Underwood, E. C., R. C. Klinger, and M. L. Brooks. 2019. Effects of invasive plants on fire regimes  
2967 and postfire vegetation diversity in an arid ecosystem. *Ecology and Evolution* 9.  
2968 <[www.ecolevol.org](http://www.ecolevol.org)>.
- 2969 U.S. Department of Defense. 2021. Department of Defense Climate Risk Analysis.
- 2970 U.S. Fish and Wildlife Service. 1990. Endangered and threatened wildlife and plants;  
2971 determination of threatened status for the Mojave population of the desert tortoise. *Federal*  
2972 *Register* 55:12178-12191. Volume 55.
- 2973 U.S. Fish and Wildlife Service. 2011. Revised Recovery Plan for the Mojave Population of the  
2974 Desert Tortoise (*Gopherus agassizii*).
- 2975 U.S. Fish and Wildlife Service. 2015. Range-Wide Monitoring of the Mojave Desert Tortoise  
2976 (*Gopherus agassizii*): 2013 and 2014 Annual Reporting.
- 2977 U.S. Fish and Wildlife Service. 2016. Range-wide Monitoring of the Mojave Desert tortoise  
2978 (*Gopherus agassizii*): 2015 and 2016 Annual Reporting. Volume 10.
- 2979 U.S. Fish and Wildlife Service. 2018. Range-Wide Monitoring of the Mojave Desert Tortoise  
2980 (*Gopherus agassizii*): 2017 Annual Reporting.
- 2981 U.S. Fish and Wildlife Service. 2019a. Status of the Desert Tortoise.
- 2982 U.S. Fish and Wildlife Service. 2019b. Range-Wide Monitoring of the Mojave Desert Tortoise  
2983 (*Gopherus agassizii*): 2018 Annual Reporting.

- 2984 U.S. Fish and Wildlife Service. 2020a. Range-Wide Monitoring of the Mojave Desert Tortoise  
2985 (*Gopherus agassizii*): 2019 Annual Reporting DRAFT.
- 2986 U.S. Fish and Wildlife Service. 2020b. Translocation of Mojave Desert Tortoises from Project  
2987 Sites: Plan Development Guidance.
- 2988 U.S. Fish and Wildlife Service. 2022a. Mojave Desert Tortoise (*Gopherus agassizii*) 5-Year  
2989 Review: Summary and Evaluation.
- 2990 U.S. Fish and Wildlife Service. 2022b. Range-Wide Monitoring of the Mojave Desert Tortoise  
2991 (*Gopherus agassizii*): 2021 Annual Reporting DRAFT.
- 2992 U.S. Fish and Wildlife Service. 2022c. Range-Wide Monitoring of the Mojave Desert Tortoise  
2993 (*Gopherus agassizii*): 2020 Annual Reporting.
- 2994 VanDerWal, J., H. T. Murphy, A. S. Kutt, G. C. Perkins, B. L. Bateman, J. J. Perry, and A. E. Reside.  
2995 2013. Focus on poleward shifts in species' distribution underestimates the fingerprint of climate  
2996 change. *Nature Climate Change* 3:239–243.
- 2997 Vaske, J. J., and M. P. Donnelly. 2007. Public Knowledge and Perceptions of the Desert Tortoise.  
2998 (HDNRU Report No. 81). Report for the National Park Service.
- 2999 Webb, R. H., and S. S. Stielstra. 1979. Sheep grazing effects on Mojave Desert vegetation and  
3000 soils. *Environmental Management* 3:517–529.
- 3001 Weeks, A. R., C. M. Sgro, A. G. Young, R. Frankham, N. J. Mitchell, K. A. Miller, M. Byrne, D. J.  
3002 Coates, M. D. B. Eldridge, P. Sunnucks, M. F. Breed, E. A. James, and A. A. Hoffmann. 2011.  
3003 Assessing the benefits and risks of translocations in changing environments: a genetic  
3004 perspective. *Evolutionary Applications* 4:709–725.
- 3005 Wikipedia. 2023. Military budget of the United States.  
3006 <[https://en.wikipedia.org/wiki/Military\\_budget\\_of\\_the\\_United\\_States](https://en.wikipedia.org/wiki/Military_budget_of_the_United_States)>.
- 3007 Williams, A. P., B. I. Cook, and J. E. Smerdon. 2022. Rapid intensification of the emerging  
3008 southwestern North American megadrought in 2020–2021. *Nature Climate Change* 12:232–  
3009 234.
- 3010 Wolf, A., N. B. Zimmerman, W. R. L. Anderegg, P. E. Busby, and J. Christensen. 2016. Altitudinal  
3011 shifts of the native and introduced flora of California in the context of 20th-century warming.  
3012 *Global Ecology and Biogeography* 25:418–429.
- 3013 Woodbury, A. M., and R. Hardy. 1948. Studies of the Desert Tortoise, *Gopherus agassizii*.  
3014 *Ecological Monographs* 18:145–200.
- 3015

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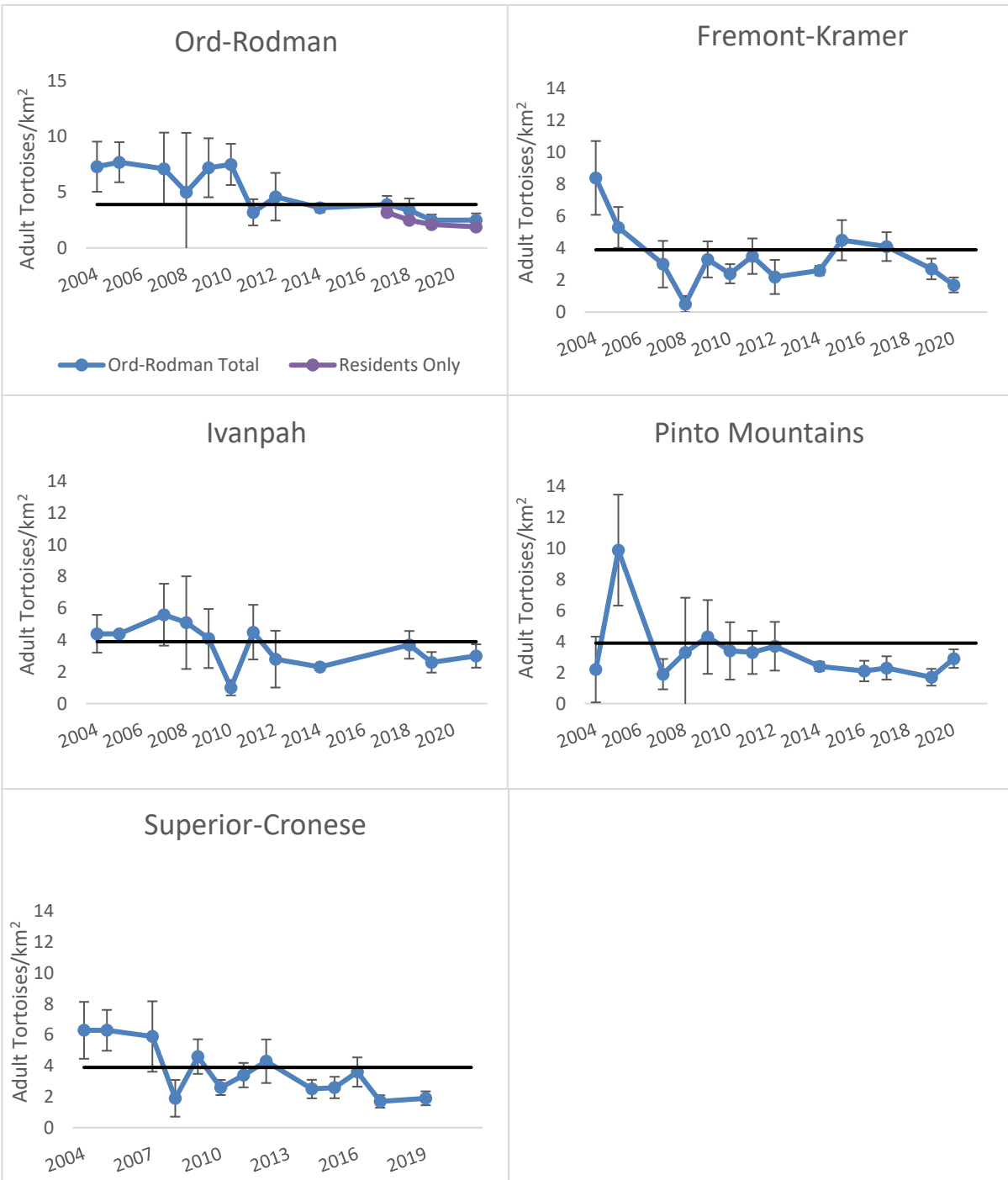
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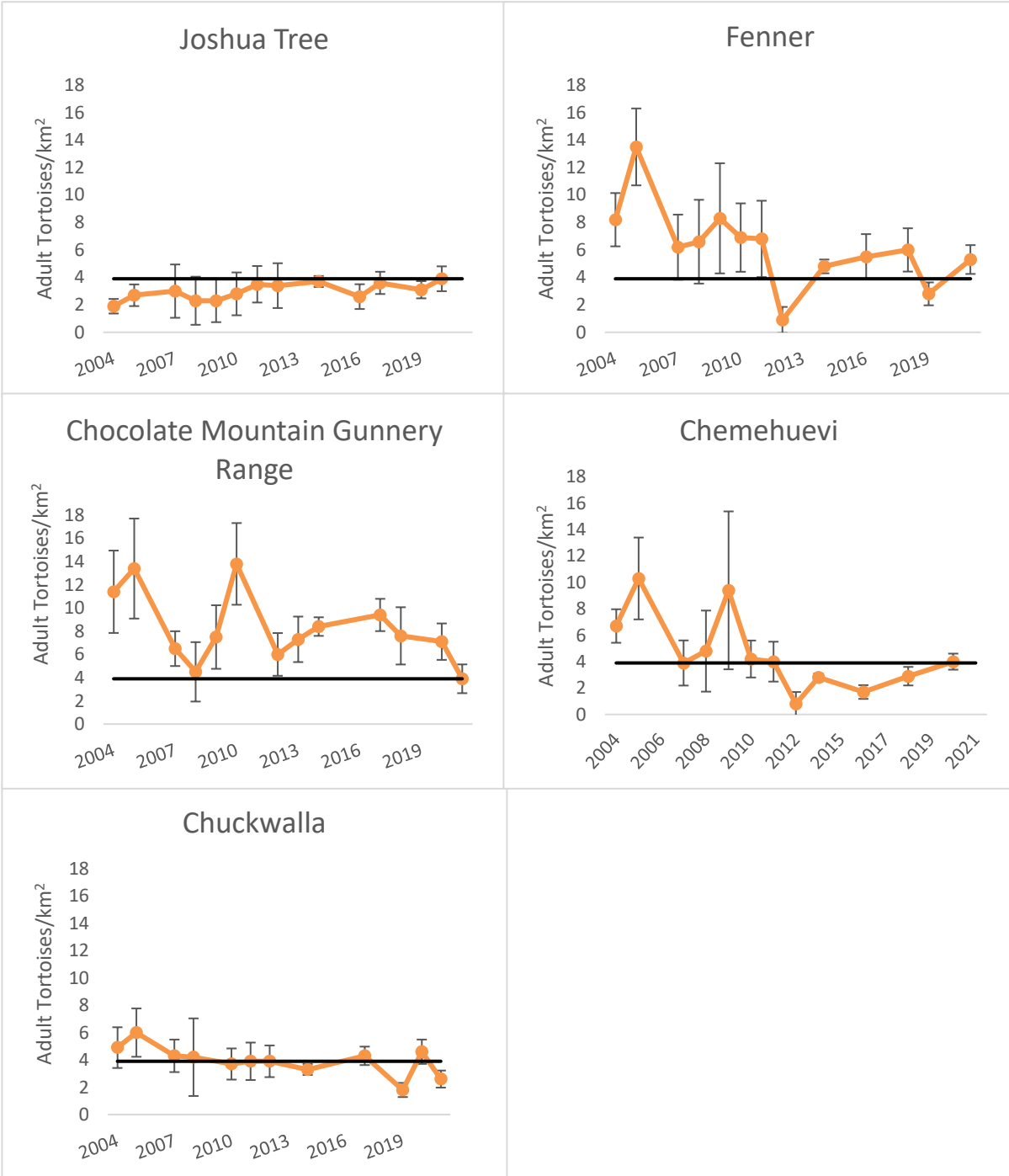
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3040 Appendix Figure 1. Estimated densities of adult tortoises ( $\geq 180$  mm carapace length) in  
 3041 Tortoise Conservation Areas in the Eastern and Western Mojave Recovery Units in California  
 3042 2004–2021. Black horizontal line represents 3.9 adults/km<sup>2</sup>, the estimated minimum density

3043 needed for population viability. 2004–2014 have standard errors (SE), 2015–2021 have  
 3044 coefficients of variation that have been converted to standard errors.

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3046 Appendix A Figure 2. Estimated densities of adult tortoises ( $\geq 180$  mm carapace length) in  
 3047 Tortoise Conservation Areas in the Colorado Desert Recovery Units in California 2004–2021.

3048 Black horizontal line represents 3.9 adults/km<sup>2</sup>, the estimated minimum density needed for  
3049 population viability. 2004–2014 have standard errors (SE), 2015–2021 have coefficients of  
3050 variation that have been converted to standard errors.



3051 Pursuant to Fish and Game Code section 2074.6, the review process included independent and  
3052 competent peer review of the draft status review by persons in the scientific/academic  
3053 community acknowledged to be experts on Mojave Desert Tortoise and related topics, and  
3054 possessing the knowledge and expertise to critique the scientific validity of the status review  
3055 contents. Appendix B contains the specific comments provided to the Department by the  
3056 individual peer reviewers, the Department’s written response to the comments, and any  
3057 amendments made to the status review (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, §  
3058 670.1, subd. (f)(2)). Independent experts that reviewed the status review are listed in Table 1,  
3059 below.

3060 **Table 1. Status Review Peer Reviewers**

Name	Affiliation
Reviewer 1 name	
Reviewer 2 name	
Reviewer 3 name	

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