BEFORE THE CALIFORNIA FISH AND GAME COMMISSION

A Petition to List the Flat-Tailed Horned Lizard (*Phrynosoma mcallii*) as Endangered under the California Endangered Species Act

Photo credit: Jim Rorabaugh/FWS

Notice of Petition

For action pursuant to Section 670.1, Title 14, California Code of Regulations (CCR) and Sections 2072 and 2073 of the Fish and Game Code relating to listing and delisting endangered and threatened species of plants and animals.

I. SPECIES BEING PETITIONED:

Common Name: Flat-Tailed Horned Lizard (*Phrynosoma mcallii*)

II. RECOMMENDED ACTION: List as Endangered

The Center for Biological Diversity submits this petition to list the Flat-Tailed Horned Lizard (*Phrynosoma mcallii*) as endangered throughout their range in California, under the California Endangered Species Act (California Fish and Game Code §§ 2050 et seq., "CESA"). This petition demonstrates that the Flat-Tailed Horned Lizard (*Phrynosoma mcallii*) clearly warrants listing under CESA based on the factors specified in the statute.

III. AUTHOR OF PETITION:

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I hereby certify that, to the best of my knowledge, all statements made in this petition are true and complete.

Signature:

Date: June 9, 2014

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Executive Summary

This petition is submitted to list the flat-tailed horned lizard (*Phrynosoma mcalli*) as endangered under the California Endangered Species Act based on numerous factors documented in detail below. The continued survival of the flat-tailed horned lizard is threatened. This species suffers declines from on-going and future direct destruction of individuals as well as destruction and modification of its habitat from numerous sources. Conversion to agriculture, urban development, energy development and other forms of development are a leading cause of historic, present and future habitat destruction. Both on-road and off-road vehicle activities have caused declines in the past and continue to threaten and directly impact individuals, who are particularly vulnerable to vehicles because their predation avoidance strategy is to freeze in place and blend in with the substrate, making them very difficult to detect. All of these impacts also create fragmentation of the lizard's habitat, which increases negative edge effects, isolates populations and ultimately causes population declines. Barriers to movement prevent genetic connectivity between adjacent populations resulting in small isolated populations sizes that, in turn, result in genetic inbreeding which increases the likelihood of localized population extirpation. Because some of the flat-tailed horned lizard's habitat occurs on military bases in California, training activities directly and indirectly impact flat-tailed horned lizard and its habitat through non-exploding bombing, ground-based training, target maintenance, target site clean-up, road travel and maintenance, mobile target activities, and target and run-in-line grading. U.S. - Mexico border activities include direct impacts to the flat-tailed horned lizard from illegal immigration and narcotics smuggling and Border Patrol law enforcement to control illegal activities through the use of off-road vehicle travel, barrier structures for vehicles and pedestrians, which are barriers for flat-tailed horned lizards, and surveillance cameras, which provide perches for predators.

Predation of flat-tailed horned lizards is increased by constructing structures including fences, transmission lines, towers, and other tall structures that provide additional perching opportunities for avian predators including ravens, loggerhead shrikes, kestrels and others. Urbanization and agriculture subsidize predators such as the round-tailed ground squirrel. Development and roads increase fragmentation of habitat and increases habitat edges which provide greater habitat for flat-tailed horned lizard predators.

While no lizard species directly competes with the flat-tailed horned lizard for resources, key flat-tailed horned lizard resources are being negatively outcompeted by non-native species. Saharan mustard (*Brassica tournefortii*) is permanently altering Aeolian sand habitat and becoming the dominant annual plant throughout the flat-tailed horned lizard's range, outcompeting native plants, compacting soils, and causing decreases in harvester ants which are the primary food for flat-tailed horned lizards. Argentine and other invasive ants invade along the edges of development, outcompeting and displacing native harvester ants upon which the flat-tailed horned lizard rely. Flat-tailed horned lizards will not consume Argentine or other invasive ant species.

To date, overexploitation and diseases have not been documented to cause declines in flat-tailed horned lizards.

Other natural occurrences and human-related activities also negatively affect flat-tailed horned lizard populations. Non-native annual grasses have changed the ecology of the habitat for flat-tailed horned lizards by increasing fires, to which desert habitats are not adapted, ultimately causing type conversion to a plant community type that is unsupportive of flat-tailed horned lizards. Additionally, increased anthropogenic nitrogen deposition has been linked to the spread of invasive grasses and an accelerated fire regime in the Colorado Desert.

Climate change also threatens the flat-tailed horned lizard. Climate models predict that southwestern North America will not only become warmer but also drier over the over the 21st century. Precipitation variability has already increased leading to changes in plant composition which negatively affects flat-tailed horned lizards. With a warming climate, species are predicted to change their ranges to seek refuge at higher latitudes and/or elevations. However, with the fragmentation and barriers to movement that already occur in the lizard's current contracted range, the flat-tailed horned lizard has very limited ability to move its range to escape the worst effects of climate change. In addition, warmer temperatures are likely to cause behavior changes in flat-tailed horned lizards that will require them to spend more time in burrows and less time actively foraging and finding mates which may jeopardize their ability to grow and reproduce successfully. Increasing temperature may shift the flat-tailed horned lizards emergence from hibernation to earlier in the season which coincides with heavier off-road vehicle activities.

The current management efforts are inadequate and do not effectively prevent the on-going declines in flat-tailed horned lizard populations and habitat. The Interagency Conservation Agreement is inadequate because all conservation measures are subject to availability of funding, parties are able to withdraw from the agreement at any time, and agencies are not legally bound to abide by the Rangewide Management Strategy. The Rangewide Management Strategy (RMS) fails to include a sufficient amount of current habitat in protection. It does not sufficiently protect the flat-tail horned lizard inside and outside of the management areas from threats including off-road vehicles and development, failure to secure connectivity between populations, and failure to successfully rehabilitate degraded habitat. Monitoring protocols used under the RMS are inadequate to detect significant changes in flat-tailed horned lizard populations within the management areas and therefore it is impossible to know if the triggers for action under the RMS are met, making it likely they will never be implemented. No monitoring is done outside of the management areas under the RMS. The Coachella Valley Multiple Species Habitat Conservation Plan establishes only two relatively small (<2300 ha each) disjunct conservation areas, of which only the smaller one unequivocally documents flat-tailed horned lizards. Currently, flat-tailed horned lizards can only be collected with a permit under California regulations. BLM has designated the flat-tailed horned lizard as a sensitive species in California and the CDFW considers it a Species of Special Concern. These designations do not provide any specific protections.

Recommendation for Management and Recovery are provided.

Procedural History

The flat-tailed horned lizard (*Phrynosoma mcallii*) ("FTHL") is in need of California Endangered Species Act protection as is shown in this petition. Previous efforts to seek protection for this species under state and federal law are described below.

California

The FTHL is designated as a California Department of Fish and Wildlife Species of Special Concern (SSC). On January 25, 1988, the California Department of Fish and Game (CDFG) and Commission received a petition to list the FTHL as endangered under the California Endangered Species Act. On May 13, 1988, the Commission designated the FTHL as a candidate species for listing, and upon review by the CDFG, the species was recommended for listing as a threatened species. However, on June 22, 1989, the Commission voted against the proposed listing.

Federal

The Bureau of Land Management (BLM) first designated the FTHL as a sensitive species in California in 1980. In its original "Review of Vertebrate Wildlife," in 1982 the United State Fish and Wildlife Service (USFWS) listed the FTHL as a Category 2 candidate species for listing as threatened or endangered under the U.S. Endangered Species Act (ESA)(47 FR 58454). On September 18, 1985, the USFWS retained the FTHL as a Category 2 candidate species (50 FR 37958), but on January 6, 1989, the species was elevated to a Category 1 candidate, indicating there was sufficient information to support a proposed ruling to list the species as threatened or endangered (54 FR 554). After remaining a Category 1 species when evaluated in 1991 (56 FR 58804), the USFWS issued a proposed rule to list the FTHL as threatened under the Act on November 29, 1993 (58 FR 62624).

By 1997, after considerable delays related to the passage of Public Law No. 104-6, 109 Stat. 73 in 1995, no decision was made on the 1993 proposed rule. Defenders of Wildlife and other groups filed suit against the Secretary of the Interior, and on May 16, 1997 the Arizona District Court ordered the USFWS to issue a final decision within 60 days on the 1993 proposed rule. On June 15, 1997, the USFWS issued a notice to withdraw the FTHL proposed listing, stating:

> "Flat-tailed horned lizard population trend data are inadequate to conclude that significant population declines have occurred… Since the publication of the proposed rule to list the flat-tailed horned lizard as threatened, several of the threats identified on public lands have been reduced or eliminated… In addition, the conservation commitment of the agencies has increased with the signing of a [Conservation Agreement] and Management Strategy designed to protect the flat-tailed horned lizard on public lands."(62 FR 37852, 37859-60)

The decision was challenged by Defenders of Wildlife et al. in the District Court of the Southern District of California, which upheld the USFWS decision of withdrawal. Upon appeal, the Ninth Circuit Court of Appeals reversed the District Court's ruling as arbitrary and capricious, stating that the USFWS did not properly consider the threat of extinction throughout a significant portion of the FTHL's range. *Defenders of Wildlife et al. v. Norton*, 258 F.3d 1136 (9th Cir. 2001). As ordered by the District Court, on December 26, 2001 the USFWS reinstated the 1993 proposed rule to list the FTHL under the ESA (66 FR 66384). During this time, multiple state and federal agencies signed a voluntary Interagency Conservation Agreement in 1997 in order to implement the Flat-tailed Horned Lizard Rangewide Management Strategy (FTHLICC 1997).

On January 3, 2003, the USFWS once again withdrew the 1993 proposed rule on the basis that:

> "Much of the species' habitat has been lost, fragmented, or degraded, but available data concerning population abundance, trends, and threats do not indicate that because of this habitat loss and degradation the species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range." (68 FR 331, 348)

The Tucson Herpetological Society, Center for Biological Diversity, Defenders of Wildlife and other groups promptly challenged the 2003 withdrawal arguing that the USFWS did not adequately consider whether a significant portion of the FTHL historical range has been lost. The U.S. District Court for the District of Arizona ordered that the 2003 withdrawal be revoked, prompting the USFWS to vacate the 2003 withdrawal and restore the 1993 proposed rule on December 7, 2005 (70 FR 72776). In 2003, the Interagency Coordinating Committee, established as part of the Interagency Conservation Agreement, published a revised version of the Flat-tailed Horned Lizard Rangewide Management Strategy, which is the current version to date (FTHLICC 2003).

On June 28, 2006, the USFWS again withdrew the 1993 proposed rule based on its conclusion that:

> "The lost habitat is not significant because the species has persisted despite a large amount of habitat loss in the early 20th century, the species remains viable throughout most of its current extant range, and there were no particular attributes of the lost habitat that made it any more significant than any other part of the range." (71 FR 36745, 36751)

On December 11, 2006, Tucson Herpetological Society, et al. filed a supplemental complaint in the Arizona District Court, which ruled in favor of the USFWS decision to withdraw the proposed rule. Upon appeal, the Ninth District Court of Appeals reversed the District Court ruling and set aside the 2006 withdrawal because the USFWS failed to demonstrate that FTHL populations were stable and viable throughout a significant portion of the current range. *Tucson Herpetological Soc'y, et al. v. Salazar*, 566 F.3d 870 (9th Cir. 2009) Once again, on remand the Arizona District Court ordered the USFWS to reinstate the 1993 proposed rule, which was done on March 2, 2010 (75 FR 9377).

On March 15, 2011, the USFWS withdrew the 1993 proposed rule for the fourth time. The 2011 withdrawal decision was made on the basis that:

> "The effects to the species associated with the implied meaning of fragmentation… are not likely to constitute a substantial threat to the species now or within the foreseeable future… the conservation efforts implemented by signatories of the Interagency Conservation Agreement and associated Rangewide Management Strategy reduce the impact of existing threats in the United States and promote actions that benefit the flat-tailed horned lizard throughout its range, including Mexico." (76 FR 14210; 14252-53)

Because there are no protections for this imperiled species under the Federal Endangered Species Act and the current conservation actions are inadequate to protect the species and its habitat in California, petitioners seek to list the FTHL as endangered under California's Endangered Species Act.

The CESA Listing Process and Standard For Acceptance of a Petition

Recognizing that certain species of plants and animals have become extinct "as a consequence of man's activities, untempered by adequate concern for conservation," (Fish & G. Code § 2051 (a)), that other species are in danger of extinction, and that "[t]hese species of fish, wildlife, and plants are of ecological, educational, historical, recreational, esthetic, economic, and scientific value to the people of this state, and the conservation, protection, and enhancement of these species and their habitat is of statewide concern" (Fish & G. Code § 2051 (c)), the California Legislature enacted the California Endangered Species Act ("CESA").

The purpose of CESA is to "conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat...." Fish & G. Code § 2052. To this end, CESA provides for the listing of species as "threatened"[1] and "endangered."[2] The Fish and Game Commission is the administrative body that makes all final decisions as to which species shall be listed under CESA, while the Department of Fish and Wildlife is the expert agency that makes recommendations as to which species warrant listing.

The listing process may be set in motion in two ways: "any person" may petition the Commission to list a species, or the Department may on its own initiative put forward a species for consideration. Fish & Game Code § 2072.7. In the case of a citizen proposal, CESA sets forth a process for listing that contains several discrete steps.

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[1] "Threatened species" means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant 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 this chapter. Fish & G. Code § 2067.

[2] "Endangered species" means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant 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.

Upon receipt of a petition to list a species, a 90-day review period ensues during which the Commission refers the petition to the Department, as the relevant expert agency, to prepare a detailed report. The Department's report must determine whether the petition, along with other relevant information possessed or received by the Department, contains sufficient information indicating that listing may be warranted. Fish & G. Code § 2073.5.

During this period interested persons are notified of the petition and public comments are accepted by the Commission. Fish & G. Code § 2073.3. After receipt of the Department's report, the Commission considers the petition at a public hearing. Fish & G. Code § 2074. At this time the Commission is charged with its first substantive decision: determining whether the petition, together with the Department's written report, and comments and testimony received, present sufficient information to indicate that listing of the species "may be warranted." Fish & G. Code § 2074.2. This standard has been interpreted by courts as the amount of information sufficient to "lead a reasonable person to conclude there is a substantial possibility the requested listing could occur." *Natural Resources Defense Council v. California Fish and Game Comm.* 28 Cal.App.4th at 1125, 1129. If the petition, together with the Department's report and comments received, indicates that listing "may be warranted," then the Commission must accept the petition and designate the species as a "candidate species." Fish & G. Code § 2074.2.

Once the petition is accepted by the Commission, then a more exacting level of review commences. The Department has twelve months from the date of the petition's acceptance to complete a full status review of the species, seek peer review of the draft report, make the final report available to the public for at least 30 days, and recommend whether such listing "is warranted;" the department may seek an extension of up to six months if needed to complete peer review and public review. Fish & Game Code § 2074.6. Following receipt of the Department's status review, the Commission holds an additional public hearing, which may be continued, and determines whether listing of the species "is warranted." Fish & Game Code § 2075.5. If the Commission finds that the species is faced with extinction throughout all or a significant portion of its range, it must list the species as endangered. Fish & G. Code § 2062. If the Commission finds that the species is likely to become an endangered species in the foreseeable future, it must list the species as threatened. Fish & G. Code § 2067.

Notwithstanding these listing procedures, the Commission may adopt a regulation that adds a species to the list of threatened or endangered species at any time if the Commission finds that there is any emergency posing a significant threat to the continued existence of the species. Fish & G. Code § 2076.5.

1.0. Population Status and Trends

The flat-tailed horned lizard (*Phrynosoma mcallii*) is at serious risk of continuing population decline due to habitat destruction associated with human activities. Large areas of suitable FTHL habitat have already been lost to development, especially within the California portion of the species' range (Rado 1981; Turner et al. 1980; Johnson and Spicer 1985; Bolster and Nicol 1989; Hodges 1997; Piest and Knowels 2002; FTHLICC 2003; 76 FR 14210). Although urban and agricultural development has slowed recently (76 FR 14210), threats associated with human activities are still prevalent (Piest and Knowels 2002; Wright 2002; USFWS 2003; McGrann et al. 2006; Lovich and Ennen 2011, 2013). For decades, researchers have warned that habitat loss poses a direct threat to the viability of the FTHL and is expected to cause declines in the population (Turner et al. 1980; Turner and Medica 1982; Johnson and Spicer 1985; Bolster and Nichol 1989; Hodges 1997; Young and Young 2005; Mulcahy et al. 2006; Barrows et al. 2006; Barrows and Allen 2009). Habitat fragmentation and isolation of meta-populations due to human development has long been linked to rapid population declines (Fischer and Lindenmayer 2007). In 1989, the California Department of Fish and Game suggested that the FTHL be listed as a threatened species on the basis that "Without the benefit of listing, most of these [habitat loss and fragmentation] threats will likely continue to be the source, either individually or in combination, of continued declines in FTHL numbers and habitat" (Bolster and Nicol 1989; pg. 44). Ultimately, the species was not listed, but the threats associated habitat loss and fragmentation in California has only intensified since that time.

Despite the serious threats to FTHL viability due to habitat loss and fragmentation, direct monitoring studies, though numerous, have failed to adequately estimate accurate population sizes and trends over time throughout the majority of the species' range. It is difficult to properly estimate population trends with the available data because of un-standardized, and in some cases, inappropriate survey methods (i.e. while scat was and still is frequently used, it is not a reliable indicator of FTHL abundance; Beauchamp et al. 1998). Wright (2002) attempted to analyze trends in FTHL abundance using data collected from monitoring studies conducted between 1979 and 2001. He found no significant trend in the number of lizards detected, indicating that the "lizard population in 2001 was probably not dramatically different from that in 1979" (Wright 2002, pg. 50). However, this conclusion is predicated on the assumption that the data analyzed accurately reflects the relative abundance of FTHLs, which Wright (2002) admits is "tenuous," indicating that the insensitivity of the methodology "may have prevented the detection of real population change" (pg. 50). In fact, even when only the most robust data were used, the analysis was unable to detect a ±30 percent change in the population (Wright 2002).

In an effort to standardize survey methods and obtain more accurate estimates of population trends, several state and federal government agencies developed a uniform monitoring program. This effort was done as part of an Interagency Conservation Agreement that was signed in 1997 and prompted signatories to establish a Flat-tailed Horned Lizard Rangewide Management Strategy (RMS; FTHLICC 2003). More standardized and rigorous monitoring methods have been in place since 2007. The most recent thorough analysis indicates that from 2007-2009, FTHL densities "seemed relatively stable" (Root 2010; pg. 28). The author continues,

> "However, there are no comparable monitoring data prior to 1998 with which to provide historical context. Also, because only 3 years of standardized monitoring have occurred, these data cannot yet provide meaningful long-term trend inference" (Root 2010; pg. 28).

Furthermore, these data were collected from high quality habitat, which is known to contain FTHLs (Root 2010). Thus, these estimates cannot be used to infer population status or trends in lower quality habitats, which comprise the vast majority of FTHL range (Root 2010). The Interagency Coordinating Committee (ICC), which is responsible for the coordination and implementation of the RMS, has failed to provide monitoring data for the majority of locations since 2010 and has yet to fully analyze the most recent data (FTHLICC 2011). Therefore, the currently available information is unable to provide an accurate quantitative assessment of population status or trends.

Due to their cryptic coloration and threat-evasion “freezing” behavior, FTHLs are extremely difficult to detect. FTHLs are generally considered rare lizards (Klauber 1939; Pianka and Parker 1975) and capture is uncommon (Norris 1949). Despite this, there is anecdotal evidence that points to localized population declines across FTHL habitat in California. Within the Coachella Valley, which has experienced the most extensive habitat loss, “occasional sightings of *P. mcallii* have been reduced to zero over the past two decades” (Barrows and Allen 2010, pg. 189-190).

In East Mesa, an area of relatively low human impact, Turner et al. (1980) report:

> “Findings in 1979 paralleled those in 1978 with regard to the relatively low counts in northern portions of East Mesa. Although many *P. mcallii* were collected here in the early 1960s this area apparently no longer supports high densities of this species.” (pg. 2)

Altman et al. (1980) summarize population declines in the Algodones Dunes area:

> “Between February 1961 and October 1964, 502 *P. mcallii* were collected (or found dead) along a 7-mile stretch of Highway 78 between the Coachella and East Highline Canals (Wilbur Mayhew, pers. comm.). In May 1963 Mayhew concluded that *P. mcallii* was the most abundant reptile occurring in the creosote bush scrub between these canals. In 1964, these horned lizards were not as abundant as in previous years, and by the early 1970s numbers of *P. mcalli* along this once well-populated roadway were further reduced.” (pg. 3)

In the 1930s, prior to extensive off-road vehicle use, the Ocotillo Wells area was considered favorable habitat that presumably harbored large numbers of FTHLs, as sighting were “rather common” (Klauber 1939, pg. 95). Today, the area described by Klauber (1939) represents a large portion of the Ocotillo Wells State Vehicle Recreation Area (Turner et al. 1980) and likely supports a small number of FTHLs. In 2007 and 2008, so few lizards were captured (nine in total between three plots), that survey efforts were discontinued (Eric Hollenbeck pers. comm.; FTHLICC 2009). While accurate estimates of population size are difficult to determine, the considerable evidence suggests that FTHLs populations are declining and have done so for years.

2.0. Range and Distribution

<u>2.1. Historic Range</u>

The FTHL was found in appropriate substrates throughout the Sonoran Desert, Coachella Valley, and Salton Trough in California and the Gran Desierto in southwestern Arizona, Baja California and Sonora, Mexico. There has been considerable debate about which areas constitute historic range. While the exact area of FTHL habitat that has been lost to human development is uncertain, it is clear that significant FTHL habitat has been lost. Large-scale agriculture first began in the Salton Trough with the construction of a canal in the beginning of the 20th century that diverted water from the Colorado River into the desert regions. By 1904, approximately 60,700 ha of land were in active cultivation throughout the Salton Trough. Due to the poor construction of the canal and flooding of the Colorado River, by 1907 the modern day Salton Sea was created, covering over 121,000 ha of land. Agricultural development intensified and proliferated throughout much of the 20th century including in the Coachella Valley in California and along the Colorado River in southwestern Arizona. In order to accommodate the expanding agriculture in the region, urban development also increased. (For a thorough description of the history of agricultural development in the region, *see* 76 FR 14210, 14214.)

Since large-scale development began in the early 1900s, prior to any monitoring studies, it is difficult to determine which areas were historically occupied by FTHLs. Hodges (1997) estimated that approximately 51 percent of FTHL habitat in the United States has been destroyed by development. She estimated that at one time California contained over 890,000 ha of suitable FTHL habitat, but by 1997, nearly 51, 58, and 8.6 percent of that habitat had been lost in Imperial, Riverside, and San Diego Counties, respectively (Hodges 1997). Urban development has been the largest factor in habitat loss in the Coachella Valley, as an estimated 83-92 percent of suitable habitat has been lost, leaving only 1,083-5,827 ha of available habitat (FTHLICC 2003). Others have also reported large losses of geographic range due to human activities (Turner et al. 1980; Johnson and Spicer 1985; Bolster and Nicol 1989; Piest and Knowels 2002).

Hodges (1997) concluded that over 333,000 ha of California habitat had been lost to agricultural development and the flooding of the Salton Sea. Extensive agricultural development and the Salton Sea in the Imperial Valley bisects current FTHL habitat in Imperial County; however, this study was done without the benefit of genetic data, which recently, has cast some doubt on these previous estimates of historic habitat. Using mitochondrial markers, Mulcahy et al. (2006) determined that the FTHL is separated into multiple distinct populations and demonstrated that the populations east and west of the agricultural development within the Imperial Valley were isolated centuries ago. These data suggest that much of the Imperial Valley was not frequently suitable FTHL habitat even prior to human development (Mulcahy et al. 2006). The hydrological history of the region also supports the conclusion that portions of the Salton Trough did not historically support habitat suitable for FTHLs (*see* 76 FR 14210, 14211-14212 for a detailed account of the geologic history).

In their most recent assessment, the USFWS concluded that historic habitat for the FTHL only includes: "1) habitat outside the area of the former Lake Cahuilla and 2) the habitat outside the areas historically subject to periodic flooding by the Colorado River" (76 FR 14210, 14258). The USFWS did not attempt to quantify the amount of historic habitat that has been lost. For several reasons, the USFWS's assessment of areas that encompassed historic habitat appears to be a notable underestimate. First, according to Figure 1a, prepared by the USFWS, the 39' contour of the former Lake Cahuilla lakebed--which USFWS concluded does not constitute historic habitat--encompasses areas that are considered current FTHL range, including established populations in both the West Mesa and the Ocotillo Wells State Vehicle Recreation Area (OWSVRA). Second, historic records of FTHL were documented in several areas throughout the presently developed Imperial Valley indicating that FTHL used these habitat areas (Figure 1b; Klauber 1939; Turner et al. 1980). Turner et al. (1980) indicate that FTHLs are generally seen less frequently on land below the 40 foot Lake Cahuilla shoreline, perhaps due to less sandy soil characteristics. However, even with this knowledge and a wide array of literature discussing the geologic history of the region, Hodges (1997) still chose to include the former Lake Cahuilla lakebed as historic habitat due to the presence of numerous historic records in the region. Finally, while the Mulcahy et al. (2006) study suggests that genetic connectively across the Imperial Valley is severely limited, the study does not preclude infrequent gene flow and movement of lizards across this area. Therefore, while much of the former Lake Cahuilla lakebed likely did not contain high quality FTHL habitat, it is inaccurate to exclude the *entire* former lakebed as historic habitat.

Most urban and agricultural development has stalled throughout much of the California portion of the current range. Urban development that is occurring is mostly on old farmland that has not been suitable FTHL habitat for decades (76 FR 14210). Habitat restoration efforts may allow formerly unsuitable habitat to support viable populations of FTHLs, although we are unaware of any such efforts. Agricultural expansion in current FTHL range is limited by water availability, and is not expected to proliferate in the foreseeable future (76 FR 14210). However, FTHL habitat has recently been lost to energy development projects and associated transmission lines, route proliferation, and other localized development projects as discussed below (see Factors Affecting Ability to Survive and Reproduce).

2.2. Current Range

The FTHL has the smallest range of any horned lizard in the United States and has among the smallest ranges of all horned lizards (Leache and McGuire 2006), which leaves the species at greater risk of extinction (Purvis et al. 2000). They are restricted to portions of southeastern California, the extreme southwestern portion of Arizona, and the adjacent portions of northeastern Baja California Norte and northwestern Sonora, Mexico (Figure 1b; Funk 1981). Within California, FTHLs are found throughout much of the Salton Trough, in sections of eastern San Diego County, central Riverside County, and western and south-central Imperial County. FTHLs are confined to lower elevations and are most frequently found below 230 m in elevation, although they have been reported up to 520 m above sea level (Turner et al. 1980).

According to a USFWS assessment, the current range of FTHLs is 1,588,942 ha in both Mexico and the U.S. (Table 1). Only 470,848 ha are within the U.S., of which 402,926 ha are in California (76 FR 14210). While agricultural and urban development has not increased appreciably throughout FTHL range recently (with the exception of the Coachella Valley; 76 FR 14210), current habitat is still being lost to large-scale energy projects and route proliferation (see Factors Affecting Ability to Survive and Reproduce).

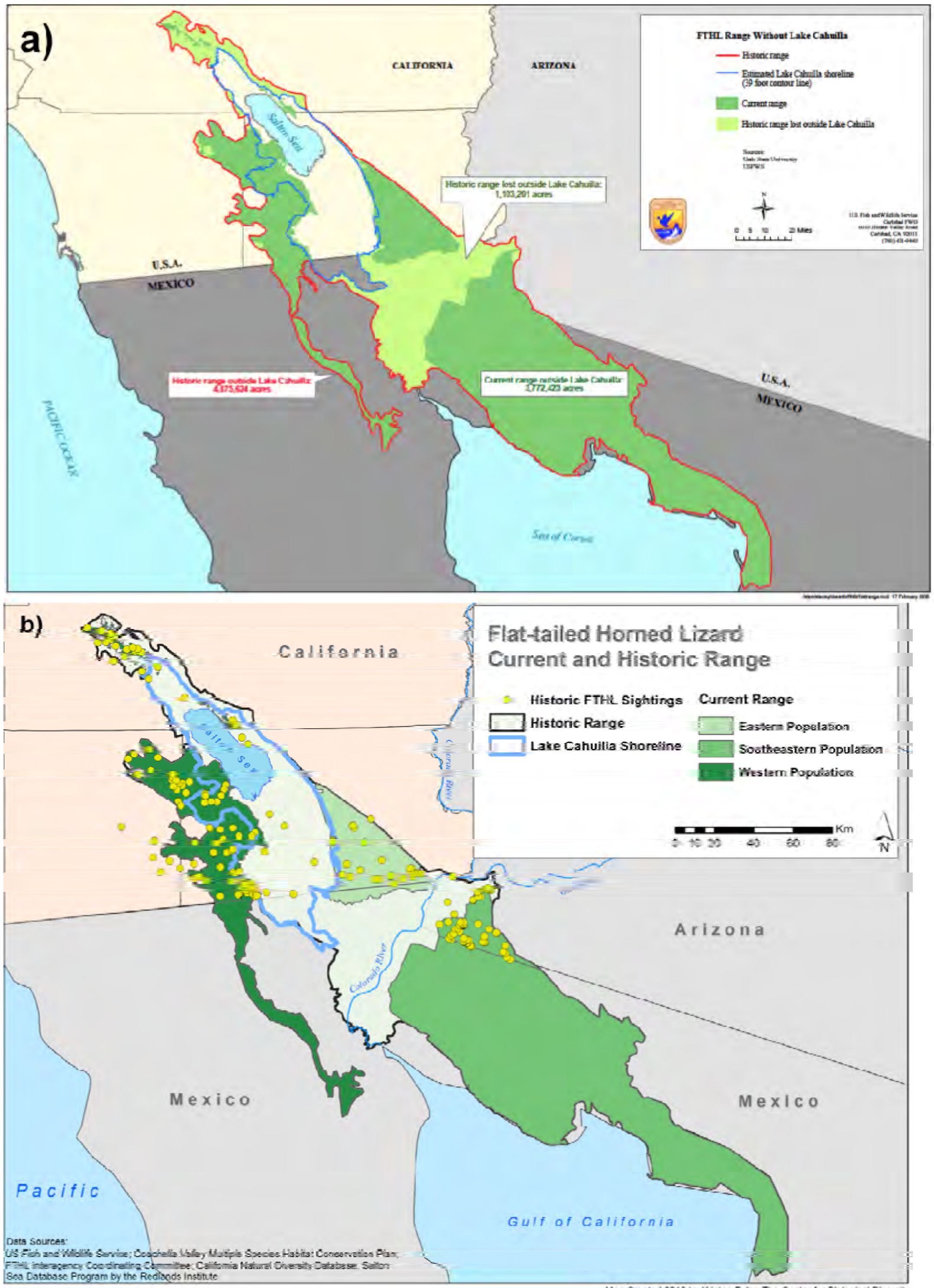

Figure 1. Flat-tailed horned lizard assessments of historic habitat. a) USFWS estimate of historic range excluding the 39-foot contour of the former Lake Cahuilla (blue line); USFWS February 17, 2006 b) FTHL historic and current habitat based on historic FTHL sightings (yellow dots) and USFWS' estimate of historic and current range. It also denotes the three genetically distinct FTHL populations.

2.2.1. Distinct Populations Segments within FTHL Current Range

There are significant barriers to gene flow that have divided the current FTHL range into at least three phylogenetically distinct populations—Western, Eastern, and Southeastern--two of which occupy portions of California (Figures 1b and 2; Table 1; Mulcahy et al. 2006). The Western population is located west of the Imperial Valley, along the western shore of the southern Salton Sea, and extends south into Baja California, Mexico (Mulcahy et al. 2006). Although genetic connectivity is likely now severed, the Coachella Valley is not significantly differentiated from the Western population (Mulcahy et al. 2006). The Eastern population is located east of the Imperial Valley predominantly in California, although the population extends across the border into Mexico (Mulcahy et al. 2006). Geographically, the largest population is the Southeastern population, of which nearly 93 percent is in Sonora, Mexico (Mulcahy et al. 2006). The remainder of the Southeastern population's range is in Arizona. The USFWS considers all three populations to be distinct population segments, each representing a significant portion of the FTHL range (76 FR 14210). Even though each population covers a large area of land, Mulcahy et al. (2006) stress that, "many areas that *P. mcallii* inhabits are now isolated from one another, as this species occupies a specific microhabitat that is now patchily distributed throughout its range" (pg. 2).

Phylogenetic analysis reveals two major clades east and west of the Colorado River (Mulcahy et al. 2006). The clade to the east (i.e. the Southeastern population) is believed to be the ancestral population that expanded west, most likely through allopatric fragmentation during the Pleistocene river avulsions (Mulcahy et al. 2006). However, since then the Colorado River has acted as a nearly complete barrier to gene flow, resulting in significant genetic differentiation between the east and west clades (Mulcahy et al. 2006). The western clade (i.e the Eastern and Western populations and the Coachella Valley to the north) is predominantly in California and shows signs of genetic differentiation among regions. The Eastern and Western Populations, now separated by urban and agricultural development in the Imperial Valley, are significantly differentiated genetically; however, as discussed in the Historic Range section above, gene flow was limited prior to any human development (Mulcahy et al. 2006). While the Imperial Valley has long acted as a barrier to gene flow, it is not as significant a barrier as the Colorado River.
The Coachella Valley population to the north is not significantly genetically differentiated from the Western population, although unique haplotypes were recovered (Mulcahy et al. 2006). More specifically:

> "The nonsignificant differentiation between North and West suggests that populations west of the Imperial Valley have had more recent gene flow between each other than with populations across the valley. Until recent human development around the Salton Sea, these populations may have been continuous along the western edge of ancient Lake Cahuilla." (Malcahy et al. 2006; pg. 15)

No genetic analyses have been conducted with lizards from the Dos Palmas area, but the geographic isolation of this population suggests there has been limited gene flow since human development began in the early 20th century (for more information about the Coachella Valley population see below). Given the strong genetic divergence between populations east and west of the Colorado River, Mulcahy et al. (2006) suggest that while FTHL within the Southeastern population are not necessarily evolutionarily significant units, they should be regarded as a distinct management unit.

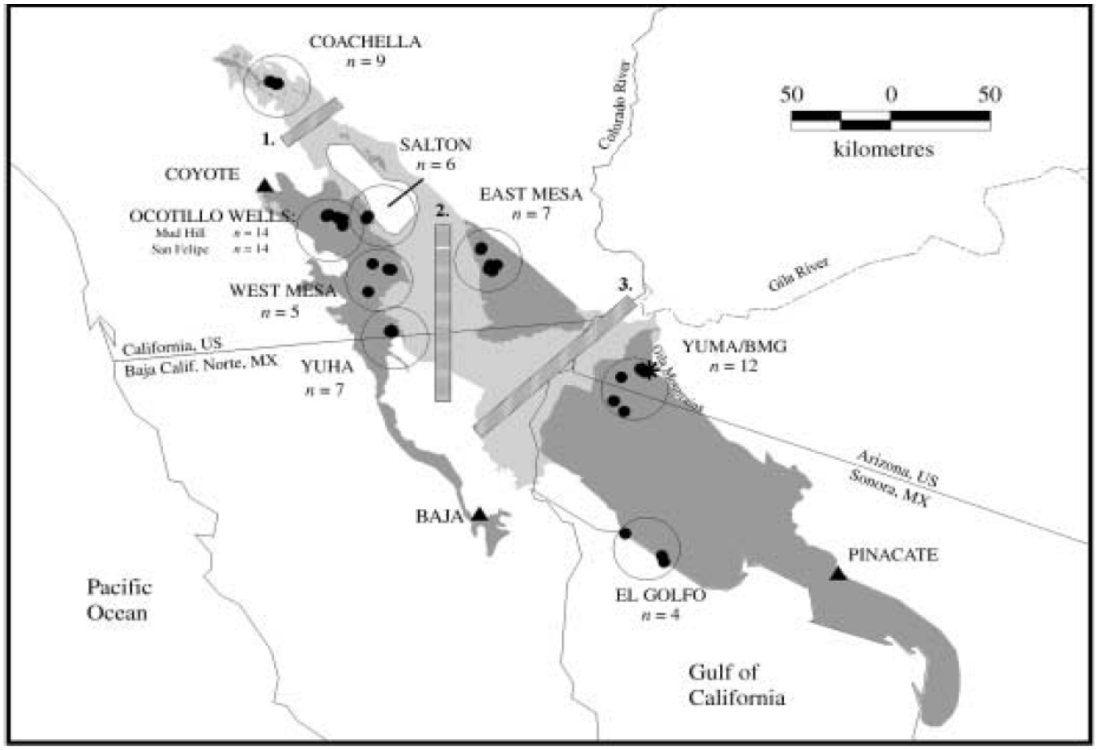

Figure 2. The geographic distribution of *Phrynosoma mcallii*: pale grey indicates historical distribution; dark grey indicates estimated current distribution. Open circles, with name and sample sizes, indicate populations sampled; black dots represent actual specimen localities, the star represents the contact zone where morphological intermediates are found in Yuma, Arizona. Triangles represent the single-sample localities. The three bars indicate current discontinuities (breaks) in the distribution of P. mcallii that were tested for levels of gene flow: (1) Salton Sink; (2) Imperial Valley; (3) Colorado River. Figure and caption from Mulcahy et al. 2006.

The majority of the current range is in Mexico, and only 30 percent of available habitat is in the U.S. (Table 1). Of the available habitat currently present in the U.S., over 85 percent is in California. When one considers only those populations that have a portion of their range in California (i.e. the Eastern and Western Populations), nearly 78 percent of FTHL current habitat is located within California. Further, 74 and 86 percent of the Western and Eastern populations are in California, respectively. Therefore, given that the Southeastern population should be considered a distinct management unit due to its genetic differentiation, and that the vast majority of the current FTHL range west of the Colorado River is within California, the California Fish and Game Department should take special precautions to protect the FTHL under the California Endangered Species Act.

2.2.2. Current FTHL Range in the Coachella Valley

Suitable habitat has been severely reduced throughout the Coachella Valley in Riverside County. The Thousand Palms Conservation Area is currently the only region with a confirmed population of FTHLs (CVMSHCP 2005, 2007; CVCC 2013b). Recently, the Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP) was adopted in order to allow for development while protecting the rare and endangered species and their habitat in the Coachella Valley. The FTHL is a covered species under the CVMSHCP (see Impacts of Existing Management Efforts for details). In an effort to identify and establish Conservation Areas for the FTHL, the CVMSHCP developed a habitat model capable of identifying potentially suitable habitat (CVMSHCP 2007). The results of this model are shown in Figure 3, and represent the full extent of current habitat capable of supporting FTHLs, although most of this area is not known to support FTHLs currently. The model estimates areas of *predicted habitat*, which includes areas where the presence of the lizards is either known or expected based on recent observations, and areas of *potential habitat*, or areas where historic sighting have been recorded but no recent observations have been documented (CVMSHCP 2007).

While there is considerable area that is classified as predicted habitat by the model (Figure 3), recent surveys indicate that there may only be one viable FTHL population remaining in the Coachella Valley. Despite surveying efforts throughout the region, lizards have only been observed in the southern portion of the Thousand Palms Conservation Area, although lizards are expected to be present in Dos Palmas Conservation Area as well (CVMSHCP 2005; Barrows et al. 2008; CVCC 2013b). The most recent monitoring report for the CVMSHCP indicates that FTHLs have become locally extinct in all surveyed areas outside of Thousand Palms, including parts of the Whitewater Floodplain, Edom Hill, and East Indio Hills Conservation Areas, all of which supported FTHLs as recently as the 1980s and 1990s (CVCC 2013b). Areas of predicted habitat outside of the CVMSHCP boundaries also previously supported FTHLs as recently as the 1990s, although no recent sightings have been recorded (Figure 3). Currently, there are only 1,678 ha of land that has been identified as "core habitat" capable of supporting a viable, long-term population of FTHLs (CVMSHCP 2007). Nearly all (1,639 ha) of that core habitat is protected under the CVMSHCP in the Thousand Palms Conservation Area (CVMSHCP 2007). The Dos Palmas Conservation Area is expected to contain suitable habitat capable of supporting a viable population of FTHLs, but more survey effort is needed in this region.

Table 1. Area (in hectares) of the three genetic populations of flat-tailed horned lizard as of 2011. The area and the percentage of the entire range and the US range only that are currently managed as conservation areas under the Interagency Conservation Agreement is also provided. The area of each population was calculated by the US Fish and Wildlife Service (76 FR 14210).

	Entire Range	**Mexico Range**	**US Range**			**Percent of Entire Range Managed**	**Percent of US Range Managed**
			US	**CA**	**AZ**		
Western Population	**341,989**	**88,969**	**253,020**	✓		**28.3**	**38.3**
Eastern Population	**169,617**	**23,496**	**146,121**	✓		**27.6**	**32.0**
Southeastern Population	**1,073,551**	**1,005,629**	**67,922**		✓	**4.9**	**78.1**
Total Area by Region	**1,585,157**	**1,118,094**	**467,063**	399,141	67,922		
Percent Area by Region		**70.5**	**29.5**	85.5	14.5	**12.5**	**42.2**
Percent Area excluding Southeastern Population*		**21.9**	**78.1**				

* The Southeastern Population has no range in California. The percentages given are the amount of FTHL range in the United States, of those populations that have at least a portion of their range in California.

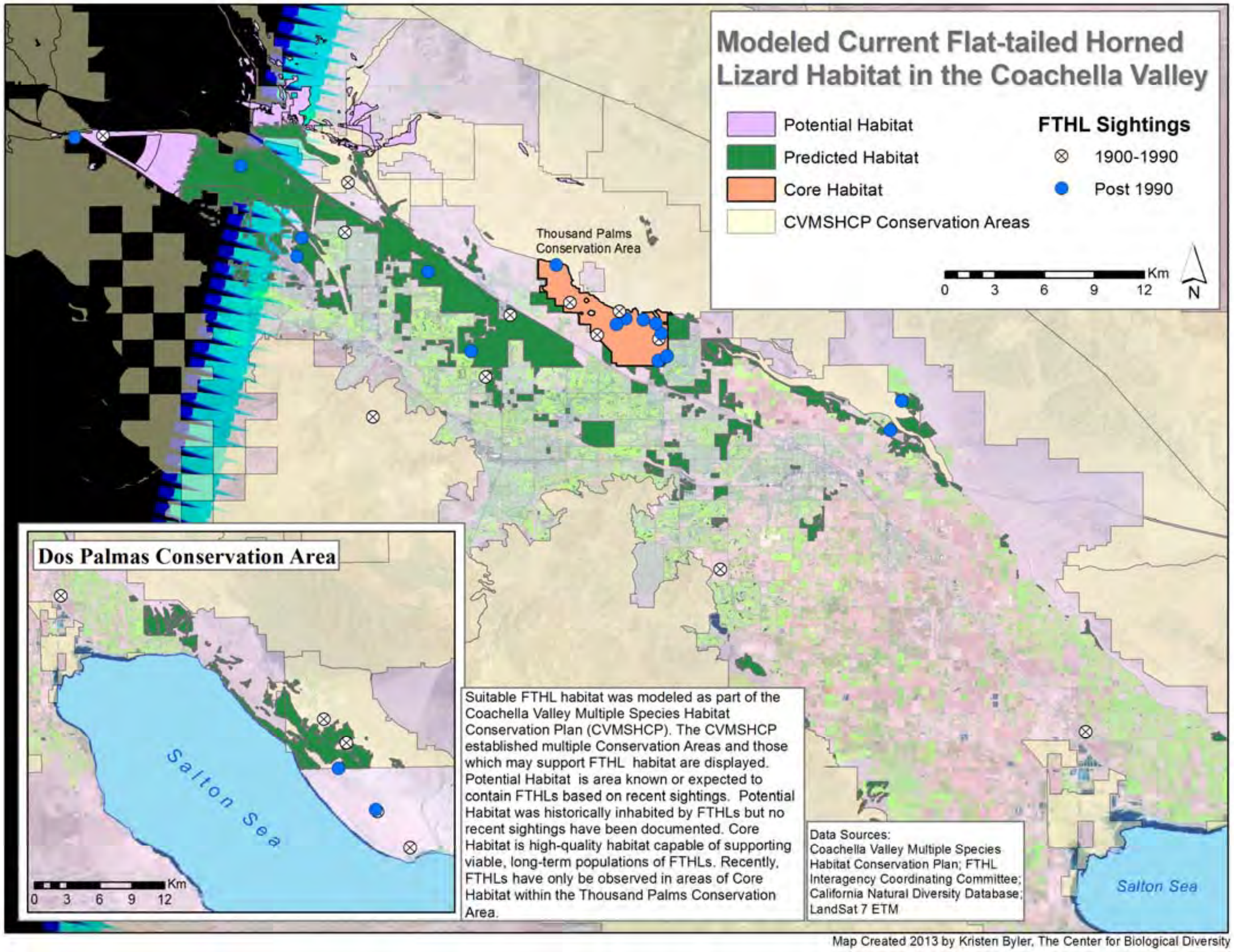

Figure 3. Suitable habitat for flat-tailed horned lizards in the Coachella Valley based on results from a habitat model. Lizards are likely not currently present throughout this entire range.

3.0. Abundance

Accurate estimates of species abundance are lacking for the FTHL. While over 40 monitoring reports have been published over the last 30 years, it is still unclear how many FTHLs are present and to what extent population densities have changed. Low detection rates coupled with un-standardized survey and analysis methods makes it difficult to compare estimates. Inferences can be made from the available data, but must be treated with caution, as all analyses for this species are associated with high levels of uncertainly and many large assumptions.

3.1. Difficulty in Detecting FTHLs

The cryptic coloration and behavior of FTHLs makes it very difficult for even skilled observers to detect the species. The ability to detect FTHLs varies considerably with the experience level of the surveyor and the habitat type being searched (Young and Young 2000; Grant and Doherty 2007). Researchers have explored various techniques to improve detection probability (Wone et al. 1994; Young and Young 2000; Young et al. 2004), but no single method has proved effective in all situations. For instance, driving surveys (Young and Young 2000; Altman et al. 1980; Rorabaugh 1996; Gardner and Foley 2001) and tracking lizard marks left in sand (Young and Young 2000) have both proven effective at increasing detection rates, but they are dependent on the presence of paved roads and sand, which is highly variable across FTHL range. Young and Young (2000) tried using traps, setting up artificial feeding stations to attract lizards, closely monitoring burrows, and even using search dogs, but all of these techniques have proven ineffective at increasing detection probability (Young and Young 2000). Simple walking surveys, in which observers attempt to visually detect lizards as they walk transects, is the most common survey method because it is easily standardized and relatively inexpensive. However, observers will often not detect lizards even if they are present. As an example, Young and Young (2000) released six lizards with radio-transmitters at a single location in the evening. The following morning, four trained observers returned to the release point and searched the surrounding area on foot for over one hour, but were unable to find any lizards. Directly following the walking survey, they used the telemetry equipment and rapidly found all six lizards within the area that had been previously searched (Young and Young 2000). Consequently, lizards may be present but will often escape detection. It is clear that more searching effort results in greater detection of FTHLs (Root 2010), but effort is often limited by monetary and personnel resources.

3.2. Early Monitoring Efforts

In an effort to determine the status of the FTHL, the Bureau of Land Management (BLM) began monitoring the species in 1978 (Wright 2002). Since then, extensive survey efforts have also been conducted by other government agencies, in conjunction with proposed development projects, and through academic research. In part due to the difficulties associated with finding FTHLs, prior to the 1990s most studies estimated the relative abundance of lizards based on their scat. Observers would walk transects for a specified amount of time, looking for lizards, but primarily focusing their efforts on the detection of scat. Survey methods varied considerably, but most studies attempted to standardize abundance estimates by reporting the number of scats recorded per hour of observer effort, and when available, the number of FTHLs per hour of effort. Table 2 compares relative abundance estimates for studies that focused on scat detection.

While it is useful to compare estimates spatially and temporally, these estimates should be viewed with extreme caution. Records that actually count the number of FTHLs observed per hour of effort are the most useful estimates because they represent confirmed sightings; however, because FTHLs are so difficult to detect, these estimates are often based on very few lizards and likely do not accurately reflect the true density of FTHLs (Muth and Fisher 1992). In fact, in many surveys, despite many hours of effort searching for lizard signs in quality habitat, no actual lizards were observed (Rorabaugh 1984; Olech 1987). Moreover, Wone et al. (1994) revealed that when surveyors concentrate on finding scat, they invariably find fewer FTHLs.

More importantly, these data should be reviewed cautiously because scat has proven to be an unreliable method for approximating FTHL abundance. Many studies have shown no statistical correlation between scat and FTHL abundance, indicating factors other than lizard abundance influence the amount of scat detected in surveys (Turner and Medica 1982; Rorabaugh et al. 1987; Muth and Fisher 1992; Rorabaugh 1994; Beauchamp et al. 1998; Young and Young 2000; Wright 2002). FTHL scat is primarily composed of ant remnants, and thus is morphologically distinct from scat that contains fewer ants (Muth and Fisher 1992). Early studies assumed that most sympatric lizard species did not consume the same volume of ants and thus FTHL scat would not be confused with scat from other species. However, Muth and Fisher (1992) found that both the fringe-toed lizard (*Uma notata*) and the whiptail (*Callisaurus draconoides*) can produce scat with high ant content under certain conditions. Therefore, in 1992, it was established that only scat greater than 5.5 mm in diameter (the minimum size of adult FTHL scat) should be counted in order to eliminate most, but not all, scat associated with other species (Muth and Fisher 1992). Long-term BLM monitoring studies changed their protocol in 1993, stipulating that only scat greater than 5.5 mm in diameter should be counted; this protocol change resulted in a 19 percent reduction in the amount of scat detected per hour (Wright 2002). Additionally, FTHL scat is indistinguishable from desert horned lizard scat (*Phrynosoma platyrhinos*), which can confound results in areas of sympatry (Young and Young 2000; Root 2010). While stipulating a minimum size for FTHL scat is useful, climatic conditions can influence FTHL scat size. For instance, during drought years, FTHL produce fewer and smaller scat (Young and Young 2000).

Variability in scat persistence also complicates the relationship between scat and FTHL abundance. Scat can persist on the surface of the ground for weeks and once buried, can last well over 100 days (Muth and Fisher 1992; Rorabaugh 1994; Beauchamp et al. 1998). Scat counts are unreliable because it is impossible to visually distinguish between multiple scats left by a single individual over multiple days and multiple lizards each leaving a single scat (Beauchamp et al. 1998). Scat abundance is also influenced by observer and substrate bias, as some observers are more adept at detecting scat (Rorabaugh 1994) and because scat is generally easier to see on sandy versus gravely substrates (Beauchamp et al. 1998). Finally, scat counts tend to peak in May and June, but then decline steady to near zero by the fall; this is contrary to the presumed population dynamics of the FTHL because in years where juveniles hatch in July, juveniles would be large enough to produce adult scat by October, which should increase scat counts (Rorabaugh 1994).

Table 2. Estimates of abundance based on scat and lizard observation surveys. Surveys were conducting using various methods but were standardized in terms of the number of scat or lizards found per hour of survey effort.

Reference	Location	Survey Year	Mean Scat/Hr	Mean Lizards/Hr
Wright 2002	East Mesa	1979-2001	11.77	0.08
Rorabaugh 1984	East Mesa	1984	0.79	-
McCalvin 1993	East Mesa	1993	2.07	
Wright 2002	West Mesa	1979-2001	6.99	0.07
Olech 1987	West Mesa	1985	24.67	
Olech 1987	West Mesa	1987	8	
Wright 2002	Yuha Desert	1979-2001	8.17	0.11
Olech 1984	Yuha Desert	1984	13.9	0.06
Olech 1986	Yuha Desert	1985	9.29	0.08
Olech 1986	Yuha Desert	1986	11.2	0.04
Olech 1987	Superstition Mountain	1987	8.06	0.68
Wone et al. 1991	OWSVRA	1991	2.2	0.08
Rorabaugh 1996	Salton Sea Test Base	1996	0.8	0.1
Klinger et al. 1990	Algodones Dunes	1990	1.7	0
Turner & Medica 1982	Multiple (CA)	1979	4.8	0.09
Turner & Medica 1982	Multiple (CA)	1980	1.08	0.04
Altman et al. 1980	Multiple (CA)	1980	1.08	0.09
Turner et al. 1980	Multiple (CA)	1979	4.8	0.09
Wright 1993	Multiple (CA)	1993	6.24	0.12

Clearly factors other than FTHL density influence scat counts. Still, some have found a positive correlation between scat and FTHL abundance and suggest that scat may be a useful metric to detect gross population changes (Young and Young 2000; Wright 2002; Wright and Grant 2003; Root 2010). Scat offers the advantage of statistical power as sample sizes are always larger when compared to studies that focus solely on lizard occurrence (Wright 2002; Root 2010). While scat cannot be reliably used as a method to determine whether an area is permanently *occupied* by a FTHL, it can serve as an indication that the area was at least *used* by a FTHL, even if the lizard only temporarily passed through the area (Root 2010). Some argue that dramatic and sustained decreases in scat abundance may act as a rough indicator of population decline (Wright 2002), while others suggest that scat cannot detect population declines (Young and Young 2000). It is likely more appropriate to recognize that scat can only be used to indicate lizard presence, but not necessarily abundance, and that low scat counts should not be interpreted as indicating low FTHL density (Beauchamp et al. 1998; Young and Young 2000).

In sum, even if there is a significant relationship between scat and lizard abundance, which has not been established, there are too many confounding variables that also simultaneously influence scat counts (Rorabaugh 1994). Therefore, scat is not a reliable method. Despite this knowledge, many recent survey efforts still rely on scat, including standard survey protocols established by the Flat-tailed Horned Lizard Rangewide Management Strategy (Wright and Grant 2001; NRA, Inc. 2010; Root 2010; FTHLICC 2003). Not only are these data problematic, but effort devoted to finding scat reduces detection of actual FTHLs, which is a far more reliable metric (Wone et al. 1994).

<u>3.3. Recent Monitoring Efforts- Implementation of the FTHL Rangewide Management Strategy</u>

With the Interagency Conservation Agreement in 1997 and the implementation of the Flat-tailed Horned Lizard Rangewide Management Strategy (RMS), signatory agencies recognized the need to establish standardized monitoring techniques capable of detecting regional population trends. The RMS designated five Management Areas (MAs) and one Research Area, which have served as the focal locations for all monitoring (Figure 4). Initial efforts focused on mark-recapture surveys based on protocols established by Wright and Grant (2003) and Grant and Doherty (2007). These studies were based on closed mark-recapture survey efforts conducted on 12 four-hectare plots that were randomly distributed throughout each of three MAs: East Mesa MA, West Mesa MA, and Yuha Desert MA. By incorporating detection probability into the analysis, relatively robust estimates of abundance were generated (Grant and Doherty 2007). Table 3 summarizes the results from these surveys including density and population size estimates. It should be noted, that population size estimates were extrapolated based on data collected from 12 plots, which only represented 48 total hectares per MA. Therefore, population estimates likely exaggerate actual population sizes, especially for the Yuha Basin in 2004 (Grant and Doherty 2007). Extrapolation also assumes that the entire MA contains suitable habitat to support FTHLs (although the authors corrected for substrate differences and assigned a random sample) and does not take into account potential areas of low density due to habitat disturbance.

In 2007, the Interagency Coordinating Committee (ICC) decided to alter the monitoring protocol, indicating that the confidence intervals yielded from previous mark-recapture surveys were too wide (FTHLICC 2007). By 2008, the ICC established two new monitoring protocols that, with some alterations, have been followed since (FTHLICC 2008, 2011):

> 1) **Occupancy surveys**- These surveys were designed to signal dramatic changes in the population status of FTHLs within MAs by addressing whether their distribution is stable, increasing, or decreasing over time. Surveys consist of small plots (4 ha) distributed throughout an entire MA that are monitored at a coarse scale for the presence or absence of FTHLs and scat. Occupancy surveys are to be conducted in each MA every three years (FTHLICC 2010; Root 2010).
>
> 2) **Demographic surveys**- In order to gain a deeper understanding of population dynamics, permanent demographic plots were established to better assess FTHL abundance, density, survivorship, and recruitment. Each MA is to contain one or two 9-ha demographic plots that are thoroughly surveyed each year using a mark-recapture technique. In order to increase FTHL detection, plots were *not* randomly selected and were placed in high-quality habitat known or suspected to contain greater FTHL densities (FTHLICC 2010; Root 2010).

Occupancy and demographic surveys conducted between 2006 and 2009 were analyzed in order to provide rough estimates of FTHL abundance and density (Root 2010). In the 2011 withdrawal of the proposed rule to list the FTHL, the USFWS estimates were derived from this analysis. It is therefore prudent to discuss the results and deficiencies of these occupancy and demographic data here, as the manner in which Root's density estimates were applied to the 2011 withdrawal yielded erroneous and misleading abundance estimates.

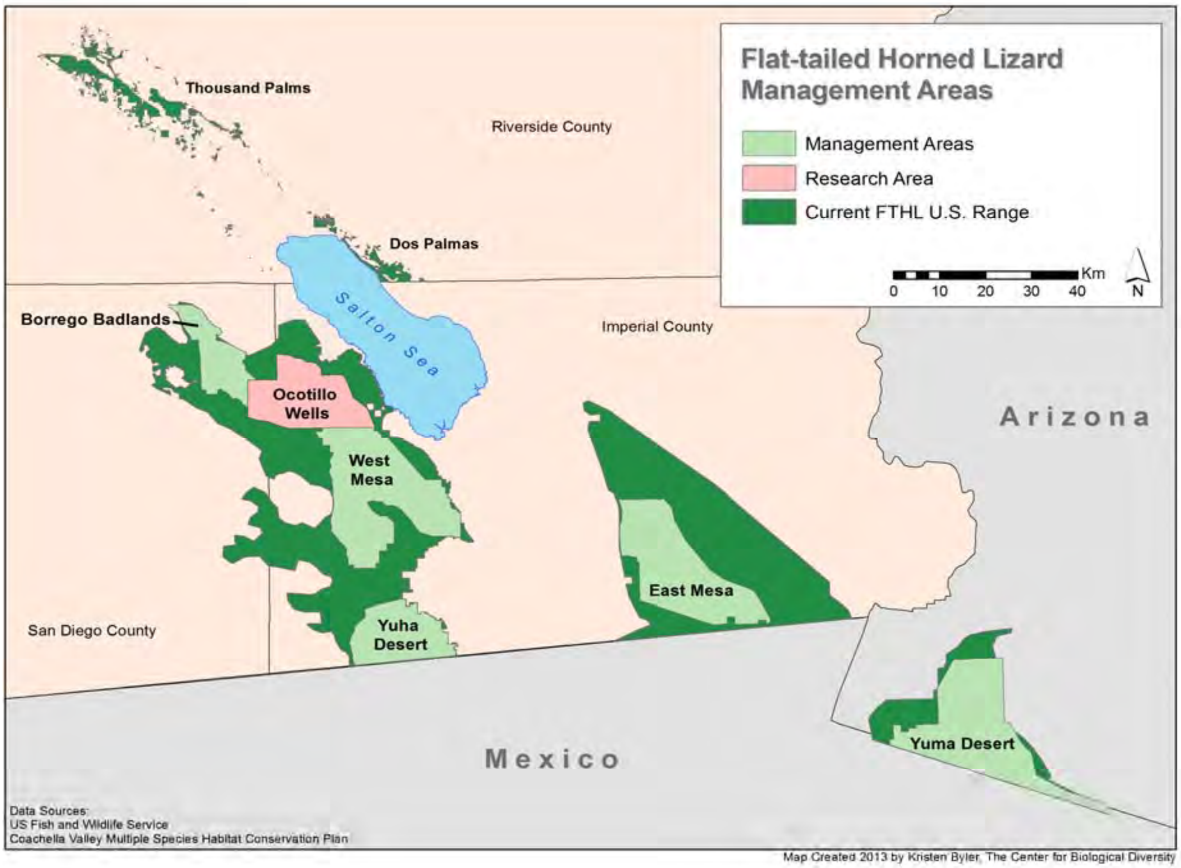

Figure 4. Flat-tailed Horned Lizard Management and Research Areas. The Mexican portion of the species range is not shown. The exact extent of the current range in the Coachella Valley is unknown, but estimates are given according to the boundaries of the Thousand Palms, East Indio Hills, and Dos Palmas Conservation Area, each of which either contain or are suspected to contain FTHLs.

Table 3. Flat-tailed horned lizard density (in individuals per hectare) and population size estimates for three Management Areas (MAs). Population estimates were extrapolated based on the area of the MA and density estimates gathered through mark-recapture surveys. 95% confidence intervals are given (LCL- lower confidence level; UCL- upper confidence level).

MA	Year	Area	Density	Population Size		
		hectares	*ind/ha*		*LCL*	*UCL*
Yuha Basin	2002	24,362	1.05	25,514	12,761	38,970
Yuha Basin	2004		3.00	73,017	4,837	163,635
East Mesa	2003	46,660	0.91	42,619	19,704	67,639
West Mesa	2003	55,077	0.20	10,849	3,213	23,486

3.3.1. Results from occupancy surveys 2006-2009

The occupancy surveys report the proportion of plots surveyed that are utilized by at least one FTHL during the study period. Since FTHL sightings are relatively rare, the presence of either FTHLs *or* scat on any given plot is analyzed in order to statistically strengthen the abundance models (Root 2010). While this survey method uses scat, which is an unreliable method for reasons described above, the interpretation of these data are not necessarily reliant on a positive correlation between scat and FTHL abundance. The occupancy surveys are only used to indicate that at least one, but not necessarily more than one, lizard used the occupancy plot at some point during the field season. Most survey efforts reveal that many plots (>70%) were occupied at some point by at least one FTHL (Root 2010). However, because each MA is only surveyed once every three years, there is little to no data for temporal comparison, which is crucial for this species given that it is known to have boom and bust population dynamics (Young and Young 2000). Occupancy plots were surveyed each year from 2006-2009 in the Ocotillo Wells State Vehicle Recreation Area (OWSVRA) Research Area; no statistically significant abundance trends were detected (Root 2010). Although this approach offers a cost and time effective survey method, the results are not sensitive enough to detect even large population changes. Many surveys were only able to detect 40 percent changes in the population even using both FTHL and scat occurrence records (Root 2010). Consequently, these surveys are not useful for estimating FTHL abundance or population trends.

3.3.2. Results from demographic surveys 2007-2009

The results from the demographic plots are based on annual mark-recapture surveys that were conducted on 9-ha plots within four MAs; the West Mesa and Yuma Desert MAs both contained two plots each, while the East Mesa and Yuha Desert MAs only contained one plot each. The data was analyzed in multiple ways in an effort to determine the most accurate abundance and density estimates. Abundance estimates ranged from 6.0-46.5 adult FTHLs per plot and 0.0-142.8 juvenile FTHLs per plot using the Huggins closed-capture method (Root 2010). Average density estimates varied depending on the method of analysis: 1) 0.3-3.3 FTHL/ha (using a mean maximum distance moved method, which is reliant on the Huggins closed-capture abundance estimate); 2) 0.7-4.4 FTHL/ha (using a hierarchical, spatially indexed capture-recapture model; Root 2010). Since there are so few demographic plots and because these plots were not randomly distributed, these data are only able to detect population changes that occur *within* the 9-ha plots themselves; no population changes were detected within these areas of high quality habitat (Root 2010). These data cannot be extrapolated broadly and cannot provide population size estimates. Root (2010) warns:

> "Although I generated FTHL density estimates from the 2007-2009 capture data, I caution that these estimates are likely to be biased to some unknown magnitude, and that to the greatest extent possible, any **inferences regarding status and trends for local FTHL population sizes be restricted to plot-by-plot assessments** [emphasis added] using the FTHL abundance estimates from the Huggins closed-capture analyses, or the FTHL density estimates from the spatially indexed hierarchical model." (pg. 11)

Despite this warning, the USFWS used these density estimates in order to generate approximate population sizes across the entire range of the FTHL:

> "Even at the lowest (most conservative) estimated density of adult FTHL of 0.3 individuals per ha (0.1 individuals per ac) there are likely more than 50,000 adult FTHL in the Western Population, 85,000 in the Eastern Population, and 322,000 in the Southeastern Population. We acknowledge that there are numerous assumptions in these calculations that limit accuracy of the extrapolated populations sizes; however, even using the most conservative density value these three populations are of sufficient size such that any threats associated with small populations would be unlikely." (76 FR 14210, 14237)

While it is unclear exactly how these population estimates were calculated (because the areal size of each population multiplied by the density estimate specified does not yield the numbers reported), it is clearly inappropriate to extrapolate even the most conservative density estimate to any areas outside of the actual demographic plots. The density estimate used (0.3 FTHL/ha) is derived from six, 9-ha plots that were non-randomly distributed within only four MAs; only four of these plots were surveyed within three MAs in California (i.e., two plots were in the Yuma Desert MA in Arizona). The MAs were designed to encompass areas that contain the most suitable FTHL habitat, while avoiding areas with extensive surface disturbance and conflicting uses (i.e. off-road vehicle (ORV) open areas within FTHL range including Ocotillo Wells State Vehicle Recreation Area, Superstition Mountain ORV Open Area, Plaster City ORV Open Area, and the Imperial Sand Dunes Recreation Area; FTHLICC 2003). Within California, 402,926 ha are considered suitable habitat, of which only 36 percent is managed as four MAs. Therefore, the majority (64%) of available habitat within California is lower-quality habitat than that within the MAs. Additionally, the demographic plots were non-randomly assigned to areas with the highest quality habitat within the MAs, meaning the demographic plots were surveyed in small plots with the best available habitat across the species entire range. Consequently, even a conservative density estimate of 0.3 FTHL/ha is based on an estimate derived from only 24 ha of the highest quality habitat present in over 400,000 ha of available habitat in California.

The USFWS asserts:

> "No abundance or density information is available for the lower-quality habitat areas outside the demographic plots. However, the complementary coarse-scale occupancy survey data mentioned above suggests FTHL are widely distributed spatially…This conclusion suggests that FTHL population trends in the surveyed lower-quality habitat areas are not dissimilar to those of the surveyed higher-quality habitat areas." (76 FR 14210, pg. 14220)

This methodology may partially justify extrapolating density estimates to an entire MA, but most certainly does not justify extrapolating to the entire range, most of which has not undergone systematic surveying and is generally degraded habitat. Since there are no reliable estimates of population density in lower-quality habitat, there is no way to correct for differences in habitat quality indicating that any range wide abundance estimates will be inaccurate.

3.4. FTHL Abundance

Unfortunately, there is currently not enough information to make accurate evaluations of FTHL abundance. For the reasons outlined above, population sizes are almost certainly lower than those estimated by the USFWS (76 FR 14210). The most reliable estimates most likely come from Grant and Doherty (2007), which within the confidence interval, indicate that populations are quite low, especially within Yuha Basin MA and West Mesa MA (Table 3). Given that the MAs represent areas of high-quality habitat and have relatively limited surface disturbance, it is reasonable to conclude that population sizes are even smaller in areas outside of the MAs. For instance, the Coachella Valley is estimated to support approximately 2,000-10,000 individuals (CVMSCP 2007). The threats associated with habitat loss and fragmentation is discussed elsewhere in this petition, but they are most assuredly negatively impacting FTHL abundance.

4.0. Natural History

4.1. Species Description

The FTHL has multiple diagnostic traits including a distinctive dark dorsal stripe down its midline, long occipital horns, a dorso-ventrally flattened tail, and a prominent umbilical scar (Figure 5; Funk 1981; Muth & Fisher 1992; Young and Young 2000). Adult lizards range in size from 57-84 mm snout vent length (SVL) and typically weigh between 12-22 g (Young 1999). The Interagency Coordinating Committee (ICC) stipulated that lizards should be classified as adults with SVL ≥ 65 mm (Root 2010); however, sexually mature specimens have been collected at sizes as small as 57 mm (Howard 1974). Others have suggested that lizards should be classified as adults when they reach a size of 60 mm (Muth and Fisher 1992; Young and Young 2000; Root 2010). FTHLs are not sexually dimorphic, as Muth and Fisher (1992) reported average adult sizes of 73 mm and 74 mm for males and females, respectively. Upon hatching, FTHL are typically ≥30 mm SVL and weigh approximately 1.5 g (Turner and Medica 1982; Young 1999; Young and Young 2000). Young and Young (2000) divided FTHLs into three distinct age classes based on size (SVL): sexually mature adults (≥60 mm), sub-adults (45-60 mm), and hatchlings (≤45 mm).

Figure 5. Adult flat-tailed horned lizard. Photo by Tyler Grant, Bureau of Land Management.

Dorsal coloration is highly variable and can be gray, tan, reddish-brown, or whitish (Funk 1981), while ventral coloration is always white or pale yellow (Young and Young 2000). The dorsal surface is decorated with multiple dark spots surrounding a prominent, dark vertebral stripe extending from the head to the tail base (Funk 1981; Young and Young 2000). FTHLs have two long, slender horns that are 3-4 times longer than their basal width, each surrounded by three temporal spines (Funk 1981). The FTHL has a dorso-ventrally flattened tail that tapers to a gradual tip and lateral gular scales that are enlarged and present in a single row (Bryant 1911, Funk 1981).

4.2. Taxonomy and Population Genetics

Hallowell first described the flat-tailed horned lizard in 1852. Based on morphological traits that were later shown to not be diagnostic, Hallowell placed the FTHL in a unique genus, naming the species *Anota m'callii* (Bryant 1911; Funk 1981). While the species has been reclassified multiple times, it is currently classified as *Phrynosoma mcallii* (Crother et al. 2012). Its taxonomic classification is as follows:

Class: **Sauropsida**
- Order: **Squamata**
  - Suborder: **Lacertilia**
    - Infraorder: **Iguania**
      - Family: **Phrynosomatidae**
        - Genus: ***Phrynosoma***
          - Species: ***Phrynosoma mcallii***
            - Common: **Flat-tailed Horned Lizard**

The genus *Phrynosoma* consists of a unique group of iguanid lizards known commonly as horned lizards. *Phrynosomids* are characterized by an ant-rich diet, squat dorso-ventrally flattened bodies, cranial horns, body fringe, cryptic coloration, reluctance to run when approached, and a long active period (Pianka and Parker 1975; Sherbrooke 2003). Horned lizards have a broad geographic distribution ranging from southern Canada to Guatemala (Hodges and Zumudio 2004).

Recent molecular studies identify 17 species within the *Phrynosoma* genus; however, the phylogentic relationships of these species are not well understood (Reeder and Montanucci 2001; Hodges and Zamudio 2004; Leaché and McGuire 2006; Mulcahy et al. 2006). It is difficult to generate a well-resolved phylogeny due to the strong incongruence between morphology and mitochondrial DNA (mtDNA; Leaché and McGuire 2006). The FTHL (*Phrynosoma mcallii*) is both morphologically and ecologically very similar to the desert horned lizard (*P. platyrhinos*; Pianka and Parker 1975; Young and Young 2000), which has prompted many to consider the two species sister taxa. The close relationship between *P. mcallii* and *P. platyrhinos* is also supported by ribosomal RNA (rRNA) and mtDNA (Reeder and Montanucci 2001; Hodges and Zamudio 2004; Leaché and McGuire 2006).

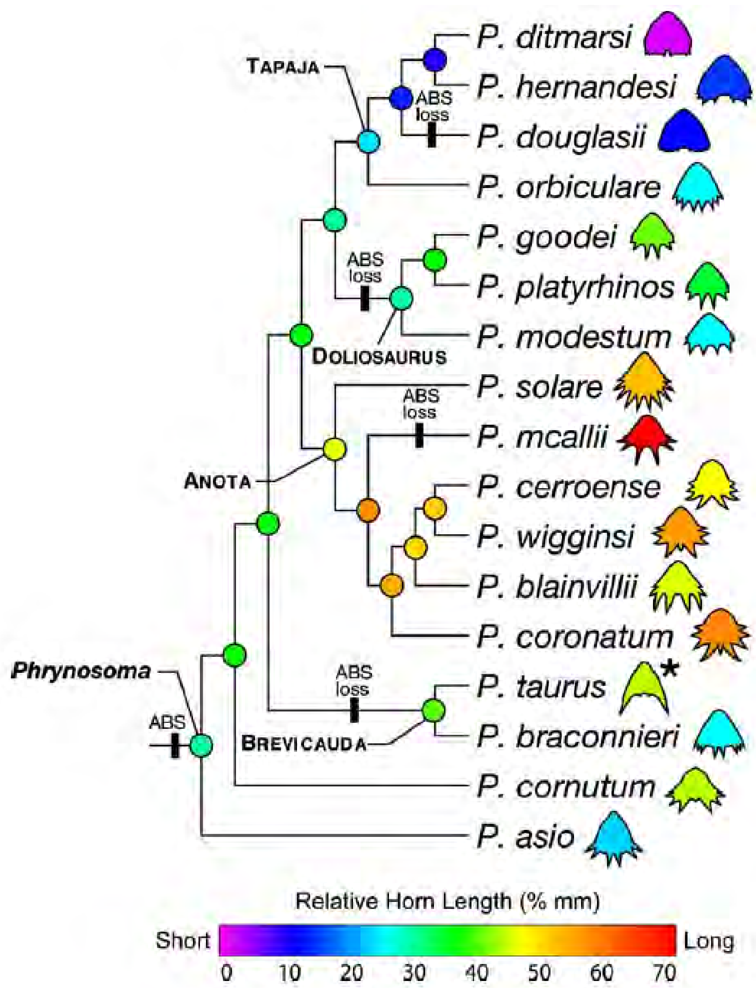

Figure 6. Preferred phylogeny for Phrynosoma based on the combined mtDNA and nuclear data. The most parimonious reconstruction of antipredator blood-squirting is mapped on the phylogeny (black bars). Shilhoutetes of Phrynosoma heads are shown to illustrate the variation in cranial horn morphology and color coded to correspond to relative horn length (ancentral stae reconstructions are mapped on each node). The asterik (*) adjacent to P. taurus indicates that the effective length of the squmosal horns of theis specie are longer than our measuring techniques protray. The Phrynosoma, Tapaja, Anota, Doliosaurus, and Brevicauda clades are defined in the discussion [see orginial publication]. *Figure and caption from Leaché and McGuire 2006.*

Nuclear DNA suggests that *P. mcallii* and *P. platyhrinos* are not closely related and belong to separate clades within the genus (Leaché and McGuire 2006). The incongruence between the nuclear DNA and mtDNA is likely due to hybridization. A new species, *Phrynosoma goodei*, was recently described and is shown to be most closely related to *P. platyrhinos* according to all molecular genes analyzed (Mulcahy et al. 2006; Leaché and McGuire 2006). *P. goodei* and *P. mcallii* share a small zone of sympatry in southwestern Arizona where hybridization events occur with unknown frequency. Both Leaché and McGuire (2006) and Mulcahy et al. (2006) hypothesize that *P. platyrhinos* and *P. goodei* acquired the *P. mcallii* mtDNA genome through introgression (hence the close phylogenetic relationship observed in mitochondrial genes but not in nuclear genes). Therefore, while *P. mcallii* is able to mate with *P. goodei*, *P. mcallii* is not closely related to either *P. goodei* or *P. platyrhinos* (Leaché and McGuire 2006). The most complete phylogeny of *Phrynosoma* is given in Figure 6, including the evolution of horn size and the separate events in which the basal blood-squirting characteristic was lost (see Leaché and McGuire 2006 for details).

4.3. Reproduction and Growth

While emergence from hibernation is highly variable (see Movement and Behavior), FTHLs are generally capable of mating upon emergence (Howard 1974), even if they leave hibernation early (Mayhew 1965). Howard (1974) reported that in a particularly wet year, upon emergence, males had enlarged testes and maintained spermatozoa at least as late as July, while females carried oviductal eggs from May through August. In years with high spring and summer precipitation, females may be capable of producing two separate clutches of eggs (Howard 1974; Turner and Medica 1982; Muth and Fisher 1992). Several researchers report that the first clutch typically hatches in mid to late July, while offspring from the second clutch hatch from late August through October (Howard 1974; Turner and Medica 1982; Muth and Fisher 1992). In dry years, females appear to produce a single clutch that does not hatch until late August or September (Young and Young 2000; Setser 2001), as copulation may not begin until late July (Setser and Young 2000). However, it is also possible that females do not lay multiple clutches, but rather different individuals lay at distinct times throughout the active period (Young and Young 2000). More research is needed to understand breeding behavior and whether precipitation is the only major factor influencing reproductive timing.

Gravid females deposit their eggs in deep burrows over a period of two to four days (Young and Young 2000). While FTHLs typically stay within a home range area (see Movement and Behavior), some gravid females will suddenly leave their home range, even traveling as far as 1,647 m to deposit their eggs before returning to their original home range site (Setser 2001; Young and Young 2000). Nests are dug deep enough to ensure that the eggs are laid in moist soil and can range from 14 cm (Setser 2001) to 90 cm (Young and Young 2000) in depth. Following oviposition, nests are filled such that they are not easily recognized from the surface (Setser 2001). The eggs are incubated for approximately 52 days before hatching (Setser 2001). Compared to other horned lizards, *P. mcallii* produce small clutches and have the lowest productivity index (the product of the probable number of clutches per year and the average number of eggs per female per clutch; Howard 1974). Average clutch size ranges from 4.7- 5.4 eggs (Howard 1974; Pianka and Parker 1975).

Upon hatching, juvenile are approximately 30 mm in length (SVL) and, on average, weigh 1.4 g (Young and Young 2000). Juveniles grow quickly, but growth rate appears to be dependent on when and where hatchlings were born, precipitation, and resource availability. Muth and Fisher (1992) tracked the growth rate of two separate cohorts of hatchlings. The first cohort, born at 36 mm in July, grew to over 60 mm by October, averaging 8 mm of growth per month (Muth and Fisher 1992). In contrast, the second cohort, born at 34 mm in September, only grew to 37 mm by October, averaging a growth rate of 3 mm per month (Muth and Fisher 1992).

One individual from the second cohort was 43 mm in November and grew to 65 mm by April (Muth and Fisher 1992). Therefore, under favorable conditions, hatchlings born in the first cohort (around mid-July) are able to reach adult size prior to hibernation and thus are able to breed at the beginning of the next year's active season, while hatchlings from the second cohort may not mature until the middle of the following summer (Muth and Fisher 1992; Young and Young 2000). Growth rates slow under drought conditions, and it may take two years before hatchlings reach maturity in dry years (Young and Young 2000).

Most studies indicate an even sex ratio (Mayhew 1965; Turner and Medica 1982; Muth and Fisher1992; Young and Young 2000); however several studies in the Ocotillo Wells State Vehicular Recreation Area have reported male-biased sex ratios (Wone and Beauchamp 1995; Young 1999; Setser 2001). The size class structure of the populations varies dependent on rainfall and whether there are multiple clutches, but in years in which there are two distinct cohorts, the population can shift from 88 percent adults in May, to 79 percent juveniles by September (Muth and Fisher 1992).

4.4. Movement and Behavior

FTHLs remain active, on average, 277 days out of the year without any prolonged periods of inactivity or aestivation (Muth and Fisher 1992). As obligatory hibernators, lizards will retreat into hibernation burrows, and remain inactive throughout most of the winter (Mayhew 1965).

4.4.1. Active Period

FTHLs maintain an active lifestyle throughout most of the spring, summer, and into the fall. Lizards begin activity in the early morning, typically between 7:00-11:45am (Muth and Fisher 1992). While they may cease activity as early as 11:20am (Muth and Fisher 1992), active lizards have been sighted as late as 10:25pm (Norris 1949). When surface temperatures reach 50ºC (122ºF) most FTHLs will retreat into burrows, although lizards have been seen out with surface temperatures of 55ºC (131ºF; Young and Young 2000). To escape from the heat, lizards will often use old rodent burrows but may also re-use old burrows they had previously dug themselves or may dig new burrows daily (Young and Young 2000). A typical burrow is approximately 70-80 cm long and 25-30 cm deep (Young and Young 2000).

Following the daily activity of six lizards, Muth and Fisher (1992) reported an average of 290 minutes of activity per day is spent digging (11%), feeding (11%), moving from place to place (32%), or remaining motionless (46%). FTHLs move in short bursts of a few meters, and may preferentially stop to rest on elevated areas with a clear vantage point, such as rocks or roads (Setser and Young 2000). Lizards will often fully or partially bury themselves when sandy substrates are available. For instance, at the point of capture (N=175), 15 percent of lizards were completely buried, 31 percent were partially buried, and the remaining 54 percent were on the surface (Young and Young 2000). Of those captures, which were done in a dry year, 80 percent used little or no cover; more lizards covered themselves more completely when surveyed during a wet year when more vegetation was present (Young and Young 2000). FTHLs were also observed taking cover during bouts of strong wind, either partially or fully burying themselves (Setser and Young 2000). Interestingly, this behavior was observed in the Ocotillo Wells State Vehicular Recreation Area (OWSVRA), which has very little loose sand, indicating that the lizards sought out sandy areas during strong wind storms (Setser and Young 2000). FTHLs typically remain inactive, fully exposed on the surface at night, but they will partially bury themselves under sand for cover and thermoregulation on cool nights (Klauber 1939; Setser and Young 2000; Muth and Fisher 1992; Young and Young 2000).

When approached by potential predators, FTHLs most frequently freeze, relying on their cryptic coloration to deter predation. Upon approach, the vast majority of FTHLs will crouch low and remain motionless until the perceived threat is gone (Wone and Beauchamp 1994; Young and Young 2000). When the researchers attempted to grasp the lizards, 73 percent still remained motionless. Of the 27 percent that ran, several ran into nearby burrows or to the base of a shrub, while others just crouched and remained motionless again (Wone and Beauchamp 1994). When grasped, FTHLs will often thrash their heads as to drive their horns into their attacker (Klauber 1939; Wone and Beauchamp 1994). Setser and Young (2000) reported differences in the avoidance behavior between lizards in Yuma, Arizona and OWSVRA in California, as lizards in OWSVRA tended to freeze more than those in Yuma.

Compared to their size, FTHLs have very large home range areas. FTHLs do not appear to be territorial (Muth and Fisher 1992) as the home ranges of males and females, males and males, and female and females often overlap (Young 1999; Setser and Young 2000; Setser 2001). Due to their cryptic coloration and freezing behavior, it is very difficult to determine accurate estimates of home range size. Estimates of home range size (Table 4) and daily movement vary widely, potentially due to differences in location, sex, climatic conditions, and density dependence.

Table 4. Variation in the mean home range sizes of male and female flat-tailed horned lizards over time and throughout their range.

Reference	Year(s)	Location	Mean Home Range Size (ha)			Method
			Male	Female	Range	
Turner & Medica 1982	1978	CA Range	0.13	0.05	0.01-0.21	Mark-recapture (≥ 3 captures)
Setser & Young 2000	1998	OWSVRA	1.38	0.29	-	Radio-telemetry (≥ 10 captures)
	1999	OWSVRA	1.01	0.56	-	Radio-telemetry (≥ 10 captures)
Setser 2001	2000	OWSVRA	1.32	1.0	-	Radio-telemetry (≥ 10 captures)
Muth & Fisher 1992	1990-1991	West Mesa	1.79	1.97	0.09-13.13	Radio-telemetry (≥ 3 captures)
Young & Young 2000	1996	Yuma	2.5	1.3	-	Radio-telemetry (≥ 10 captures)
	1998	Yuma	10.3	1.9	34.4 (max)	Radio-telemetry (≥ 10 captures)

While several studies have reported that males maintain larger home ranges than females (Turner and Medica 1982; Young 1999; Setser and Young 2000), others have found no significant difference between sexes (Muth and Fisher 1992; Setser 2001). Juveniles typically have smaller home ranges than adults (Setser and Young 2000; Setser 2001), but some female juveniles maintain home ranges similar in size to adult females (Setser and Young 2000). Home range size also differs between wet and dry years. Male home range size increased with more precipitation (Young and Young 2000), while females may increase their home range during dry years (Setser 2001). The daily movement of both males and females increased significantly with increased precipitation (Young and Young 2000). While lizards may shift their home range area slightly over time, they typically do not move more than several hundred meters in their lifetime (Setser 2001; with the exception of some females that travel far out of their home range for oviposition).

4.4.2. Hibernation

The vast majority of FTHLs hibernate over winter, prompting their designation as obligatory hibernators (Mayhew 1965). While this is typically true, not all individuals will hibernate. Both Grant and Doherty (2009) and Muth and Fisher (1992) observed several individuals that were active throughout the entire winter and did not hibernate. Given that many juveniles born in late summer reach adult size by the following summer, it is thought that many juveniles do not hibernate (Grant and Doherty 2009; Muth and Fisher 1992). Additionally, while most lizards will remain inactive in their hibernation burrows throughout the entire winter, some individuals will become active periodically throughout the winter (Muth and Fisher 1992), while others will permanently leave hibernation early and remain active for the remainder of the winter (Mayhew 1965).

Of those individuals that do hibernate, winter dormancy usually begins on average in mid-November, but can range from October through December (Grant and Doherty 2009; Muth and Fisher 1992; Wone and Beauchamp 2003). Grant and Doherty (2009) noted a large difference in the date of initial hibernation between sites surveyed in East Mesa and eastern OWSVRA, which may be related to habitat or climate differences. The mean duration of hibernation is 89 days, but can range from only 14 days to as many as 138 days (Muth and Fisher 1992). The average time of emergence is variable and can range from December to April, but occurs on average in February (Wone and Beauchamp 2003; Mayhew 1965).

Hibernation burrows are generally shallow, averaging five to six centimeters in depth (Muth and Fisher 1992; Grant and Doherty 2009), although burrows as deep as 20 cm have been documented (Mayhew 1965). Many individuals choose hibernation sites under or near vegetation (Grant and Doherty 2009). Even after plugging their hibernation burrows, some lizards will abandon their burrows in order to build a new one in close proximity (Grant and Doherty 2009).

4.5. Diet and Foraging Ecology

Although all horned lizards prey heavily on ants, ants comprise 97 percent of the FTHL diet, which is higher than any other species of horned lizard (Pianka and Parker 1975). Analysis of scat reveals that FTHLs primarily eat harvester ants, but are known to eat smaller ants as well (Young and Young 2000). Red harvester ants are frequently the preferred prey item, but black harvester ants are frequently eaten (Young and Young 2000). The ant species most commonly recovered from scat include: *Messor pergandei*, *Pogonomyrmex californicus*, *P. magnacanthus*, *Conomyrma spp.*, *Myrmecocystus spp.* (Turner and Medica 1982). Smaller ants such as *Pheidole barbata* and *Dorymyrmex insanus* can also be important prey items at certain times of the year (Young and Young 2000). FTHLs are also known to eat other invertebrates opportunistically including sphinx moth larvae, termite casting (FTHLICC 2003), beetles, and even small scorpions (Young and Young 2000). While FTHL primarily consume preformed water from food, they will on occasion drink rainwater through "rain harvesting" (Johnson and Spicer 1985; Grant 2006). Lizards typically produce one, but sometimes two, scat per day (Young and Young 2000).

Lizards spend approximately 11 percent of their active time feeding (Muth and Fisher 1992). They are neither fully active nor sit-and-wait predators, but fall somewhere in between these two extremes (Muth and Fisher 1992). FTHLs feed more in the morning than in the evening (Young and Young 2000). In the morning, feeding rates can be as high as 80 ants per 15 minutes (Young and Young 2000). They generally eat lone ants that are out foraging and do not necessarily seek out nests or trails of ants (Young and Young 2000). Black harvester ants are known to be aggressive and in field tests on the desert horned lizard *Phrynosoma platyrhinos*, ants often vigorously mobbed lizards causing them to flee (Rissing 1981). Even still, Young and Young (2000) reported a female preference for black harvester ants during a wet year, although no preference was detected in the dryer years of the study. Some have cited correlations between FTHL abundance and the abundance of harvester ant nests (Rorabaugh et al. 1987), but others have detected no such correlation (Turner and Medica 1982). During a severe drought, Young and Young (2000) measured scat contents and found less than half the number of ants that were present in scat collected during wetter years, noting that lizards lost weight during the drought conditions. During drought years annual vegetation is depressed, resulting in decreased seed abundance, which in turn negatively affects the harvester ants that feed primarily on seeds (Barrows and Allen 2009). Therefore, a decreased prey base under drought conditions may negatively affect FTHLs. While ants are a critically important component of the environment, they are not the only, and perhaps not the most important factor affecting FTHL abundance (Turner and Medica 1982).

4.6. Ecological Niche

FTHLs are highly specialized predators that feed predominantly on ants (Turner and Medica 1982). Given that they have such a specialized prey base, FHTLs are susceptible to trophic disruptions that result from decreased annual plant growth, and therefore decreased harvester ant abundance. They are also an important prey item for many avian, reptilian, and mammalian predators, including loggerhead shrikes (*Lanius ludovicianus*), sidewinder snakes (*Crotalus cerastes*), and round-tailed ground squirrels (*Spermophilus tereticaudus*; see Mortality and Population Regulation below).

4.7. Mortality and Population Regulation

Most FTHLs live to three years in age, but individuals can live four or even six years (Young and Young 2000; FTHLICC 2003). Muth and Fisher (1992) estimated the mean annual survival rate at approximately 53 percent, noting the lowest survival rates occurred in spring and summer. During hibernation, survival is typically 100 percent (Muth and Fisher 1992; Grant and Doherty 2009). Juvenile survivorship is not clear, but the annual juvenile survival rate for *Phrynosoma platyrhinos* is significantly lower than adult survivorship (Pianka and Parker 1975). FTHLs show large fluctuations in population size between years, likely due to weather patterns and resource availability (Figure 7; Young and Young 2000). More annual plants, harvester ants, and FTHL hatchlings are seen in wet years (Young and Young 2000). Young and Young (2000) describe the variable population dynamics of FTHLs:

> "Many of our finding demonstrate the potential for rapid population growth during a single good year when food is abundant; hatchlings can reach adult size and breed within a year, laying and hatching can occur much earlier than in drought years, females can allocate more resources to producing more and/or larger eggs, and some females may lay multiple clutches in a year." (pg. 42)

The largest natural cause of mortality in FTHL is predation, as up to 40 percent of the population may be predated upon in certain years (Young and Young 2000). Since lizards spend much of their time on the surface, both during the day and at night (see Movement and Behavior), they are vulnerable to diurnal and nocturnal predations. Known or suspected predators include: <u>Avian</u>- American kestrel (*Falco sparverius*), common raven (*Corvus corax*), burrowing owl (*Athene cunicularia*), loggerhead shrikes (*Lanius ludovicianus*), red-tailed hawk (*Buteo jamaicensis*), great-horned owl (*Bubo virginianus*); <u>Reptiles</u>- sidewinder snake (*Crotalus cerastes*), coachwhip snake (*Masticophis flagellum*), leopard lizard (*Gambelia wislizenii*); <u>Mammals</u>- kit fox (*Vulpes macrotis*), round-tailed ground squirrel (*Spermophilus tereticaudus*), coyote (*Canis latrans*), badgers (*Taxidea taxus*; Duncan et al. 1994; Muth and Fisher 1992; Young and Young 2000). Avian predation increases along roads, powerlines, and urban and agricultural development (Young and Young 2000; Young and Young 2005; Barrows et al 2006).

FTHL are also highly susceptible to vehicle mortality. FTHLs can be crushed by both on-road and off-road vehicles (see Vehicular Impacts). Even on infrequently traveled paved roads, vehicular morality rates can be as high as 19 percent (Young and Young 2000). In a separate study, two of 27 radio tagged lizards that were recovered were killed by illegal off-road vehicles (ORVs) on military property closed to unauthorized ORV use (Muth and Fisher 1992). Both Klauber (1939) and Norris (1949) noted nematode and red mite parasites on FTHL; however, there is no known account of these or any other parasites causing lethal disease or infection in FTHLs.

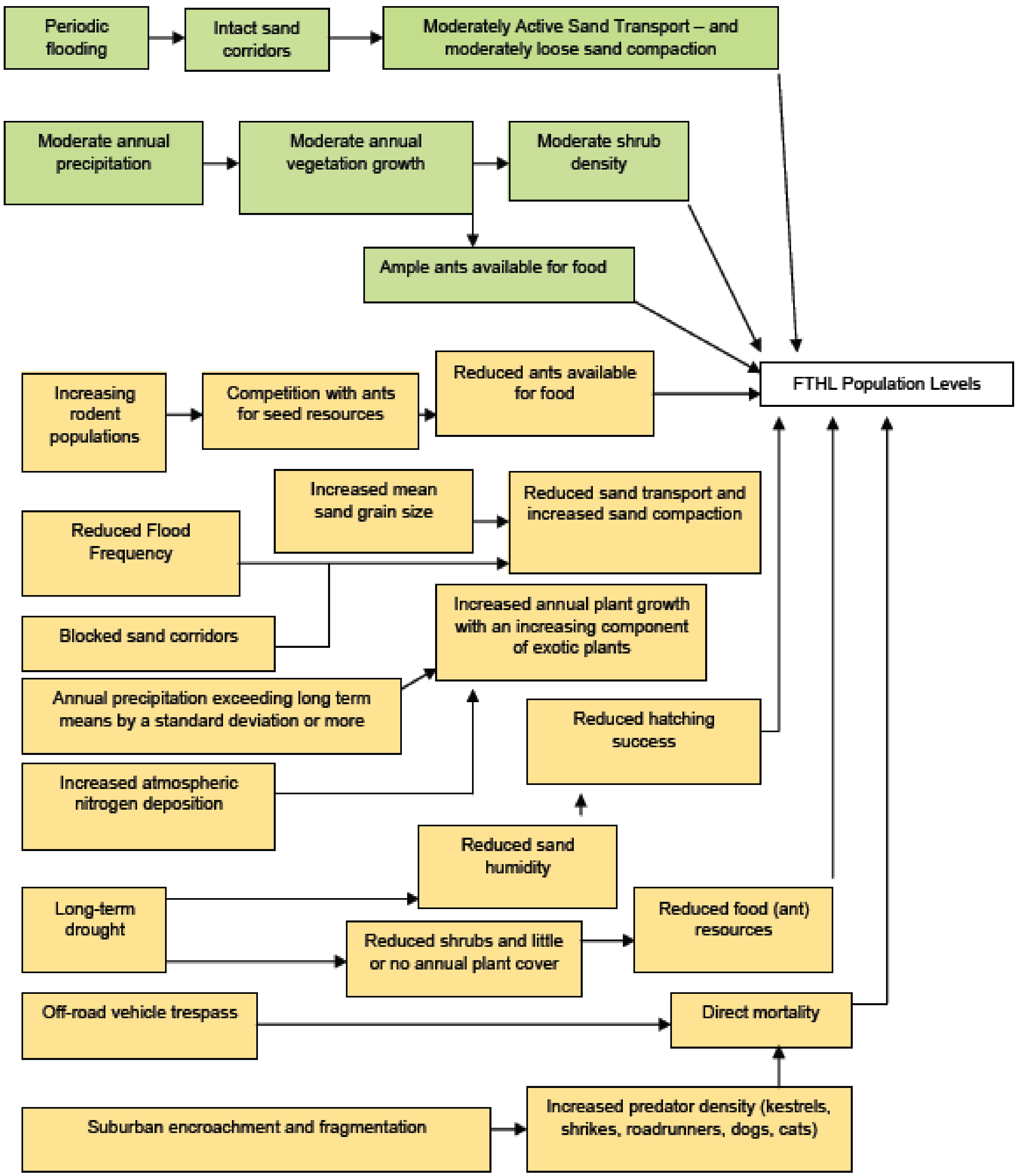

Figure 7. Envirogram of the flat-tailed horned lizard displaying the species population dynamics. Green boxes represent environmental factors that lead to positive growth; yellow boxes represent environmental factors that lead to negative growth. Figure modified from Barrows 2005, Coachella Valley Multi-species Habitat Conservation Plan Monitoring Program, pg. 52.

5.0. Habitat Requirements

FTHLs inhabit the Colorado and Sonoran Deserts in southeastern California, the extreme southwestern portion of Arizona, and into Baja California and Sonora, Mexico. The species is restricted to hot, arid desert habitats typically below 300 m in elevation, although lizards have been collected in habitats above 500 m in elevation (Johnson and Spicer 1985; Turner 1980). FTHL habitat is characterized by hot summers, with average maximum summer temperatures often surpassing 38°C (100°F; Johnson and Spicer 1985; Wone 1992) and even reaching 45°C (113°F; FTHLICC 2003). FTHLs were most frequently captured in the summer when temperatures were between 28-41°C (82-106°F; Wright 2002). Winters are generally mild with daytime temperatures in the 20s (Johnson and Spicer 1985). It is not uncommon for nighttime winter temperatures to dip below freezing (Wone 1992). Annual rainfall is temporally and spatially variable across FTHL range, but is typically low, ranging from over 13 cm per year to just 5 cm per year (Johnson and Spicer 1985). The western part of FTHL ranges predominantly experiences winter rains, unlike the eastern portion, which generally receives summer rains (Johnson and Spicer 1985). FTHL habitat is subjected to frequent drought conditions (Johnson and Spicer 1985) and flash floods during periods of heavy rain (Turner and Medica 1982). The region also experiences intermittent winds that are typically moderate, although strong winds in excess of 64 km per hour can occur (Wone 1992).

High quality FTHL habitat is typically categorized by areas of low relief with finely packed sandy soils that are covered, intermittently, with loose, fine aeolian sands (Rorabauch et al. 1987; Young and Young 2000; Turner et al. 1980). Favorable habitat is typically associated with the creosote bush shrub community, especially creosote bush (*Larrea tridentata*) and bursage (*Ambrosia dumosa*; Young and Young 2000; Turner et al. 1980; Johnson and Spicer 1985; Altman et al. 1980; Norris 1949; Turner and Medica 1982). Moderately compacted sand may be an important habitat feature in order to allow easy digging while still providing FTHLs with strong burrows able to withstand repeated use (Barrows and Allen 2009). However, FTHL are frequently reported in areas without the aforementioned qualities. For instance, FTHL have been found on sparsely vegetated gravel flats, barren clay soils, and mudhills characterized by concretions, small pebbles or gravel, and silt (Young and Young 2000; Turner et al. 1980; Beauchamp et al. 1998; Wone 1992). FTHLs are also documented on the stabilized sand fields and along the vegetated edges of active sand dunes (Turner et al. 1980; Young and Young 2000; Barrows and Allen 2010, 2009). While some have suggested that FTHL do not inhabit active sand dunes themselves (Turner et al. 1980; Beauchamp et al. 1998; 76 FR 14210), others have reported infrequent instances of FTHLs in association with sand dunes (Johnson and Spicer 1985; Luckenbach and Bury 1983; Wright 2002; Barrows and Allen 2009). Lizards have even been collected in rocky habitats in the lower slopes of the Superstition Mountains (Turner et al. 1980). It appears as though California supports a wider range of habitat types than Arizona and perhaps Mexico (Hodges 1997; FTHLICC 2003). FTHL can occupy a wide range of habitats, which makes it difficult to determine the exact locations of quality habitat throughout the species' range.

In general, most researchers report a positive correlation between FTHL abundance and perennial plant density (Setser and Young 2000; Altman et al. 1980; Barrows and Allen 2009; Turner and Medica 1982; Muth and Fisher 1992). FTHLs are most commonly associated with creosote bush (*L. tridentata*) and bursage (*A. dumosa*), but can also be found around galletta grass (*Hilaria rigida*); (Johnson and Spicer 1985), dyebush (*Psorothamnus emoryi*); (Muth and Fisher 1992; Altman et al. 1980), saltbush (*Atriplex spp.*); (Turner et al. 1980), and *Coldenia palmeri* (Altman et al. 1980). Others have noted a weak correlation between vegetation and FTHL abundance (Wright 2002), and still others have shown as negative correlation between FTHLs and thick vegetation (Beauchamp et al. 1998). Muth and Fisher (1992) provide a unique assessment of vegetation within FTHL habitat. While FTHL abundance was positively correlated with perennial plant density, the strongest association was with bursage (*A. dumosa*) and dyebush (*P. emoryi*); interestingly, creosote bush (*L. tridentata*) was weakly negatively correlated with FTHL abundance (Muth and Fisher 1992). Moreover, FTHLs seemed to actively avoid *Tiquilia plicata*, even though it was the most abundant species present on the study site at the El Centro Military Base in West Mesa (Muth and Fisher 1992). The authors hypothesized that FTHL preferred bursage and dyebush because these species produce a large number of branches that not only provide high quality shade, but also protrude from the base of the plant and thus trap large amounts of sand (Muth and Fisher 1992). Positive correlations between FTHL and the abundance of sand (Wright and Grant 2003; Hollenbeck 2004; and Norris 1949), gravel hardpan and mud hills (Beauchamp et al. 1998; Wone 1992), and harvester ant nests (Turner et al. 1980; Barrows and Allen 2009; Rorabaugh et al. 1987) have all been reported.

6.0. Factors Affecting Ability to Survive and Reproduce

6.1. Development

Land use change through human development is a well-recognized threat to wildlife, particularly species with small geographic ranges (Fischer and Lindenmayer 2007). There are various forms of human development that threaten the FTHL, including agricultural, urban, and energy infrastructure development.

6.1.1. Agricultural Development

Agricultural development throughout the Colorado Desert exploded following the introduction of intensive irrigation in the early 1900s. This proliferation undoubtedly destroyed FTHL habitat resulting in fragmentation and likely reduced genetic connectivity (Mulcahy et al. 2006). While agricultural development has occurred throughout portions of Mexico and Arizona, in California, intensive agriculture has destroyed either known or potential FTHL habitat throughout the Imperial Valley, Coachella Valley, and Borrego Springs area (Figures 8 and 9; Hodges 1997). Within the last several decades, new agricultural development has slowed substantially and is unlikely to expand significantly due to water limitations. Increasing conflict over water resources in southern California has resulted in some agricultural fields being fallowed (76 FR 14210). It is possible that abandoned agricultural fields could serve as FTHL habitat following either active or passive restoration, although we are unaware of any such efforts or research.

Beyond the direct impacts of land conversion, agricultural development and associated irrigation canals pose numerous indirect threats to the FTHL. Predators are often attracted to agricultural lands and their influence can extend well beyond the disturbed area, threatening FTHLs present in the undisturbed habitat that borders development (Young and Young 2005; Barrows et al. 2006; see Edge Effects section below). Additionally, ample supplies of irrigated water allow Argentine ants (*Linepithema humile)* to invade regions otherwise too arid; ant invasions can also extend beyond the habitat border, displacing native ant species that FTHLs rely on as a nearly sole source of food (Pianka and Parker 1975; Suarez et al. 1998; see Edge Effects section below).

6.1.1.1. Pesticide Spraying

The spraying of pesticides has the potential to directly or indirectly affect FTHLs. Pesticides may kill harvester ants near agricultural fields, and due to drift, potentially in areas surrounding agricultural fields. Anything that causes decreases in harvester ant abundance negatively impacts FTHLs. Currently there is very limited aerial pesticide spraying in FTHL habitat (FTHLICC 2003; 76 FR 14210). More research is needed to understand how pesticides impact FTHLs.

6.1.2. Urban Development

The majority of the urban development within the California portion of FTHL range has occurred to support agricultural expansion. As a consequence, most large urban centers were built on converted agricultural fields and are largely surrounded by active agriculture (e.g. the cities of El Centro, Calexio, or Brawley in the Imperial Valley). Urban development, independent of agriculture, does occur in the Coachella Valley and Borrego Springs area, as well as Yuma, Arizona and portions of Mexico (FTHLICC 2003; 76 FR 14210). Urbanization directly affects FTHLs through land conversion, building and road construction, landscaping, and the development of parks and golf courses (FTHLICC 2003). Indirect effects include off-road vehicle (ORV) use, route proliferation, the spread of nonnative plants, trash accumulation, and increased predation (FTHLICC 2003). Most land within the U.S. portion of the FTHL range is owned by the State of California or various federal agencies (Figure 10). Private land holdings are relatively small and discontinuous throughout the range (76 FR 14210) indicating development of private land is likely to have localized impacts. Extensive urban development on federal and states lands is unlikely (76 FR 14210).

While the CVMSHCP, which was finalized in 2008, provides conservation assurances for areas of suitable habitat for the life of the plan (25 years; whether lizards are present or not), it ultimately still allows for reductions in existing habitat. The only “core habitat” that remains for the FTHL within the plan is the existing Thousand Palms Conservation Area. While some land is authorized for development within Conservation Areas, most suitable FTHL habitat within Conservation Areas is not subject to take. However, of the over 18,000 acres of suitable FTHL habitat in the CVMSHCP, approximately 50 percent is authorized for take and will likely be developed.

6.1.3. Energy Generation Development

Although urban and agricultural development has slowed in the Colorado Desert region, renewable energy development has increased dramatically. Renewable energy development directly and indirectly threatens many aspects of desert ecosystems, and the FTHL specifically. The demand for renewable energy has increased significantly recently, especially in southern California (Lovich and Ennen 2011, 2013; Cameron et al. 2012). Federal and state initiatives to increase renewable energy development ensure development will continue. At a federal level, the Obama administration has developed the New Energy for America Plan with the goal of making 25 percent of America’s energy sources renewable by 2025. California also has aggressive goals of increasing renewable energy, as Executive Order S-14-08 and Senate Bill X1-2 require that by 2020, 33 percent of California’s energy come from renewable sources.

These goals put tremendous pressure for increased development throughout the Mojave and Sonoran Deserts, which offer premium locations for solar and wind development (Figure 11). In order to meet goals in greenhouse gas reductions, the California Energy Commission estimates 25,000 ha of land will need to be developed in California deserts (CEC 2012). Despite the potential positive benefits, renewable energy development comes with a very large physical and ecological footprint that significantly threatens desert wildlife (Lovich and Ennen 2011, 2013; Cameron et al. 2012; Stoms et al. 2013).

There are numerous pending and approved renewable energy projects within the FTHL range. While not all of these projects will be approved or built, many will and they pose a significant threat to the FTHL. While there is renewable energy development in Mexico and Arizona, the threat is most pervasive in California. The USFWS suggested that renewable energy is not a significant threat to the FTHL because energy projects only impact approximately two percent of the species entire range (76 FR 14210); however, currently in the state of California, seven percent of FTHL habitat will potentially be impacted by pending or approved projects and the demand for additional projects is only increasing. Lovich and Ennen (2011, 2013) reviewed the numerous impacts of utility-scale solar and wind energy development on wildlife in Californian deserts; summaries of wildlife impacts are presented in Lovich and Ennen (2011) and (2013). Moreover, large and single-use renewable energy projects on public lands displace other multiple use activities, which in turn increases impacts from off-road vehicle use and other uses in FTHL habitat.

The Bureau of Land Management has recently established a renewable energy zone that borders and extends slightly into current FTHL habitat in East Mesa. The Chocolate Mountains Renewable Energy Zone is located approximately 22.5 km northeast of the East Mesa MA and includes 8,402 ha of public lands (78 FR 54677). Most of this zone is within historic FTHL range east of the Salton Sea but FTHLs have been sighted within this zone as recently as the early 1990s in the Dos Palmas area. No recent studies have evaluated the population status of FTHLs in this region. This zone is available for solar, wind and geothermal development, which not only threatens any current populations in the region, but may also prevent the re-establishment of FTHL populations in this area of potentially suitable habitat. Furthermore, if a viable population of FTHLs is present in Dos Palmas, it may have genetic connectivity with the Eastern population of FTHLs in East Mesa (although genetic studies are needed to confirm this). If connectivity does occur, development within the Chocolate Mountain Renewable Energy Zone could threaten the viability of this region as a habitat corridor.

While the Desert Renewable Energy Conservation Plan (DRECP) is proposed to allow for appropriately planned renewable energy development while conserving habitat for a suite of 50+ species throughout the California deserts, the plan is still in its formative stage. The FTHL is proposed as one of the “covered species”. However, the draft biological goals and objectives as proposed in May 20, 2013 fall well short of assuring conservation for the FTHL throughout their range within the boundaries of the DRECP (DRECP 2013).

6.1.3.1. Solar Energy

Available research indicates that utility-scale solar energy projects have the potential to produce numerous and far-reaching negative impacts on desert ecosystems (reviewed by Lovich and Ennen 2011; also see Cameron et al. 2012). Unfortunately, many of the sites being considered for solar development in the Mojave and Sonoran Deserts are relatively undisturbed sites, which exacerbate the threat (Lovich and Ennen 2011). According to the Solar FPEIS,

> "[n]umerous wildlife species would be adversely affected by loss of habitat, disturbance, loss of food and prey species, loss of breeding areas, effects on movement and migration, introduction of new species, habitat fragmentation, and changes in water availability. Impacts potentially could be dispersed across the 19 million acres of variance areas" (BLM and DOE 2012).

Various spatial models have been developed to determine sites that are most compatible for energy development yet minimize biological impacts (Cameron et al. 2012; Stoms et al. 2013). Stoms et al. (2013) generated a compatibility index model for southern California that determined sites most suitable for solar development based on the level of on-site and off-site degradation, i.e. how degraded the landscape already is and how close project sites are to established transmission line infrastructure. FTHL habitat ranked fairly high on the compatibility index indicating their habitat is heavily degraded according to the model (Figure 12; Stoms et al. 2013). Additionally, FTHL habitat is at increased risk of development due to its close proximity to established transmission infrastructure such as the Sunrise Powerlink (see below). It is important to note, that the Stoms et al. (2013) model did not incorporate species distributions or habitat designations leading them to recommend that the biological value of all compatible sites be evaluated independently; if the biological value is high, as in the case of FTHL habitat, applications should be denied (Stoms et al. 2013).

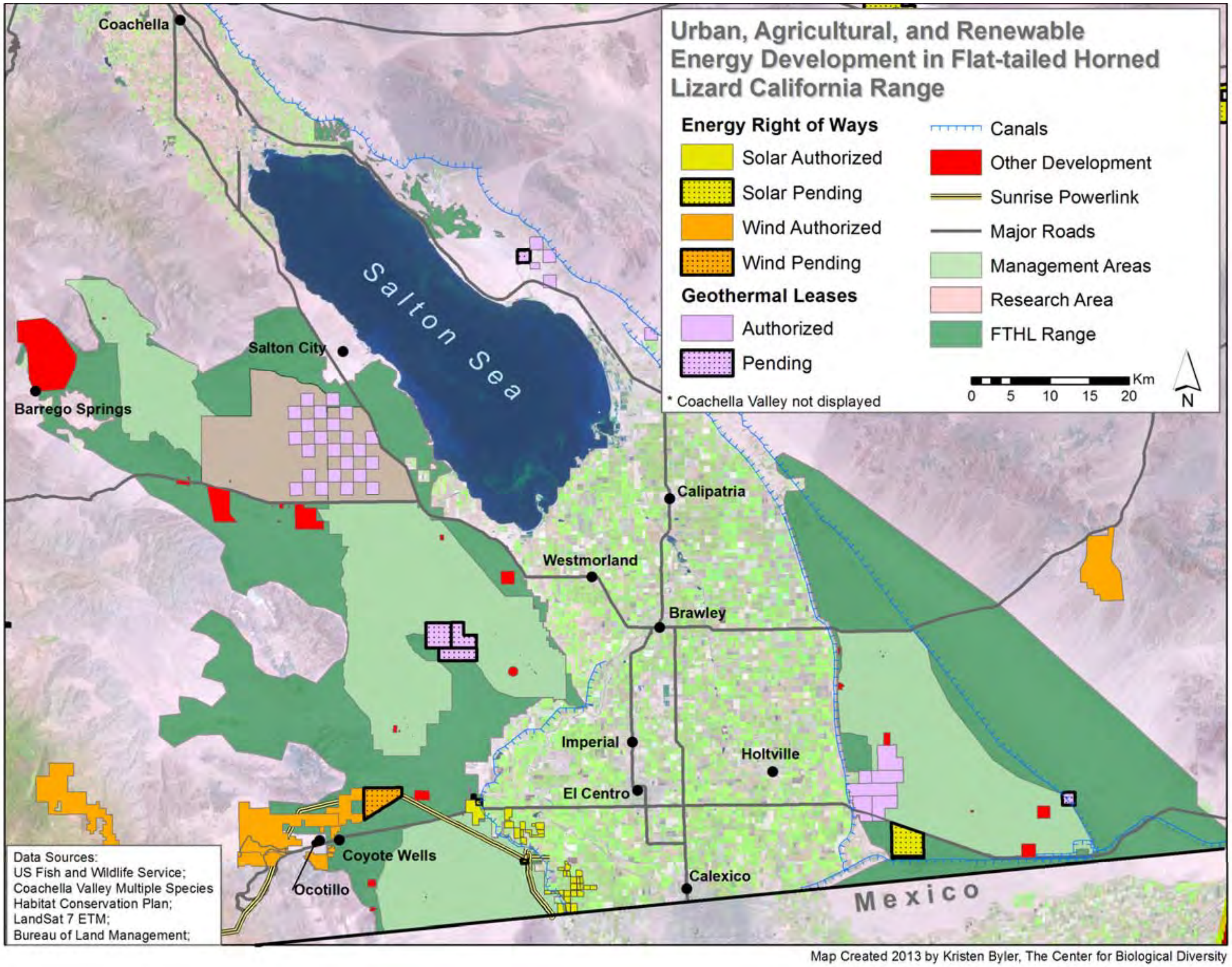

Figure 8. Urban, agricultural, and renewable energy development in flat-tailed horned lizard California range.

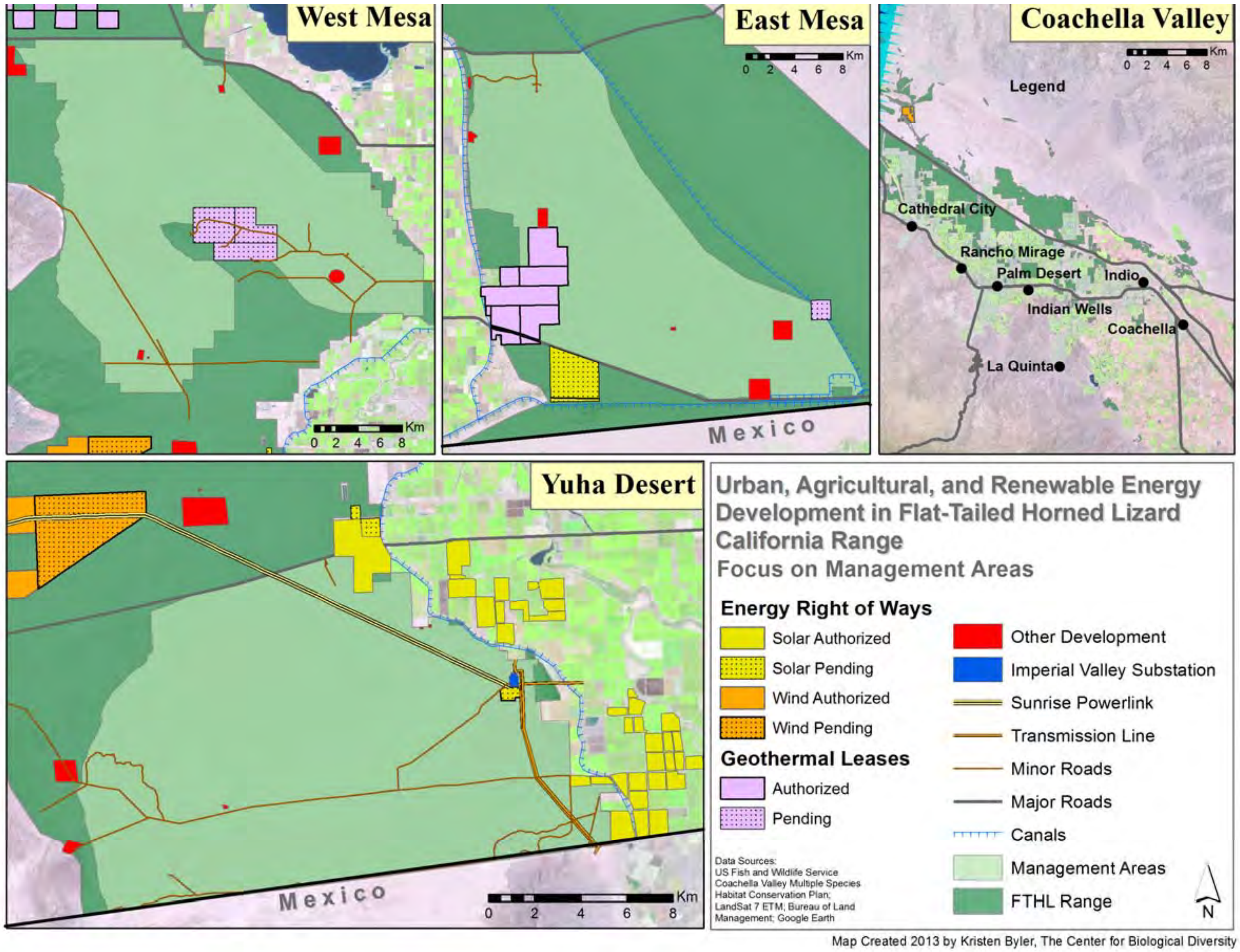

Figure 9. Urban, agricultural, and renewable energy development in flat-tailed horned lizard California range: focus on Management Areas.

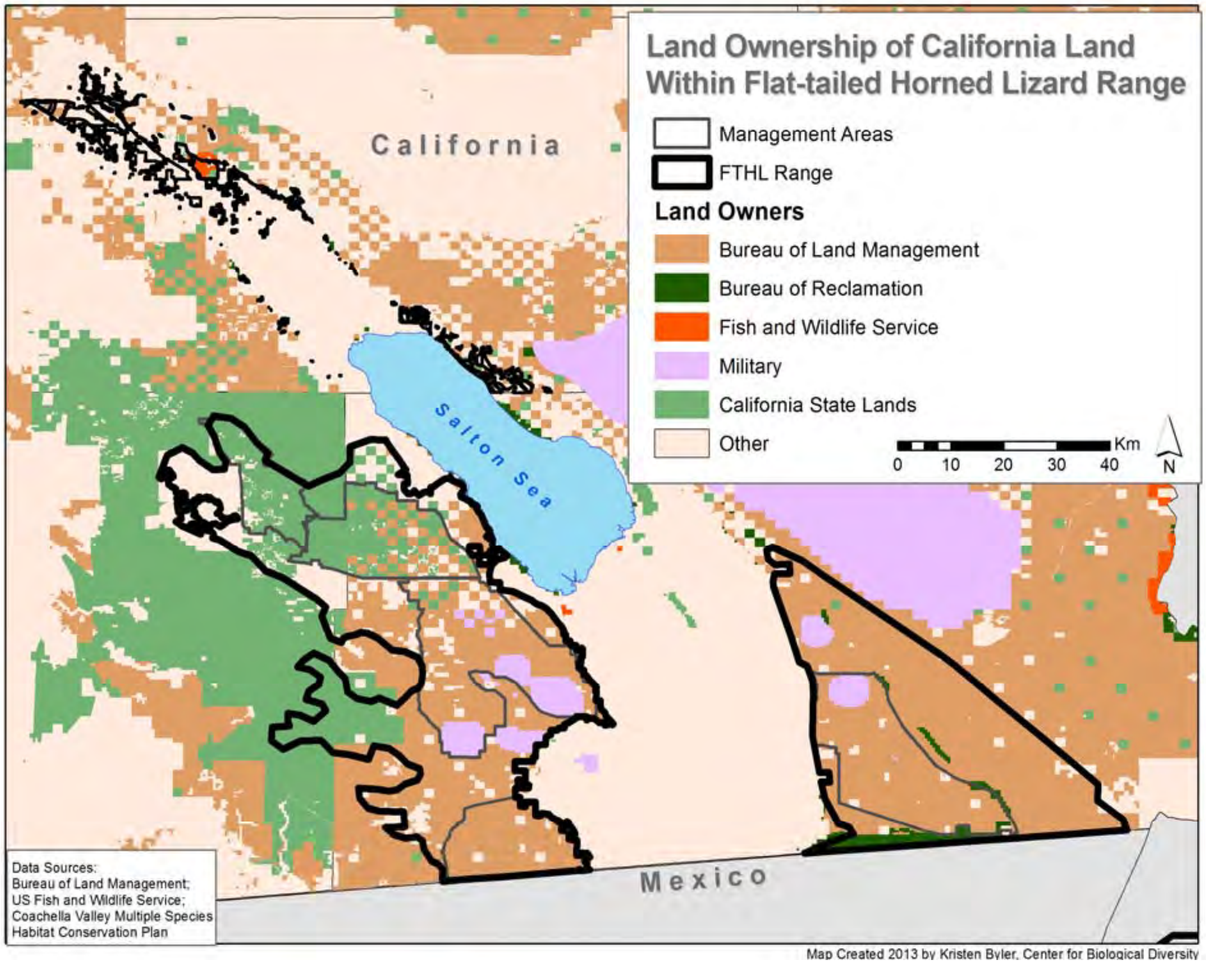

Figure 10. Land ownership of California land within flat-tailed horned lizard range.

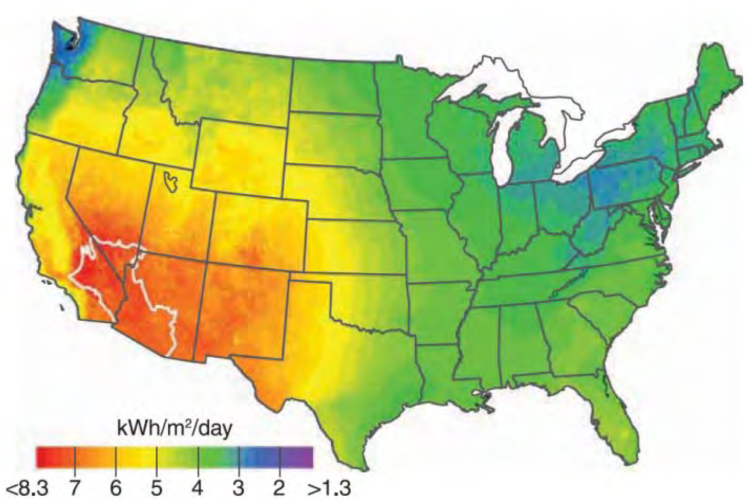

Figure 11. Solar energy potential in the United States. Note that the entire U.S. FTHL range is located within an area with the highest solar potential (red). The white outline indicates the range of the Agassiz desert tortoise and is unrelated to this analysis. Figure generated by Lovich and Ennen 2011.

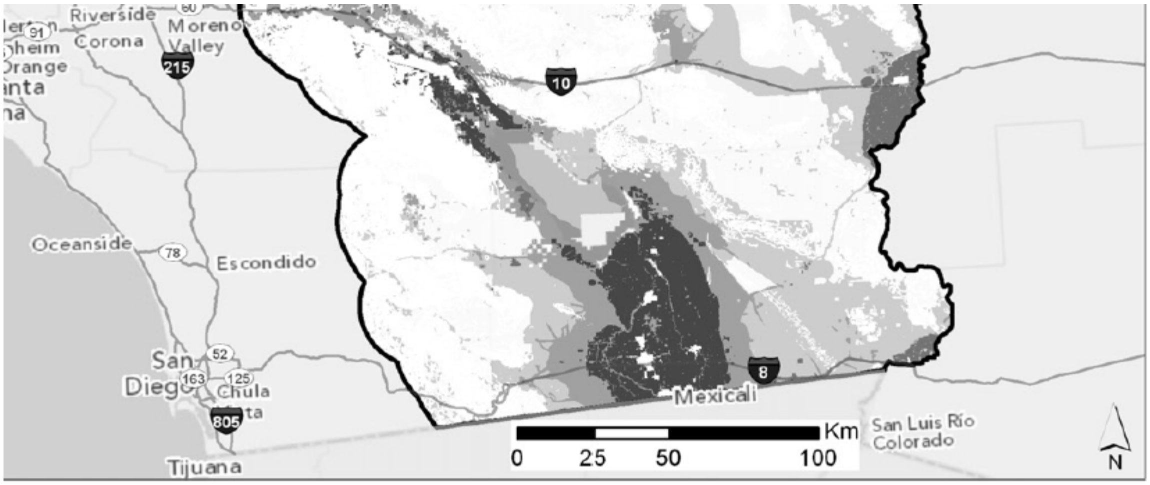

Figure 12. Solar development compatibility index scores, where high compatibility scores indicate the most heavily degraded areas. Darker shades indicate higher compatibility scores. Nearly all FTHL range is located in heavily degraded landscapes, increasing the likelihood of development pressures in FTHL habitat. Figure was modified from Stoms et al. 2013.

While the impacts vary dependent on the type of project, in desert regions, dry-cooling systems are generally required because they require far less water than wet-cooling systems, but dry-cooling requires a much larger areal footprint (Lovich and Ennen 2011). The construction process, including associated road construction, results in significant physical disturbance including increased erosion, soil compaction, and large amounts of dust (Lovich and Ennen 2011). Dust can negatively affect wildlife, including native plants, but dust can also decrease solar output. Therefore, operators often use a wide-variety of dust suppressants. The ecological implications of dust suppressants are unknown, but suppressants are known to be transported through runoff and thus likely have a far-reaching impact (Lovich and Ennen 2011). New roads are often constructed to create access to solar development sites, which increases the risk of direct morality of FTHLs by vehicles, causes habitat fragmentation and potential barriers to gene flow, and makes previously inaccessible areas available to vehicles including off-road vehicles. Construction sites are often surrounded by fences (fencing is a required mitigation strategy under the RMS), which can increase artificial perching sites for predatory birds. Gen-tie transmission lines may also increase avian predation by providing additional perching sites. Toxic wastes, such as coolants, antifreeze, rust-inhibitors, and heavy metals, can also accumulate and negatively affect on-site and off-site locations (Abbasi and Abbasi 2000). All renewable energy projects also carry an increased risk of fire (Lovich and Ennen 2011). Large-scale solar projects can even alter the microclimate of a region:

> "It has been estimated that a concentrating solar facility can increase the albedo of a desert environment by 30%–56%, which could influence local temperature and precipitation patterns through changes in wind speed and evapotranspiration. Depending on their design, large concentrating solar facilities may also have the ability to produce significant amounts of unused heat that could be carried

> downwind into adjacent wildlife habitat with the potential to create localized drought conditions." (Lovich and Ennen 2011, pg. 987)

Drought conditions decrease FTHL fecundity (Howard 1974; Turner and Medica 1982; Muth and Fisher 1992; Setser and Young 2000); therefore, any activities that increase the risk of drought threaten the ability of FTHLs to reproduce (CVCC 2013a).

There are currently seven pending and authorized solar projects in FTHL range (Figures 8 and 9), impacting in total 1,735 ha of land in FTHL California range. The Centinella Solar Project, the Imperial Solar Energy South, and Imperial Solar Energy West Transmission Projects were authorized for the disturbance of 5.4, 1.3, and 5.5 ha, respectively, within the Yuha Desert MA (FTHLICC 2011). Recently, the Campo Verde Solar Project was also authorized on 6.9 ha of BLM land (CA BLM 2013). Each of these projects link up to the Imperial Valley Substation located within the Yuha Desert MA and thus have relatively small footprints within the actual MA; however, each project is actually much larger. Centinella, Imperial Solar Energy South and West, and Campo Verde Solar projects are predominantly on private land directly bordering the Yuha MA and are 836, 383, 457, and 584 ha in total size (CA BLM 2013). As these large projects border the Yuha Desert MA, they can be expected to produce edge effects that negatively impact the FTHL (see Edge Effects section below). In addition to these projects, there are also several pending solar projects on FTHL habitat. The recently approved Ocotillo Sol (46 ha) solar project and the Dixieland project (91 ha), if approved, and will also impact the Yuha Desert MA. The Solar Programmatic Environmental Impact Statement (Solar PEIS) identifies a solar zone – Imperial East SEZ - for streamlined permitting and it is located in FTHL habitat in southeastern Imperial County. This 2,314 developable-hectare area is separated from the East Mesa MA by Interstate 8 along its northern boundary. The final Solar PEIS did not analyze impacts to the flat-tailed horned lizard (BLM and DOE 2012). Currently, there is a single 1,550 ha pending application for a solar power tower in this zone (i.e. Imperial Solar project; SEDP EIS 2013).

The Sunrise Powerlink transmission line runs through the Yuha Desert MA, introducing above ground transmission lines that not only cause surface disturbance in otherwise remote areas of high-quality FTHL habitat, but also provides additional perching sites for predatory birds. Furthermore, the Sunrise Powerlink is expected to attract additional renewable energy development applications. During the construction of the Sunrise Powerlink, from just April to November, 103 lizards were relocated and 25 FTHL mortalities were recorded (FTHLICC 2011). Given how few lizards are typically found through surveying (see Abundance), finding 25 dead FTHLs highlights the imminent threat that renewable energy transmission development poses to the persistence of the species.

6.1.3.2. Wind Energy

The terrestrial footprint associated with wind development is smaller than that from solar projects, but wind energy still requires a large amount of land and can impact wildlife in areas surrounding the wind farm (reviewed by Lovich and Ennen 2013). Similar to solar development, surface disturbance due to construction can increase erosion, dust, and soil compaction. Similar to solar development, the construction, maintenance and decommissioning processes often involve the construction of new roads that are capable of transporting heavy equipment needed to facilitate the land clearing, grading, excavation, blasting, and trenching required to set up turbines and associated electrical wiring (Lovich and Ennen 2013; TEEIC 2012). The many transmission lines associated with wind development also increase the risks of route proliferation and the risk of predation. Specifically, ravens (*Corvus corax*), a FTHL predator, are attracted to areas of human disturbance including wind energy facilities (Lovich and Ennen 2013). Increased route proliferation affects FTHLs by increasing the threat of direct mortality and fragmentation which is a barrier to gene flow (see Vehicular Impacts and Fragmentation, Barriers, and Small Populations sections below), but also by allowing increased vehicular access to remote areas. Wind energy creates an increased risk of fire, as several large fires in southern California have been linked to wind farms (Lovich and Ennen 2013); the risk of fire for the FTHL is discussed below in the context of nonnative plants. Persistent, loud noise and vibrations associated with wind farms may also negatively affect wildlife, including reptiles (Lovich and Ennen 2013).

There are currently five pending and authorized wind projects (Figures 8 and 9) impacting nearly 3.4 percent of FTHL range in California, or approximately 13,500 ha. The Ocotillo Wind Energy Facility, a project by Pattern Energy, is located on over 4,900 ha of land, managed by the Bureau of Land Management (BLM), adjacent to the Yuha Desert MA. The facility was connected to the SDG&E Sunrise Powerlink transmission line in December of 2012. The project consists of 112 turbines and required the construction of a 500 kV switchyard adjacent to the industrial facility (SDG&E 2013). There are also three authorized wind testing facilities impacting 7,243 ha of BLM land most of which is in FTHL range. Candlewood Power also has a pending wind energy application that would impact 1,231 ha of land near the Yuha Desert MA (CA BLM 2013).

6.1.3.3. Geothermal

There are currently 28 geothermal leases in FTHL range, 24 of which have been authorized (Figures 8 and 9). While geothermal energy typically has a smaller physical footprint compared to wind and solar development, geothermal development does cause surface disturbance. In total, project sites impact nearly 13,200 ha of land and have the potential to harm FTHLs.

6.1.4. Other Forms of Development

Throughout the California portion of FTHL range, other types of human development are prevalent including mineral mines, the Warren H. Brock Reservoir, the All-American and Coachella irrigation canals, landfills and junkyards, transmission lines, and several major interstate and state highways (Figures 8 and 9). There are also numerous large, open access off-road vehicle (ORV) areas, which result in considerable surface disturbance (see Vehicular Impacts section below).

6.1.5. Inadequacy of Existing Management- Development

The Flat-tailed Horned Lizard Rangewide Management Strategy (RMS) was developed in accordance with the Interagency Conservation Agreement that was signed to protect the FTHL in 1997 (see Impacts of Existing Management Efforts). The RMS strives to reduce development through minimization, mitigation, and compensation procedures. To protect areas of key habitat for the FTHL, five Management Areas (MAs) were established, four of which are in California (West Mesa MA, Borrego Badlands MA, Yuha Desert MA, and East Mesa MA); the Ocotillo Wells State Vehicle Recreation Area (OWSVRA) was also established as a research area. While there is privately owned land within the MAs, the majority of the land is public land managed by federal and state agencies which are signatories to the Interagency Conservation Agreement and voluntarily follow the guidelines established in the RMS. Within each MA, signatory agencies are limited to a one percent development cap. In calculating the development cap, edge effects associated with development are not considered yet they pose a significant threat to the FTHL (see Edge Effects below). Due to edge effects, development projects have a larger ecological footprint than its physical footprint. Clearly these impacts need to be included when calculating the extent of development projects' impacts.

As an example, the BLM recently approved the Ocotillo Sol Solar Project located within the Yuha Desert MA (BLM 2014). The physical development footprint is 46 ha, but the edge effects associated with development and habitat disturbance will significantly increase this footprint. There are currently two studies that have estimated the extent of impact that edge effects associated with development have on FTHLs (see Edge Effects below; Young and Young 2005; Barrows et al. 2006). Young and Young estimated that 450 m of habitat are impacted beyond the boundary of a developed area, while Barrows et al. (2006) estimated a 150 m impact. Using these estimates, the footprint of the Ocotillo Sol project will increase from 46 ha to 93 ha or 232 ha, assuming a 150 m and 450 m edge effect, respectively (Figure 13). The 2011 FTHL Interagency Coordinating Committee (ICC) Annual Report (the most recent report available), stated that 69 ha of land within the Yuha Desert MA have been authorized for development, which only equals 0.30% of the area of the entire MA and well below the 1% development cap (FTHLICC 2011). However, approval of the Ocotillo Sol Solar Project brings the percent of developed land up to 0.47, without even considering edge effects. Assuming a 150m indirect impact zone, the percent of developed land would increase to 0.67%, and if a 450m buffer is considered, which it should be, this one project will have exceed the development cap, resulting in 1.2% of the Yuha Desert MA being affected by development. It is important to note that both Young and Young (2005) and Barrows et al. (2006) derived these estimates from the impacts of urban and agricultural development, not energy development; therefore, the true impact of edge effect may be more or less for energy development present in relatively remote areas when taking all impacts including heat effects into account. The Ocotillo Sol project, however, is bordered by extensive agriculture and thus, this project would be expected to exacerbate any edge effects.

Even without considering a larger footprint due to edge effects, various member of the Interagency Coordinating Committee, the committee responsible for development and implementation of the RMS, have voiced concerns that certain MAs (i.e. Yuha Desert) may be close to reaching their development caps (FTHLICC 2010; pers. comm. with BLM).

Any authorized development projects are subject to mitigation and compensation procedures regardless of whether they are inside or outside of the MAs. Avoidance and minimization should always be the first goal of project siting and design. If impacts still occur, mitigation and compensation is required for any projects inside of MAs, and compensation is required on all projects that occur on potential FTHL habitat (regardless of whether lizards are actually present or not). If FTHLs are present, mitigation measures must be taken; however, if FTHL are deemed absent following a survey of the proposed project site, no mitigation is required. The RMS outlines a protocol for evaluating project sites, which includes a survey of the site based on

FTHL observations and scat (FTHLICC 2003, Appendix 6). Scat is not a reliable method to determine FTHL absence (see Abundance), and thus projects that were determined as not requiring mitigation may have contained FTHLs that simply went undetected during surveys. A more thorough survey protocol for FTHL is needed to ensure that proper avoidance, minimization and mitigation procedures are followed on all development projects. Additionally, if mitigation is required, the RMS calls for mitigation through fencing the project site and translocation of lizards from project sites (FTHLICC 2003; Appendix 7). However, studies have shown that translocation procedures for FTHL are largely unsuccessful and result in high mortality rates (FTHLICC 2007; Germano and Bishop 2009).

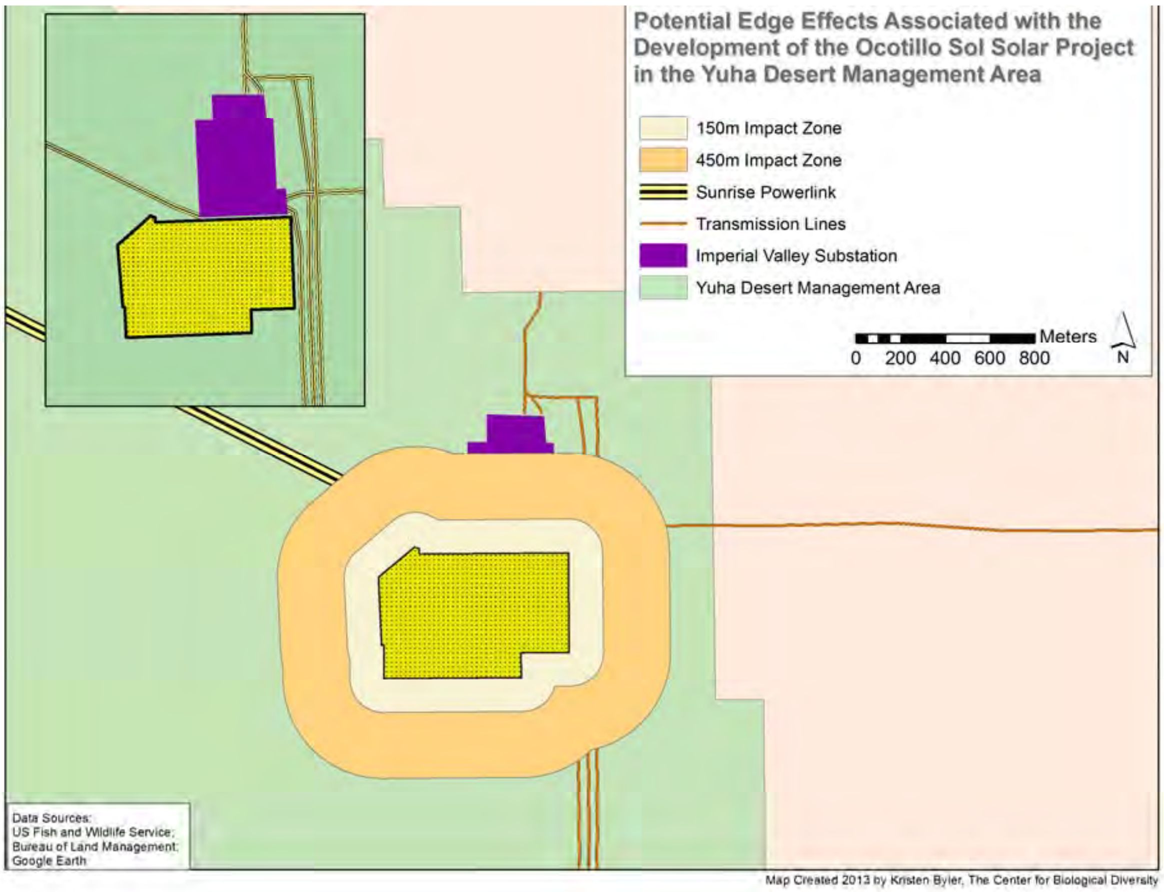

Figure 13. Potential edge effects associated with the development of the Ocotillo Sol Solar Project in the Yuha Desert Management Area. 450m edge effect based on calculation from Young and Young 2005; 150m edge effect based on calculations from Barrows et al. 2006.

The USFWS concluded that impacts associated with development, particularly renewable energy development, do not pose a significant threat to the FTHL because development projects will be minimized due to mitigation and compensation procedures under the RMS (76 FR 14210). However, in early drafts of the USFWS 2011 withdrawal of the proposed rule to list the FTHL as threatened, a USFWS employee noted: "We've just discovered the avoidance, minimization, and compensation measures incorporated into the RMS are not very adequate at avoiding and minimizing impacts from these large solar facilities" (USFWS 2011). Moreover, the mitigation and compensation requirements under the RMS do not seem to be sufficient to deter renewable energy development, which has been increasing significantly in the past decade and is projected to continue to increase (Lovich and Ennen 2013; Cameron et al. 2012).

6.2. Vehicular Impacts

It has long been recognized that off-road vehicles (ORVs) damage desert ecosystems and pose a significant threat to wildlife (Bury and Luckenbach 1983; Busack and Bury 1974; Luckenback and Bury 1983; Lovich and Bainbridge 1999; Luckenbach 1975; Vollmer et al. 1976; McGrann et al. 2005; 2006). Numerous studies have investigated the effects of ORVs on lizards by comparing lizard abundance in areas with limited ORV use to areas with heavy ORV use. In most cases, lizard abundance was significantly lower in areas with high ORV use (Luckenbach 1975; Bury and Luckenbach 1983; Luckenbach and Bury 1983; Busack and Buyr 1974; Knauf 2001; Wright 2002; McGrann et al. 2006). Luckenbach and Bury (1983) surveyed multiple lizards in the Algodones Dunes area and found there was 1.8 times more species, 3.5 times as many individuals, and 5.9 times higher lizard biomass on control plots free of ORV use as compared to ORV plots. Similar results were found for mammals, arthropods (Luckenback and Bury 1983; Bury and Luckenback 1983), and native plants (Luckenback and Bury 1983; Vollmer et al. 1975; McGrann et al. 2005). Busack and Bury (1974) hypothesize that lizards are negatively affected due to reduced plant cover resulting in reduced invertebrate food sources, which in turn causes reduced food resources for lizards. While relatively few studies have investigated the impacts of ORVs on FTHLs specifically, many of the impacts of ORVs on desert landscapes are known to impact FTHLs, including loss of native vegetation, soil disturbance and compaction, nonnative plant introductions, and decreased harvest ant populations. FTHL face two different types of vehicular threats, ORVs and vehicles traveling on paved and unpaved roads.

6.2.1. On-Road Vehicles

FTHLs are frequently found on and around paved roads. In fact, road surveys, in which researchers drive slowly in search of lizards, are often considered a preferred survey method to increase detection (Muth and Fisher 1992; Young and Young 2000; FTHLICC 2003). Of the over 300 FTHLs captured by Muth and Fisher (1992) in West Mesa, nearly all were captured near a road that received low traffic flow. Radio-tagged individuals revealed that lizards' home ranges can extend over roads (Muth and Fisher 1992). Male FTHL appear to occur on roads more frequently than females, which places males at increased risk of direct mortality and could potentially to alter sex ratios (Young and Young 2000).

Heavy vehicle traffic can cause local depressions in reptile populations surrounding roads (Klauber 1939) and there is strong evidence to suggest that roads can cause considerable morality in FTHLs. FTHLs freeze in the presence of threats, including vehicles, which makes them particularly susceptible to road kills. In the 1960s, over a three-year period, Mayhew collected 502 FTHL in California along Highway 78; 121, or 24 percent, of those lizards were killed by traffic (Turner et al. 1980). In 1997, Hodges (1997) reported that no lizards were found in this same location despite the high quality habitat surrounding the highway. Young and Young (2000) documented mortality rates ranging from 3 to 19 percent from traffic. Even lightly trafficked roads can result in high rates of mortality:

> "This paved road [on the Barry M. Goldwater Range in Yuma, Arizona], although small and lightly traveled by military vehicles only, results in high FTHL mortality. In late summer and fall of 1993, 23% of observed FTHLs were killed by traffic. Additional traffic on this road will increase mortality." (Hodges et al. 1997, pg. 12)

Beyond vehicular road kills, roads also have pronounced edge effects capable of impacting the FTHL habitat surrounding roads and potentially limiting gene flow (see Edge Effects below; Lovich and Bainbridge 1999; Young and Young 2000; Barrows et al. 2006). FTHLs may use highway underpasses, but it is unknown if they are sufficient to allow gene flow in natural populations (ADOT 2007).

6.2.2. Off-road Vehicles

Nearly all of the land within FTHL range in California is subject to either open or limited off-road vehicle (ORV) use (Figure 14). Large open areas allow users to operate ORVs freely with no spatial or temporal restrictions (there are different permit types and use regulations related to vehicle emissions). There are four large open areas within FTHL range on BLM and state lands including the Superstition Mountain Open Area, Plaster City Open Area, and portions of the Ocotillo Wells State Vehicle Recreation Area (OWSVRA) and the Imperial Sand Dunes Recreation Area (ISDRA; Figure 14). In addition to these large open areas, limited use ORV routes crisscross much of the remaining FTHL habitat. On limited use routes ORV users are expected to remain on ORV routes, as off-route use is prohibited; in certain cases, limited use routes also have temporal or seasonal restrictions. The BLM established designated ORV routes as part of the Western Colorado (WECO) ORV Routes of Travel Designations Plan that covers approximately 192,000 ha and over 2,700 km of limited use ORV routes in San Diego and Imperial Counties (Figure 14; CA BLM 2007). Open and limited ORV use is allowed within FTHL MAs, and users are expected to remain on WECO designated routes (FTHLICC 2003). There are also some areas in FTHL range that are closed to ORV use including military bases (Figure 14). While closed and limited areas are designed to limit ORV impacts on desert ecosystems, illegal ORV use off of designated routes is common and threatens FTHLs (Figure 15 and 16; FTHLICC 2003; Muth and Fisher 1992; Rorabaugh 2010, McGrann et al. 2006).

ORV recreation is one of the fastest growing outdoor activities and continues to increase in popularity (Cordell et al. 2008). In California, ORV use has increased especially rapidly. Visitation rates to State Vehicle Recreation Areas increased by 52 percent from 1985 to 2000 (Grant and Doherty 2009) and ORV registrations have similarly increased (OHMVRD 2011). In 2011, OWSVRA received over 500,000 visitors (CSPS 2012). Within FHTL MAs, "off-road activity has increased dramatically over the last decade in the Yuma Desert, Yuha Desert, and West Mesa MAs" (FTHLICC 2003, pg. 14). Significant increases in ORV tracks from 1994-2001 were found in both the Yuha Desert and West Mesa MAs (FTHLICC 2003). ORV use has also increased along the U.S.-Mexican border (see Activities along the United States-Mexico Border below).

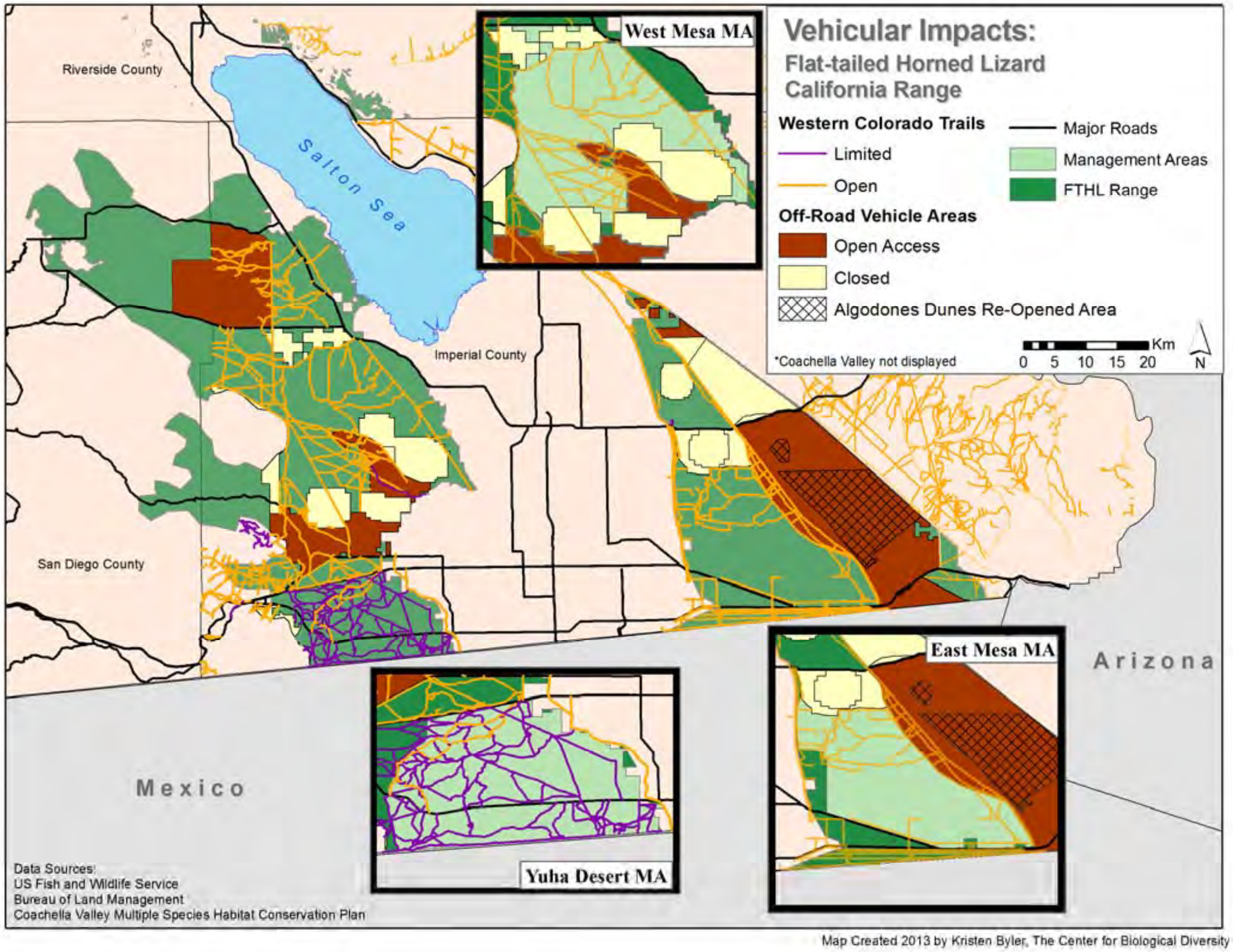

Figure 14. Vehicular impacts on the flat-tailed horned lizard in California range. FTHLs are negatively impacted by both paved roads and off-road vehicle routes and open areas. Note the Imperial Sand Dunes Recreation Area has recently altered their open and closed access area, making more land available for open access off-road vehicle use than is shown here.

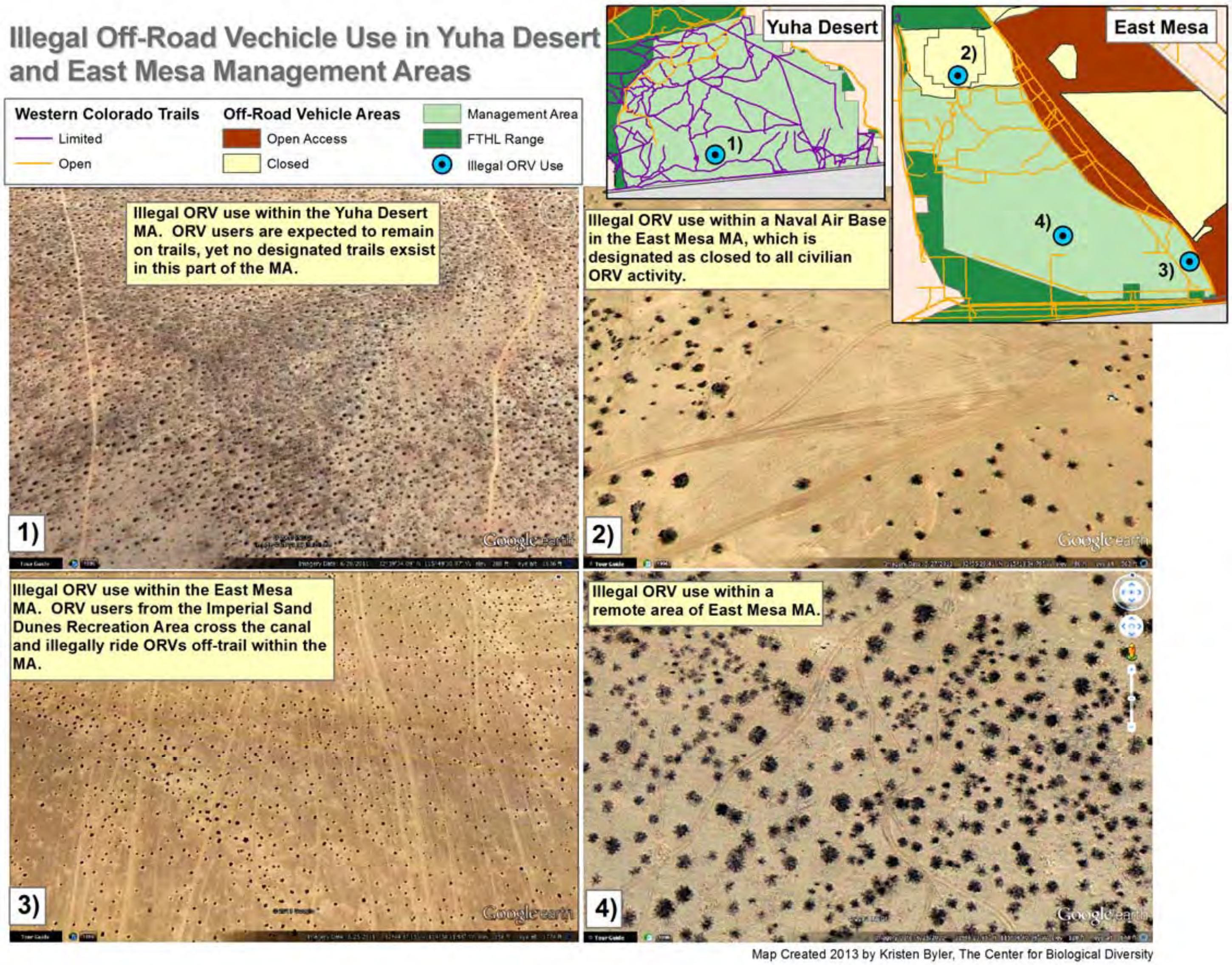

Figure 15. Illegal off-road vehicle use in Yuha Desert and East Mesa Management Areas. Images obtained from satellite imagery via Google Earth. Images were captured between 2008 and 2012 depending on the region.

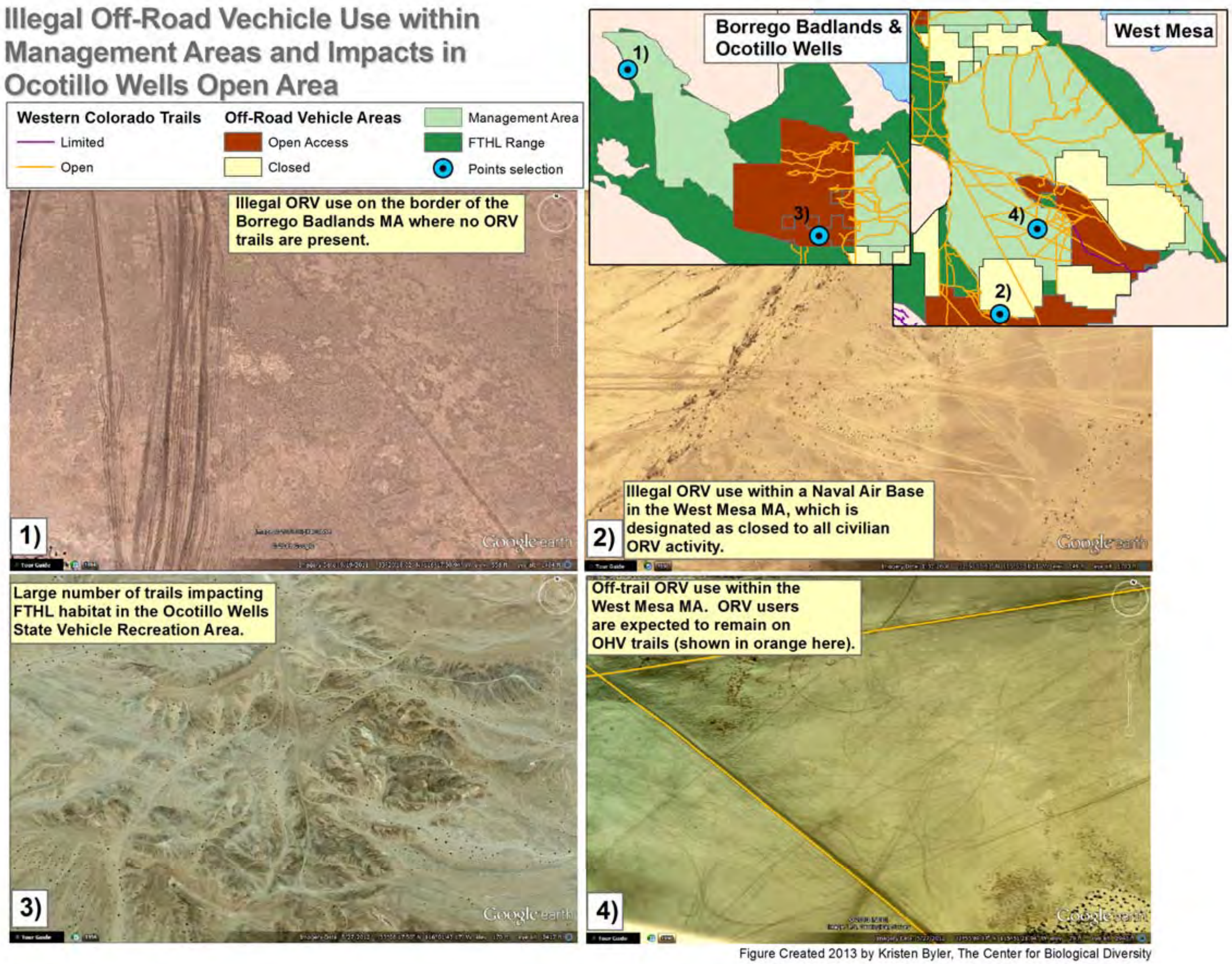

Figure 16. Illegal off-road vehicle use within Management Areas and impacts in Ocotillo Wells Open Area. Images obtained from satellite imagery via Google Earth. Images are were captured between 2008 and 2012 depending on the region.

6.2.2.1. ORV Impacts During the FTHL Hibernation Period

Due to extreme summer temperatures, the heavy-use ORV season in the Colorado Desert typically occurs from late October through May (Grant and Doherty 2009). Although the dates of onset and emergence from hibernation vary, FTHLs begin hibernation on average in mid-November and emerge from hibernation on average in February (Wone and Beauchamp 1994), which leaves many FTHLs vulnerable during portions of the ORV active season. Juveniles may be particularly vulnerable, especially in dry years, when lizards may not hatch until mid-October, leaving neonates exposed to the start of the ORV season (Setser 2001). Moreover, not all individuals hibernate, while others may become active intermittently throughout the winter (Grant and Doherty 2009; Muth and Fisher 1992). Of particular concern, juvenile FTHLs born in late summer likely do not hibernate, as they are able to reach adult size by the following summer (Grant and Doherty 2009; Muth and Fisher 1992). Any activities that disproportionately affect juvenile FTHLs can potentially lead to significant population declines during the following breeding season.

Even hibernating FTHLs may be threatened by the impacts of ORV use (Lovich and Bainbridge 1999; Nicolai and Lovich 2000; Stebbins 1995; Luckenbach 1975; Webb 1983). FTHLs typically use rather shallow hibernation burrows that are often no more than five to six centimeters deep, although they can be as deep as 20 cm (Mayhew 1965; Muth and Fisher 1992; Grant and Doherty 2009). Tire passes by lightweight vehicles are known to increase soil compactions to depths of 30-60 cm (Webb 1983), leading many to hypothesize that FTHL may be crushed by passing ORVs (FTHLICC 2003; Stebbins 1995). Aggressive riding can destroy FTHL burrows. Although in a controlled study, Grant and Doherty (2009) reported no instances of FTHLs being killed while in hibernation even when run over directly, this study had very low statistical power and was unable to detect mortality rates as high as 22 percent (Grant and Doherty 2009). While no direct kills were observed during hibernation, there was indirect evidence of ORV impacts. In OWSVRA (an open area with frequent ORV use) 78 percent of FTHLs chose hibernation sites either under or near shrubs, but in East Mesa (an area of relatively little ORV use), only 42 percent chose burrow sites near shrubs (Grant and Doherty 2009). This result implies that FTHLs in heavy ORV use areas may preferentially choose burrows sites near shrubs not because they are favorable sites for FTHLs, but because ORV riders may tend to avoid shrubs. Additionally, ORVs cause reduction in native vegetation and harvester ant abundance (Lukenbach and Bury 1983; Bury and Luckenbach 1983), thus, as lizards emerge from hibernation, they may have limited food resources and associated decreases in fecundity (Young and Young 2000). Although not documented in FTHLs, the loud noises associated with ORVs have been shown to cause early emergence from aestivation in other animals (Lovich and Ennen 2011).

6.2.2.2. ORV Impacts During the FTHL Active Period

ORV activity is generally lower over much of the time that FTHLs are active (Grant and Doherty 2009). Even still, many researchers have observed dead FTHLs and other desert lizards killed by ORVs (Luckenbach 1975; Luckenbach and Bury 1983; Muth and Fisher 1992). Few studies have directly analyzed the effects of ORVs on FTHLs specifically (Beauchamp et al. 1998; Setser and Young 2000; Setser 2001; Wright 2002; Nicolai and Lovich 2000) and even fewer studies have done so in a rigorous controlled manor (McGrann et al. 2006; Grant and Doherty 2009). Studies have revealed potential behavioral impacts in FTHLs exposed to ORVs. For instance, three male lizards showed reduced movement following a large ORV race (Nicolai and Lovich 2000). Lizards in OWSVRA exhibit unique habitat preferences that may be an indication that FTHLs seek refuge in unique habitats to escape ORVs; however it may simply be an indication that FTHLs are able to utilize diverse habitats (Beauchamp et al. 1998). Setser and Young (2000) and Setser (2001) both reported a strong inverse relationship between ORVs use intensity and FTHL abundance in OWSVRA, but the cause of this trend remains unknown, as it was not directly tested. An analysis by Wright (2002) also indicates that FTHL encounter rates were significantly more frequent in limited use areas (e.g. Naval base) compared to open ORV areas (e.g. Plaster City and Superstition Mountain Open Areas). Luckenbach and Bury (1983) recount anecdotal evidence that FTHL abundance has decreased sharply in Algodones Dunes, an area with extremely high ORV use.

In a controlled study, McGrann et al. (2006) investigated the impact of ORVs in paired high and low use plots along the border of the West Mesa MA (limited use area) and Superstition Mountain Open Area as well as along a limited use route in the Yuha Desert MA. In the West Mesa area, open access, high use plots supported fewer FTHLs with reduced body mass compared to low use plots (McGrann et al. 2006). Therefore, ORV use can reduce FTHL densities. In contrast, there was no significant difference in lizard densities between high and low use plots along the Yuha Desert limited use route, but FTHL body mass was significantly lower in high use plots. In all cases, harvester ant abundance was lower in high use plots (McGrann et al. 2006). In all cases these results indicate that ORV impacts reduce FTHL mass (McGrann et al. 2006). The authors hypothesize that reduced mass may be due to altered feeding behaviors or poor habitat quality in high use areas (McGrann et al. 2006). In either case, high use areas do not properly satisfy the nutritional needs of FTHLs, which can have disastrous impacts on fecundity and recruitment (Young and Young 2000; CVCC 2013a; McGrann et al. 2006) placing the FTHL as increased risk of extinction due to ORVs.

In the 2011 withdrawal of the proposed rule to list the FTHL as threatened, the USFWS concluded that vehicles do not pose a significant threat to the FTHL:

> "Because the FTHL occurs naturally in low densities, roads are generally widely separated, and ORV activity is only intense in a few areas, the changes that a FTHL being crushed by vehicle activity is low over the majority of the species' range." (76 FR 14210, pg. 14250)

This conclusion is misguided. Figures 14, 15 and 16 clearly show that ORV use is extensive throughout the California portion of FTHL range. Studies show that vehicular mortality on paved roads can be as high as 23 percent, even on infrequently traveled roads (Hodges 1997). Mortality rates from ORV are less clear, but of the 42 lizards that Muth and Fisher (1992) equipped with radio-transmitters, one was killed along a very infrequently traveled military road and two were killed by illegal ORV use. Therefore, even in areas where unauthorized ORV use is banned with military enforcement, five percent of FTHLs were directly killed by ORVs (Muth and Fisher 1992). The entire Yuha Desert MA is crossed by limited use ORV routes, which are expected to be more frequently used by ORVs than military areas. Assuming even this conservative ORV kill rate of five percent and a population size of 25,000 lizards (Grant and Doherty 2007) and no unlawful off-route use, over 1,200 lizards in the Yuha Desert MA are at risk of direct mortality associated with ORVs.

6.2.3. Inadequacy of Existing Management- Vehicles

The RMS does little to protect the FTHL from ORV use. The MAs were originally established to encompass as much high quality habitat as possible while avoiding management conflicts, such as ORV use (FTHLICC 2003; 76 FR 14210). Therefore, since its inception, the Interagency Coordinating Committee (ICC) has intentionally avoided addressing conflicts associated with ORVs, which effectively undermined efforts to manage for responsible ORV use. The RMS calls for efforts to reduce route proliferation within MAs, including roads. However, Figure 14 clearly shows that the RMS has not effectively reduced the proliferation of human disturbance in MAs. Although all routes within MAs are designated as limited use and efforts were made to place signs on routes to increase public awareness of rules and encourage compliance (FTHLICC 2003), enforcement is inadequate. In a report generated by the U.S. General Accounting Office in 1995 (prior to the development of the RMS), ORV enforcement was lacking:

> "At all locations, ORV use was being monitored casually rather than systematically, adverse effects were seldom documented, and needed corrective actions remained to be prioritized. Although citations were being written for violations at all locations enforcement was hampered by confusion over where and when restrictions applied" (USGOA 1995, pg. 2).

We found no evidence to suggest that enforcement has improved greatly since this report.Wright (2002) reported that between 1985 and 2001, the number of routes within the Yuha Desert, West Mesa, and East Mesa MAs had increased a total of 387 percent, while routes increased by 819 percent within areas completely open to off-road vehicle use. McGrann et al. (2006) reported heavy ORV disturbance in limited areas within the Yuha Desert MA, highlighting the ineffectiveness of current management designations. Figures 15 and 16 demonstrate the prevalent of illegal ORV use. Evidence from other areas of the California desert managed by the BLM, including the West Mojave (WEMO) plan area, also shows widespread noncompliance with limited routes and inadequate enforcement.[3] Increased enforcement is required to ensure compliance, but the provisions set forth by the RMS are not only voluntary, but also subject to the availability of funds and resources (FTHLICC 2003).

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[3] Information collected by the BLM in monitoring the motorized route network in the WEMO plan area shows very high levels of non-compliance with limited use routes and use of closed routes. In September 2012, the BLM provided the results of its "baseline monitoring" within the WEMO plan area. The baseline data focused on whether closed or otherwise unauthorized routes intersecting open routes were receiving motorized use. The monitoring data demonstrated that non-compliance with the route designations is extremely widespread. The BLM's Monitoring Results table establishes that of 1952 unauthorized or closed routes initially assessed, 1898, or 97%, were documented to have received some degree of unauthorized motorized use. (*See* BLM WEMO Monitoring Results http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/cdd/west_mojave_plan_updates.Par.39996.File.dat/Exhibit%20B%20-%20WEMO%20Route%20Monitoring%20Results%20Filed%2012_21_12.pdf). Of those, 49% were documented to have received "heavy route use," defined as 26 tracks or more. (*Id*.) In 2013, BLM did a "pilot test" repeat monitoring in the Black Mountain subregion. This test showed that the number of illegal routes or "incursions" and unlawful use had risen significantly in only one year. (*See* Black Mountain Pilot Test Summary http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/cdd/west_mojave_plan_updates.Par.57813.File.dat/Pilot_Test_Summary_062813.pdf).

As stipulated in the RMS, the OWSVRA was established as a Research Area (FTHLICC 2003). While research has occurred in OWSVRA, there are no conclusive park-run studies that have rigorously tested the effects of ORVs in this area (but see Grant and Doherty 2009). Beuchamp et al. (1998) note how difficult it is to test ORV impacts because OWSVRA does not have sufficient control sites, as the entire region is heavily impacted by human disturbance. Therefore, in over 10 years of operation as a designated Research Area, OWSVRA has not sufficiently served its research purposes.

Experts warn that until the full effects of ORVs are known, sensitive areas should be closed to ORV activity (Lovich and Bainbridge 1999; McGrann et al. 2006). Even in areas of limited ORV use, plants and animals, including FTHLs, can be impacted negatively (Bury and Luckenbach 1983; McGrann et al. 2005; McGrann et al. 2006). Given the considerable threats that ORVs and vehicles pose to FTHLs and the fact that the vast majority of FTHL range in California is subject to ORV use, the RMS is not sufficiently protecting the FTHL leaving the species as risk of serious population decline and extinction.

6.3. Fragmentation, Barriers, and Small Populations

Habitat fragmentation due to dispersal barriers that isolate small populations poses a threat to the viability of the FTHL. Lasky et al. (2011) briefly review the effects of barriers:

> "Reduced gene flow between populations, [which] can lead to drift caused genetic divergence between populations and rapid loss of genetic diversity in small isolated populations. Smaller isolated populations may also be subject to an increased risk of extinction. Populations near species' range margins are often of low density and might be similarly vulnerable if isolated by dispersal barriers. Even slight decreases in dispersal may have large consequences for species' populations such as extinction of a low-density metapopulation." (Lasky et al. 2011, pg. 674)

FTHLs typically remain in relatively small home ranges for the duration of their life, but gravid females have been observed traveling well beyond their home ranges (over 1.6km) for oviposition (Young and Young 2000; Setser 2001). Barriers may disrupt these reproductive behaviors.

FTHLs are divided into three distinct genetic populations, only two of which have a portion of their range in California (i.e. Eastern and Western populations, see Range and Distribution). Although genetically similar to the Western population, FTHLs in the Coachella Valley are completely isolated from the large populations to the south due to extensive human development in the region (CVCC 2013b). The USFWS conducted an analysis of each population to determine if manmade barriers and fragmentation have resulted in small populations that are left at greater risk of extirpation (76 FR 14210). They separated each population into small segments that are presumed to be isolated from gene flow by complete barriers such as major highways, canals, railroads, and the international border. Then, using density estimates (Root 2010), they estimated the population size of each of these fragmented areas to determine if they should be considered "small populations." For the purposes of their assessment, they considered a population to be "small" if, through extrapolations, the area was too small to support at least

7,000 individuals. Vertebrate populations are estimated as needing between 5,000-7,000 breeding individuals to remain viable (Traill et al. 2010; Reed et al. 2003); however, such estimates are speculative as necessary minimum populations sizes vary by species (Thomas 1990; Flather et al. 2011). Most portions of the range are large enough to support "viable" (as defined by >7,000 individuals) populations of FTHL. As discussed previously in the Abundance section, there are serious issues with extrapolating density estimates to the entire FTHL range in order to estimate population size and viability. Density estimates are based on the highest quality FTHL habitat and do not represent density of low-quality habitat, which comprises the majority of FTHL range (Root 2010). Using the invalid assumption that FTHL density estimates obtained from high quality plots could be extrapolated to the species entire range, the USFWS determined: "For the Western, Eastern, and Southeastern population areas combined, about 91% of the… area is in large enough blocks that the populations of FTHL therein are not likely to be affected by threats associated with small populations" (76 FR 14210, pg. 14247). However, since the assumptions used to produce this conclusion are invalid, the assessment does not accurately reflect the magnitude of the threats facing the FTHL and should not be used to guide policy decisions.

While the calculations used to determine if barriers have produced "small" populations were flawed, it is true that there are numerous barriers that fragment FTHL habitat and result in numerous metapoplations that are at increased risk of localized extirpations. Major roads, canals, railroads, and the U.S.-Mexican border most certainly act as barriers to the free movement of wildlife. The USFWS did not consider other barriers in their assessment even though minor roads, areas of heavy and frequent off-road vehicle use, renewable energy, and other forms of development also serve as potential barriers. With the possible exception of canals and major interstate highways, most of these barriers are likely semipermeable, allowing some level of gene flow (76 FR 14210; Rorabaugh 2010; Barrows et al. 2006). However, barriers can still strongly influence populations, even if they are semipermeable, by creating small, marginal populations (Epps et al. 2005). Lasky et al. (2011) remind:

> "Marginal populations can be important to species' genetic diversity and may be important to future species' evolution, especially against a background of environmental change. Dispersal may also play a key role in community assembly, so that barriers may also alter ecological communities." (pg. 683)

It may be true that in isolation the barriers bisecting FTHL habitat do allow for limited gene flow, but FTHL habitat is so severely impacted that cumulatively these semipermeable barriers may turn into complete barriers, entirely isolating small populations (Figure 17). For example, both the Yuha Desert MA and the West Mesa MA support populations of FTHLs and the RMS specifically states that efforts should be taken to maintain habitat corridors between these MAs to allow genetic connectivity (FTHLICC 2003, pg. 29). Despite this goal, the Yuha Desert population is separated from the West Mesa MA by the Plaster City ORV Open Area, portions of the Ocotillo Wind Energy Facility, and Interstate 8. Combined, these barriers likely prevent any genetic connectivity. The effects of ORV Open Areas and energy development projects should not be dismissed as barriers to the FTHL:

> "If not carefully planned, it [utility-scale renewable energy development] could come at the expense of the viability of local species today or constrain their ability to adapt to future conditions by destroying, or creating dispersal barriers to, areas they will need in the future;" (Cameron et al. 2012, pg. 1)

> "If dunes are fragmented and effectively made into small habitat islands by vehicular recreation or management schemes, then immigration rates would be expected to become lower while extinction rates would increase." (Bury and Luckenbach 1983, pg. 218).

6.3.1. Edge Effects

The interface between human development and natural areas produces a boundary effect, frequently manifesting negative impacts on native flora and fauna that are dependent on areas of undisturbed habitat. Due to the indirect influences of human development, edge effects can often extend several hundred miles into natural, undisturbed areas (Laurance 2000). While the impacts of human development vary considerably from species to species, the FTHL is particularly vulnerable to negative impacts associated with edge effects (Young and Young 2005; Barrows et al. 2006). Young and Young (2005) analyzed the effect of boundaries between undisturbed FTHL habitat and urban and agricultural development in Yuma, Arizona. There was a highly significant negative correlation between FTHL presence and proximity to development, indicating a negative impact far beyond the boundaries of human development (Young and Young 2005). In fact, FTHLs were negatively impacted at least as far as 450 m away from developed land (Young and Young 2005). Therefore, development along the border of protected conservation areas greatly diminishes the overall size of the reserve. Young and Young (2005) estimated that for every mile of development bordering a managed area at least 73 ha of land are impacted within the reserve boundary. Barrows et al. (2006) reported a slightly more modest but still pronounced and highly significant edge effect, indicating FTHLs are negatively impacted up to 150 m from the habitat boundary.

This loss of habitat in reserve land can have potentially dire consequences "because the habitat [within the managed area] is still intact [so] FTHL[s] will continue to move into these areas, creating a population sink that will have a negative impact on the overall population on an ongoing basis" (Young and Young 2005, pg. 7). The cause of such edge effects has primarily been linked to predation (Young and Young 2005) and potentially also road mortality (Barrows et al. 2006). Loss of viable habitat coupled with shifting trophic interactions threatens the viability of FTHL:

> "Dynamics of the flat-tailed horned lizard population occupying a 100–200m boundary region of the available habitat appears to have shifted from a bottom-up process where the lizard numbers are regulated by native ant abundance, to a top-down process where the lizards are limited by predation, and possibly road mortality. This shift in regulatory processes may contribute to a habitat ''sink'' along the preserve boundary. For 2003 and 2004 combined, the horned lizards' mean reproductive success ranged from 0 to 0.2 hatchlings/adult at distances from 0 to 150m from the habitat edge; at 200m from the edge and in core plots, mean reproductive success averaged 0.8 hatchlings/adult (Barrows, unpubl. data).

> Without immigration from the preserve core, flat-tailed horned lizards may not be able to sustain populations in the boundary region." (Barrows et al. 2006, pg. 493)

Some argue that since FTHL MAs are very large relative to the movement of the species that the negative impacts of edge effects are reduced (Young and Young 2005; 76 FR 14210); however, given that most MAs are surrounded by heavily disturbed areas, the impact is not negligible. Using Young and Young's (2005) estimate (for every mile of development along a reserve boundary, 73 ha of the reserve are indirectly affected), Figure 18 demonstrates the impact edge effects have on the Management Areas and preserves that harbor FTHL populations. Large proportions of the Yuha Desert, East Mesa, and West Mesa MAs boundaries border human development, which due to edge effects, effectively decreases the overall size of the Management Areas. At least 6.5, 6.6, and 3.0 percent of Yuha Desert, East Mesa, and West Mesa MAs, respectively, are indirectly affected by development bordering the MAs, which limits the amount of habitat that is available for FTHLs (Figure 18). Moreover, within MA boundaries and beyond the reach of urban and agricultural centers, each MA has a large and ever increasing degree of human disturbance (Figures 19 and 20); Wright 2002; USFWS 2003). The MAs are heavily fragmented by roads, ORV routes, power lines, and authorized development projects, all of which increase the number of 'edges' capable of negatively influencing FTHLs. While roads and off-road vehicle routes may not cause 450m of impact as does more intensive agricultural and urban development, even infrequently traveled roads have been shown to influence edge effects (Young and Young 2000; Barrows et al. 2006).

The negative influence of edge effects on FTHLs has been linked to increased predation in association with human development and road mortality. The spread of invasive species along habitat boundaries is also a potential threat the FTHL.

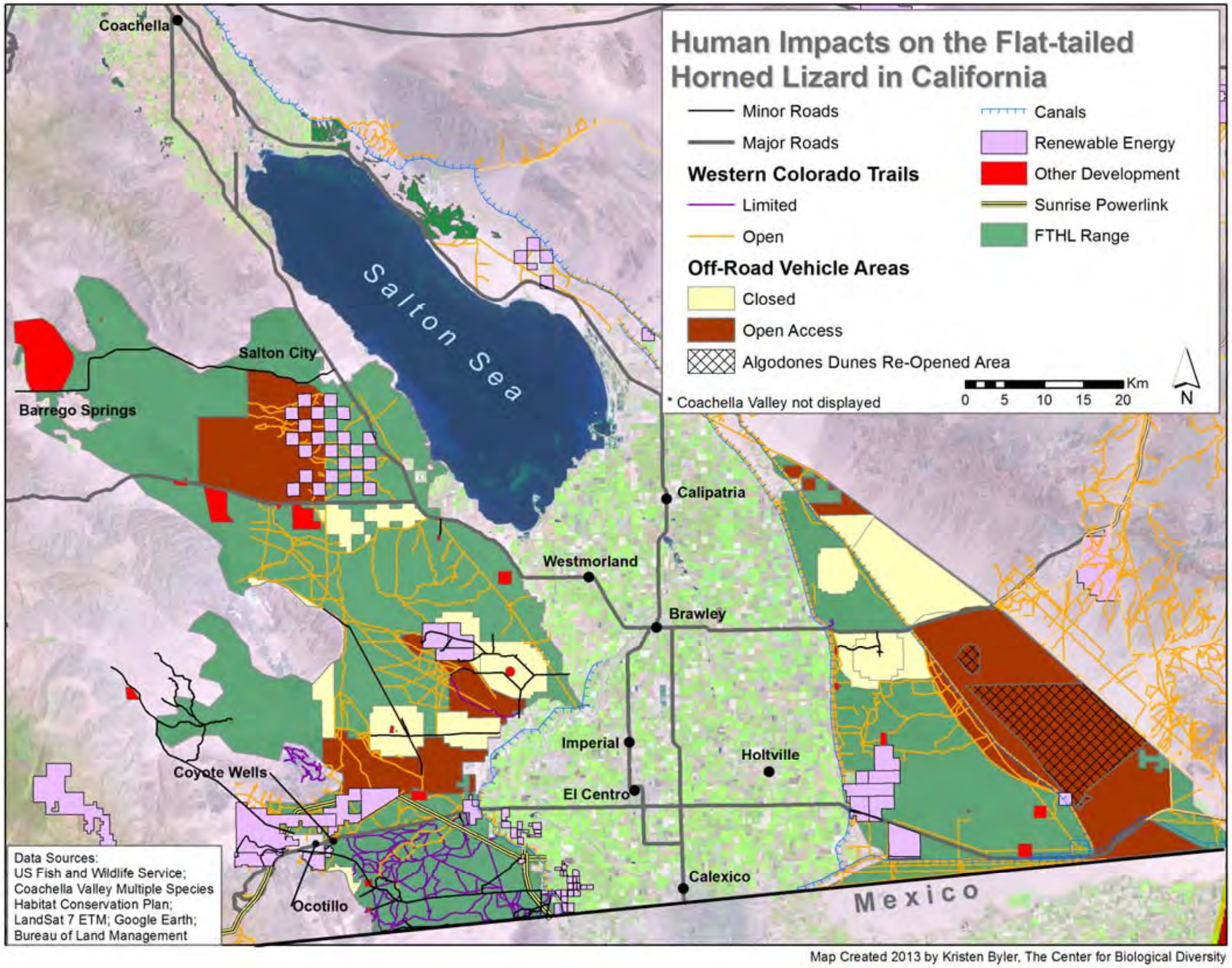

Figure 17. Human impacts on the flat-tailed horned lizard in California. The cumulative impacts demonstrate how little FTHL habitat remains undisturbed. Note the Imperial Sand Dunes Recreation Area has recently altered their open and closed access area, making more land available for open access off-road vehicle use than is shown here.

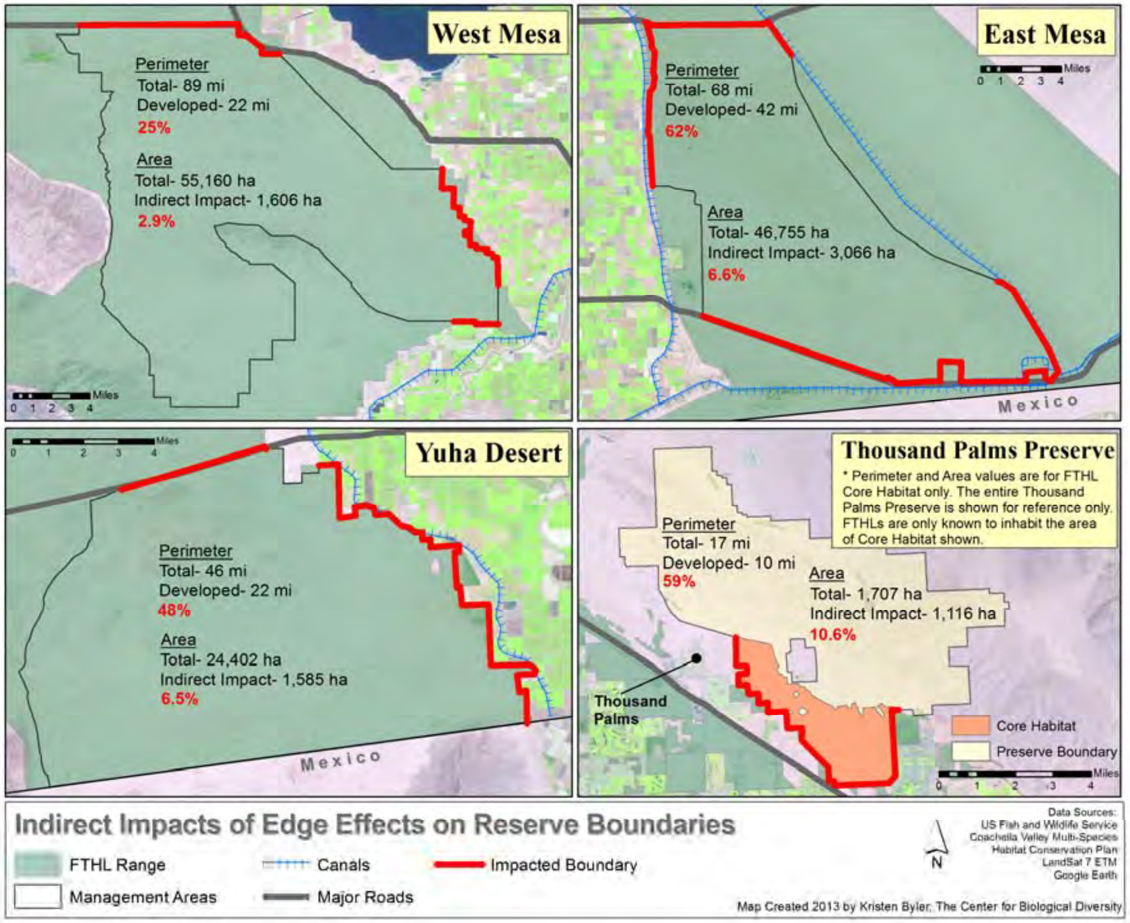

Figure 18. Indirect impacts of edge effects influencing the boundaries of FTHL Management Areas and Habitat Conservation Areas. Only major roads, canals, and areas of agricultural and urban development were considered as producing pronounced edge effects. For every mile of development along a reserve boundary (red lines), 73 ha of the reserve are indirectly affected (Young and Young 2005). Using this estimate, the total area and percent of each reserve that is indirectly impacted by edge effects is given. The Borrego Badlands Management Area is not displayed as it is not strongly impacted by edge effects. FTHLs do not occupy all of the land within the Thousand Palms Preserve.

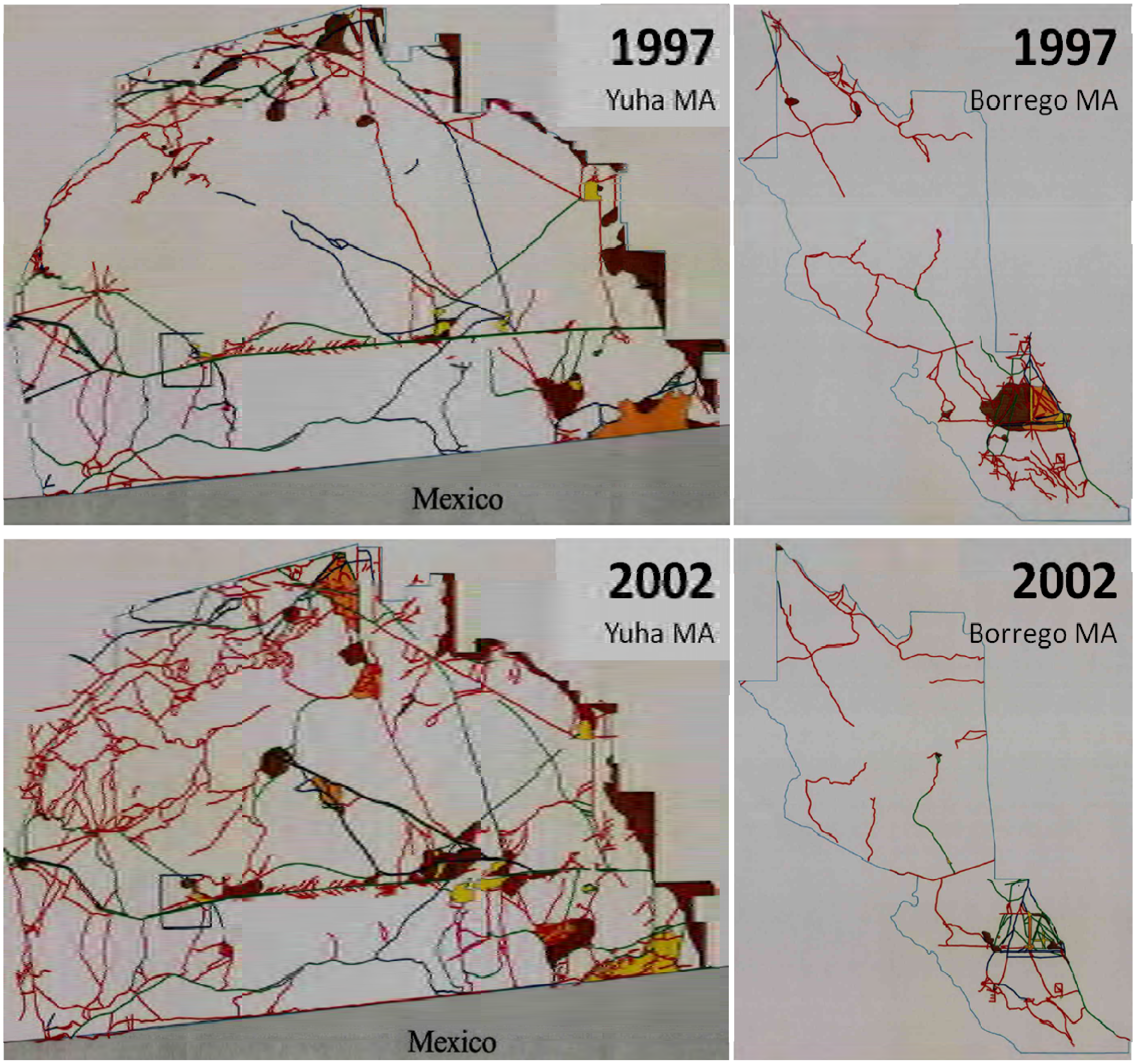

Figure 19. Increases in human disturbance within the Yuha Desert and Borrego Management Areas from 1997 to 2002. Lines indicate roads and routes (red= single track, green= double track, blue= triple track); areas of high, medium, and low disturbance are shown in yellow, orange, and dark red respectively. Analysis was conducted using aerial photography. Maps modified from maps prepared by Matthew Daniels at the U.S. Fish and Wildlife Service in 2002; maps are from an unpublished U.S. Fish and Wildlife Service report (USFWS 2013).

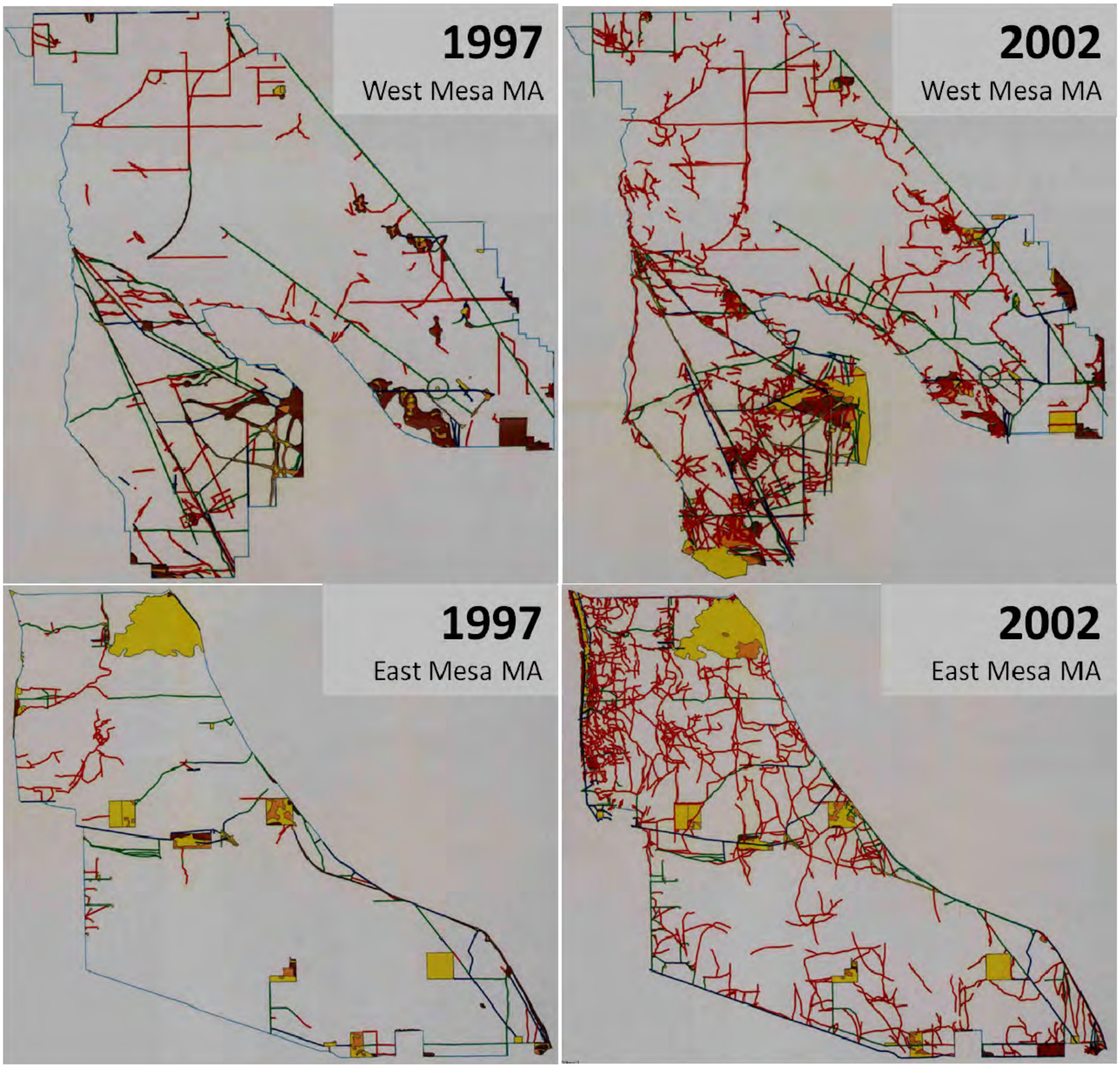

Figure 20. Increases in human disturbance within the West Mesa and East Mesa Management Areas from 1997 to 2002. Lines indicate roads and routes (red= single track, green= double track, blue= triple track); areas of high, medium, and low disturbance are shown in yellow, orange, and dark red respectively. Analysis was conducted using aerial photography. Maps modified from maps prepared by Matthew Daniels at the U.S. Fish and Wildlife Service in 2002; maps are from an unpublished U.S. Fish and Wildlife Service report (USFWS 2013).

6.3.1.1. Predation

FTHLs are naturally subjected to relatively high rates of predation, but rates increase closer to habitat boundaries (Young and Young 2000, 2005; Barrows et al. 2006). Many predators actually increase in abundance in association with edge effects, leaving FTHLs especially vulnerable. For instance, Barrows et al. (2006) showed a strong positive correlation between the habitat edge and loggerhead shrike (*Lanius ludovicianus)* abundance. Another major FTHL predator, the round-tailed ground squirrel (*Spermophilus tereticaudus*), are more abundant in association with urban and agricultural development (Young and Young 2000, 2005). While these are both natural predators, any increase in predation rate may jeopardize the viability of FTHL populations. Young and Young (2000) warn that increased ground squirrel densities will negatively impact FTHLs.

FTHLs are especially susceptible to loggerhead shrike attacks in areas of increased human disturbance, especially along roads. FTHLs loose the benefit of camouflage on paved roads, and since they freeze when in danger, they are particularly vulnerable. Creosote bushes typically grow taller along roads, which supply shrikes and other birds with prime perching sites; powerlines also frequently line roads and also act as excellent perches (Young and Young 2000). Although not empirically tested, Young and Young (2000) noted that juvenile FTHL are more frequently predated upon by shrikes, leaving the entire population vulnerable to even slight increases in predation. In the Coachella Valley, urban and suburban development has increased the prevalence and range of many native avian predators (Barrows et al. 2006). American kestrels (*Falco sparverius*) have become more common due to the increased prevalence of palm trees and other exotic vegetation favored in landscaping and as nesting sites for kestrels. Dead FTHLs are frequently found in palm trees up to 0.7km from the habitat edge (Barrows et al. 2006). Increased vegetation and agricultural fields also offer more sheltered and favored nesting sites for loggerhead shrikes. Prior to human development, there were no trees in and around the Coachella Valley sand dunes, suggesting FTHLs are being subjected to levels of predation not experienced in a pre-development landscape (Barrows et al. 2006).

6.3.1.2. Road Mortality

Infrequently traveled, two-lane roads do not appear to be a barrier to FTHL movement as lizards are frequently found on roads (Norris 1949; Altman et al. 1980; Muth and Fisher 1992; Young and Young 2000; Barrows et al. 2006). However, FTHLs are vulnerable to direct mortality via road kills (see Vehicular Impacts above). Barrows et al. (2006) found that while edge effects are present in association with all road types, the effect is more pronounced on busier and larger roads. Young and Young (2000) also noted that roads have prominent edge effects, as lizard as far as 500m away from a road will frequently come in contact with the road. They estimate that for every kilometer of road, approximately 100 ha of the surrounding habitat may be impacted (Young and Young 2000).

6.3.1.3. Invasive Species

Biological invasions are also capable of reducing the effective size of a reserve through edge effects. For instance, in desert landscapes the highly invasive Argentine ant (*Linepithema humile*) is generally limited to developed areas with ample water supplies; however, they are able to invade up to 100 m into semi-arid undisturbed habitats, greatly reducing native ant abundance within that range (Suarez et al. 1998). Argentine ants, coupled with habitat loss and fragmentation, have been linked to population declines in *Phrynosoma coronatum*, a close relative of the FTHL (Suarez and Case 2002). Since horned lizards specialize on harvester ants, when invasive Argentine ants displace native ant species, the horned lizard prey base is negatively affected. When *P. coronatum* were only fed Argentine ants, lizards suffered zero or negative growth rates, indicating that it is highly unlikely that horned lizards will be able to survive on diets composed primarily of invasive ants (Suarez and Case 2002). Those studies that have investigated the impact of Argentine ants on FTHLs have failed to show a decrease in harvester ants abundance near edges (Young and Young 2005; Barrows et al. 2006). Regardless, along the margins of urban and agricultural development, Argentine ant abundance should be closely monitored, as invasions have the potential to displace native harvester ant species and harm the viability of FTHLs.

6.3.2. Inadequacy of Existing Management- Edge Effects

The RMS offers no specific mitigation strategies to address edge effects. While development within MAs is discouraged, and any development on FTHL habitat is subject to mitigation and compensation, development along the boundaries of MAs is increasing. Additionally, habitat disturbance continues within the boundaries of MAs (USFWS 2003), which contributes to fragmentation and increased exposure to potential edge effects even within the "protected" cores of the MAs. The RMS does not specify the need to establish strategies to reduce predation associated with development (FTHLICC 2003), although the compensation procedures do suggest that indirect effects be considered, such as predation associated with the development of powerlines, towers, and other perching locations. The RMS does not prevent development outside of MAs, even if edge effects are a prominent threat. Within MAs, the RMS stipulates that development should not exceed one percent of the total area of the MA. However, in determining this cap, only the direct physical footprint of the disturbance is considered. Given the clear relationship between development and decreased FTHL abundance, edge effects should be included in the calculation of the development cap.

6.4. Military Training Activities

There are two military installations within the FTHL range, which are predominantly used for military training activities. The Barry M. Goldwater Range is located in Yuma, Arizona and is administered by the U.S. Marine Corps Air Station. Within California, the Naval Air Facility El Centro has two large ranges within FTHL range; Range 2510 has 12,060 ha of land within the West Mesa MA, representing 22 percent of the MA; all of the 3,440 ha of Range 2512 are located within the East Mesa MA, covering 7% of the MA (FTHLICC 2003). Most training is aircraft related, but military activities causing surface disturbance do threaten FTHLs. On the ground activities include non-exploding bombing, ground-based training, target maintenance, target site clean-up, road travel and maintenance, mobile target activities, and target and run-in-line grading (FTHLICC 2003; 76 FR 14210). There are three areas used for inert bombing exercises, each with an impact radius of up to 460 m (FTHLICC 2003). Certain incendiary devices are capable of starting wildfires, although efforts are taken to reduce fire risk (FTHLICC 2003). Non-military ORV use is prohibited, but illegal ORV recreation does occur on the military bases (FTHLICC 2003; Muth and Fisher 1992). Both the U.S. Marine Corps and the U.S. Navy are signatories to the Interagency Conservation Agreement having incorporated components of the RMS into their respective Integrated Natural Resources Management Plans (76 FR 14210). Both agencies have devoted monetary resources to monitoring efforts (FTHLICC 2005-2011), although it is unclear what actions have been taken to mitigate the threats associated with military activities. The USFWS argues "most military activities are confined to previously disturbed areas, so the amount of destruction or modification of FTHL habitat is limited" (76 FR 14210, 14231). Even though additional habitat may not be lost by military activities, continued impacts preclude habitat restoration in areas of otherwise high-quality FTHL habitat and serve to further fragment the landscape.

6.5. Activities along the United States-Mexico Border

The FTHL range extends across the international U.S.-Mexican border in three distinct regions, with portions of the Eastern, Western, and Southeastern populations all straddling the border (see Range and Distribution). The U.S.-Mexican border is heavily trafficked due to illegal immigration and narcotics smuggling (Goodwin 2000; Cohn 2007; Lasky et al. 2011). In response, U.S. Customs and Border Patrol actively patrols the border using off-road vehicles and surveillance cameras, in addition to pedestrian and vehicle fences and barriers (FTHLICC 2003; Cohn 2007; Rorabaugh 2010; Lasky et al. 2011). Activities along the international border directly and indirectly impact FTHLs through direct impacts from vehicle travel, fragmentation of the landscape, and indirect impacts from fences/barrier providing predator perching opportunities and others.

6.5.1. Border Fences

Largely due to the Secure Fence Act of 2006, barriers to human movement currently cover over 1200 km of the international border (Cohn 2007; Lasky et al. 2011). In a very thorough analysis Lasky et al. (2011) estimated that the border runs through 320 km of FTHL range (this estimate likely included historic range), of which 133 km have pedestrian fences; the USFWS estimated that about 126 km of current FTHL range is affected by border activity (76 FR 14210). Many argue that the construction of border fences and walls will "fragment the Sonoran Desert ecosystems, damage the desert's plant and animal communities, and prevent free movement of wildlife between the U.S. and Mexico" (Cohn 2007; pg. 96). While the Department of Homeland Security need not consider environmental consequences in relations to border walls as dictated by the REAL ID Act of 2005 (Cohn 2007; Lasky et al. 2011), the impacts of border activities on FTHLs should be considered carefully in order to ensure any negative effects are mitigated where possible and compensated for through additional conservation efforts throughout the FTHL's range.

Most of the pedestrian fences present in California are known as bollard fences, which are typically 18 ft high, with four-inch gaps between each bollard (Lasky et al. 2011, suppl. mat.). While in many cases the gaps in bollard fences extend to the ground allowing for passage of small organisms, in some cases the bollards are raised off the ground limiting movement (Lasky et al. 2011, suppl. mat.). Rorabaugh (2010) also notes that pedestrian fences do not likely act as complete barriers to FTHL movement, although they do likely limit connectivity. It is well understood that barriers need not be complete to negatively affect species (reviewed by Lasky et al. 2011). Species are at greatest risk from current barriers if they have small ranges that are split through the middle by the border (Laskey et al. 2011). The range of the Western FTHL population is not only small, but is also split by the border. While the border also splits the Eastern population, the vast majority of this population's range is in California and species are more vulnerable to perturbations along the margins of their range (Lasky et al. 2011). Thus, because the Eastern population is small and the border crosses through the southern margin of the species range in this location, border fences within the Eastern populations pose a disproportionally larger threat to the FTHL.

6.5.2. Border Patrol

There is evidence to suggest that illegal border crossing traffic and associated ORV use has been reduced in Yuma, Arizona because of the border fence (Rorabaugh 2010). The effects of the fence are less clear in California. Since the border fences are not continuous, any breaks in the fence generally experience increased traffic, which may only serve to concentrate negative impacts (Lasky et al. 2011). Regardless of the impact of the border fence itself, illegal ORV use, and ORV use associated with border patrol enforcement, occurs along the border (FTHLICC 2003; Rorabaugh 2010; 76 FR 14210). ORV impacts on the FTHL are discussed in detail above, and efforts should be taken to minimize ORV use. U.S. Customs and Border Patrol also use remote video surveillance systems (RVSS) to monitor illegal activities along the border. Recently, the Department of Homeland security approved a plan to build 18 RVSS towers, and associated access roads, in Yuma and Tucson, Arizona (USCBP 2012). Two of these towers are located in the Yuma FTHL MA and another four are within FTHL range. The direct surface disturbance is relatively small (approximately 0.4 ha) but towers do provide additional perching sites for avian predators, which has been shown to negatively affect FTHLs (Young and Young 2005; Barrows et al. 2006). Despite the increased risk of predation, RVSS can monitor a larger area than deploying border agents to patrol the region by vehicle (USCBP 2012) and may reduce some vehicle use along the border.

6.5.3. Inadequacy of Existing Management- U.S.-Mexico Border

The RMS calls for actions to reduce the impacts of border patrol. Specifically, the RMS encourages coordination between Mexico and the U.S. Immigration and Naturalization Service in an effort to ensure FTHL movement across the borders in the Yuha Desert and Yuma Desert MAs; it is unclear why the East Mesa MA is not included in this Planning Action (FTHLICC 2003, pg. 29). The use of remote cameras and vehicle barriers is also encouraged to deter ORV activity. RMS signatories have engaged the U.S. border patrol agents in educational presentations including a one-to-two hour presentation on desert ecology (FTHLICC 2003, pg. 34). While these mitigations measures are likely beneficial, the RMS has little to no authority or influence on border activities. The FTHL is more likely to be able to sustain the negative impacts associated with border activities if ORV use, human development, fragmentation, nonnative plants, and climate change in other parts of its range do not simultaneously threaten FTHLs.

6.6. Nonnative Plants

Nonnative and invasive plant species throughout the Colorado Desert have the capacity to alter desert landscapes and cause ecosystem shifts and trophic cascades that will negatively influence the FTHL. In general, FTHLs are associated with the creosote bush scrub community (see Habitat Requirements). While plant associations may vary across FTHL range, lizards are often found in habitats dominated by creosote bush (*Larrea tridentata*) and bursage (*Ambrosia dumosa*; Young and Young 2000; Turner et al. 1980; Johnson and Spicer 1985). FTHLs are reliant on native vegetation for shade, protection from predators, and effectively trapping windblown sand (Muth and Fisher 1992). Additionally, native vegetation provides seeds for harvester ants, which are the primary food source for FTHLs (Pianka and Parker 1975). Therefore, any forces that alter native vegetation threaten FTHLs.

6.6.1. Invasive annual grasses and altered fire regimes

Aggressive nonnative annual grasses have invaded and subsequently altered the creosote bush scrub habitat throughout the southern Californian desert (Steers and Allen 2011; Rao and Allen 2010; Brown and Minnich 1986; Lovich and Bainbridge 1999). The abundance of invasive annuals is highly dependent on rain, such that in years with heavy precipitation, invasive species rapidly proliferate (Barrows et al. 2009; Rao and Allen 2010). In years of heavy rain, invasive annuals may directly impact FTHLs, but these direct effects are likely short in duration. However, the indirect effects of invasive annual grasses threaten the stability of the entire desert ecosystem (Steers and Allen 2011), which inevitably threatens the FTHL.

Fire is generally very rare in the Colorado Desert, but invasive annual grasses have effectively heightened the extent, frequency, and severity of natural fire regimes throughout desert shrublands (Brown and Minnich 1986; Steers and Allen 2010, 2011; Rao and Allen 2010). In years of heavy rain, native and invasive species grow rapidly, producing higher than normal standing biomass, which fuels widespread and intense fires (Brown and Minnich 1986). Fire is problematic in the region because native flora is typically characterized by long-lived species with low productivity and slow recovery from disturbance. Native desert shrubs are not generally adapted to cope with fire and lack the traits needed for recovery, while invasive species are generally more fire tolerant than native species and can competitively displace natives (Steers and Allen 2010). Following a fire, there is often a shift in the species composition (Steers and Allen 2011). Even after nearly 30 years post-fire, species richness and diversity have decreased in areas within the Coachella Valley, as the landscape has become dominated by brittlebush (*Encelia farinose*), a short-lived shrub (Steers and Allen 2011). Long-lived native species have struggled to recover, including species important to the FTHL such as creosote bush and bursage (Steers and Allen 2011). Additionally, increased anthropogenic nitrogen deposition has been linked to the spread of invasive grasses and accelerated fire regime in the Colorado Desert (Rao and Allen 2010; Rao et al. 2010).

6.6.2. Sahara Mustard

Sahara mustard (*Brassica tournefortii*) is a highly invasive annual plant that posed a significant and imminent threat to the FTHL. While the majority of research on Sahara mustard has been conducted in the Coachella Valley, the species is present throughout the entire range of the FTHL in California (Figure 21). Sahara mustard has been continuously present in the Coachella Valley since its introduction in 1927, but during years of heavy rain, the species proliferates rapidly often becoming the dominant species (Barrows et al. 2009). There have been three major ‘explosions’ of mustard growth since the 1970s, but the most recent explosion in 2005 has been specifically studied in relations to the FTHL (Barrow and Allen 2009; Barrows et al. 2009; CVCC 2013a,b). While Barrows et al. (2009) explain that native vegetation has been able to re-establish after spikes in mustard abundance, more recently Barrows contends that Sahara mustard is altering aeolian sand habitats and is rapidly becoming the dominant annual plant (CVCC 2013a).

Sahara mustard has far reaching negative impacts on desert ecosystems. Following a year of extremely high rainfall in 2005, the high abundance of mustard negatively affected all the native annual plants studied, resulting in 80-90 percent reductions in flower and seed production for certain native species (Barrow et al. 2009). Soil compaction also increased in areas of heavy mustard growth (Barrows et al. 2009), which can affect FTHL’s ability to dig burrows necessary for thermoregulation, breeding, and hibernation (Barrows and Allen 2009). Although the fringe-toed lizard (*Uma inornata*) was temporarily negatively influenced by mustard growth, Barrows et al. (2009) did not detect a response from harvester ants or FTHLs when mustard was experimentally removed from plots. However, the true impacts of the Sahara mustard were likely masked due to the negative relationship between increased rain and harvester ant abundance documented by Barrows and Allen (2009). In 2005, when rainfall was over three times higher than normal, while the mustard thrived, harvester ant abundance, and concomitantly FTHL abundance crashed (Barrows and Allen 2009). This result is counterintuitive since increased rainfall should promote productivity and growth in both ants and lizards in arid environments. It is possible that harvester ants are unable to consume Sahara mustard seeds (even though they bring mustard seeds back to their nests) or require a diverse suite of seeds for growth (native seed diversity is diminished when Sahara mustard dominates; MVMSHCP 2012). When harvester ant abundance decreases so too does FTHL abundance (Barrows and Allen 2009) even though FTHLs typically grow faster and produce more offspring in wet years (Howard 1974; Turner and Medica 1982; Muth and Fisher 1992; Setser and Young 2000).

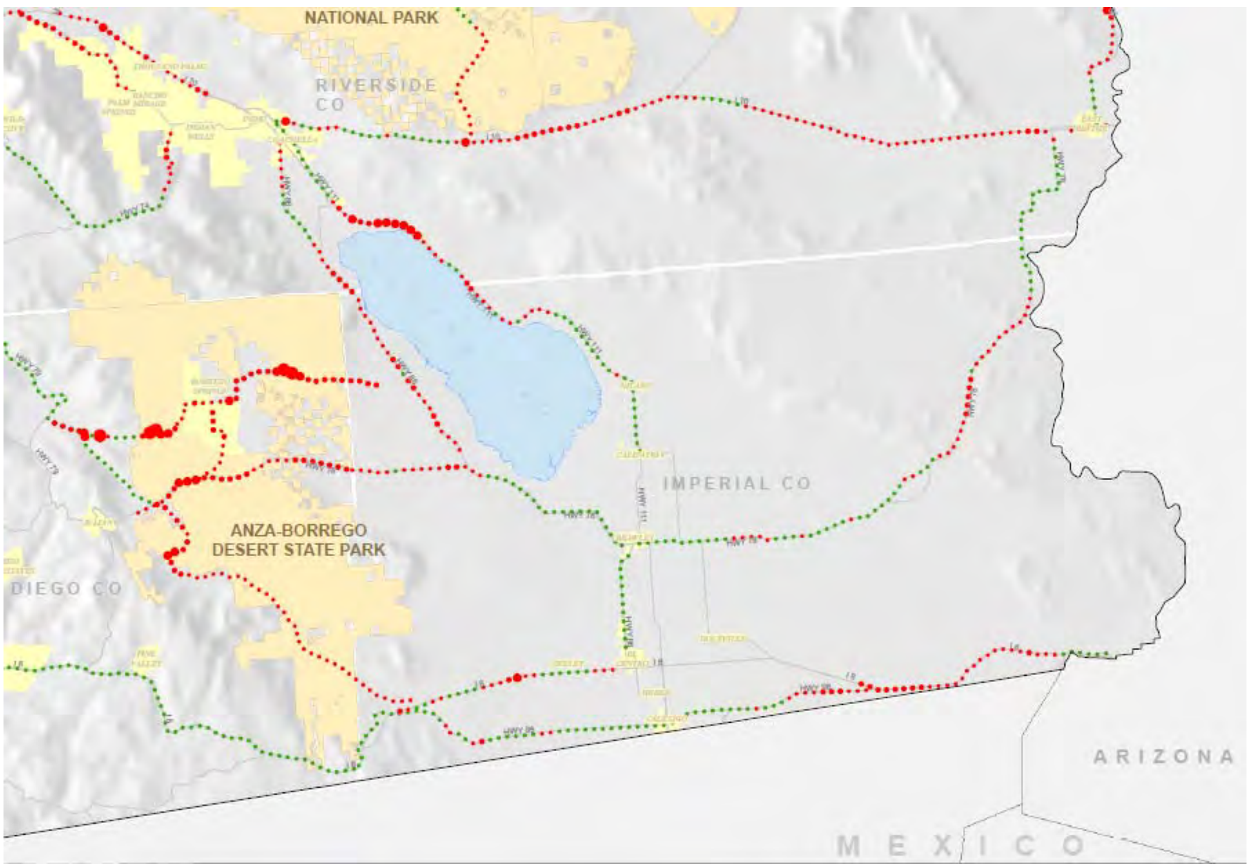

Figure 21. Surveys conducted for Sahara mustard (*Brassica tournefortii*) throughout the southern California desert in 2005. Green dots indicate absence, while red dots indicate presence; the size of the red dots is related to the percent of coverage, with larger dots indicating higher coverage. The map was created by the California Invasive Plant Council.

Barrows explains:

> "For both lizard species [fringe-toed lizard and FTHL] the mustard was identified as negatively influencing their population growth. Despite recent years with average to above average rainfall these lizards have responded much the same way they would have during drought conditions. Population persistence, at least

> at the high levels observed over the past decade, is likely dependent on positive population growth during wetter years in order to compensate for declines during dry years. If populations aren't rebounding during wetter years long-term sustainability could be at risk." (CVCC 2013b, p. i).

Therefore, the most recent analyses indicate that mustard does in fact negatively influence the FTHL by inhibiting population growth (CVCC 2013b). FTHL prefer stabilized sand dune habitats in the Coachella Valley (Barrows and Allen 2009); however, since 2005 and the mustard explosion, FTHL have been found more frequently on active sand dunes, where mustard growth is limited (CVCC 2013b). Furthermore, juveniles were 10% smaller on stabilized sand fields as compared to active dunes, potentially due to limited food resources in areas dominated by mustard (CVCC 2013b). Barrows warns:

> "While seemingly small, such size differences are enough to determine whether or not these juvenile lizards will reach adult size and breed within their first year; due to relatively high annual mortality positive population growth occurs only when a high proportion of first year lizards are successful at breeding." (CVCC 2013a, pg. 45)

Consequently, Sahara mustard poses a direct threat to the ability of FTHL to feed and reproduce.

6.6.3. Inadequacy of Existing Management- Nonnative Plants

The RMS recognizes nonnative plants species as a threat, but indicates that the effects on FTHL are unknown (FTHLICC 2003). Recent evidence, as described above, indicates that nonnative plants pose as both direct and indirect threat to the FTHL; therefore, immediate actions must be taken to minimize and eradicate nonnative plants throughout the Colorado Desert. The RMS does little to mitigate the effects of nonnative plant or remove established stands. The RMS does call for rehabilitation of damaged and degraded habitats, including seeding areas with native plants (FTHLICC 2003, pg. 29). However, restoration attempts in the Ocotillo Wells State Vehicle Recreation Area (OWSVRA) were "almost totally unsuccessful," as only five of every 246 transplants attempted were actually successful (FTHLICC 2010). The Arizona Department of Game and Fish recently supported a study to investigate the effects of Sahara mustard on the FTHL in Yuma, but the results from this study are yet to be released (FTHLICC 2011). Interagency Coordinating Committee Annual Reports indicate that "aggressive" restoration efforts are being pursued, but do not provide details of how these projects are being conducted beyond efforts to eliminate illegal off-road vehicle routes to discourage use (FTHLICC 2005-2011). Further, Annual Reports do not indicate that any efforts are actively being taken to remove or control invasive plant species (FTHLICC 2005- 2011). Continuing or increasing cover of non-native plants will continue to negatively impact populations of FTHLs.

<u>6.7. Climate Change</u>

Climate models predict that southwestern North America will not only become warmer but also drier over the over the 21st century (Seager et al. 2007). Such trends are expected to be accelerated in North America deserts (reviewed in Stahlschmidt et al. 2011; Abatzoglou and Kolden 2011). Over the last century, the Sonoran Desert has experienced increasing minimum temperatures, decreased frequency of freezing temperatures, and an overall increase in winter and spring temperatures (Weiss and Overpeck 2005; Kimball et al. 2010; Abatzoglou and Kolden 2011). In addition to clear increases in temperature, precipitation variability has also increased (Kimball et al. 2010; Abatzoglou and Kolden 2011). Precipitation is naturally quite variable in the region, but recent trends indicate annual rainfall is becoming more variable, which has the potential to alter the biological responses, facilitate the invasion of nonnative plants, and alter fire regimes (Abatzoglou and Kolden 2011). Numerous studies have indicated plant compositional changes related to climatic changes in the Sonoran Desert (e.g. Weiss and Overpeck 2005; Kimball et al. 2010; Abatzoglou and Kolden 2011; Munson et al. 2012). As outlined above, any changes in native plant composition can negatively impact FTHLs through trophic cascades and loss of appropriate vegetation to aid in thermoregulation and predator avoidance.

As the climate warms, species are predicted to expand their ranges to seek refuge in cooler climes at higher latitudes or elevations (Lenoir et al. 2008; Parmesan 2006; Lasky et al. 2011). Weiss and Overpeck (2005) predict that the "boundaries of the Sonoran Desert…may change significantly as minimum temperatures continue to rise, with contraction in the south-east and expansion northward, eastward, and upward in elevation" (pg. 2074). However, the FTHL has very specific habitat requirements and is limited to low elevations (Johnson and Spicer 1985; Turner 1980), potentially compromising their ability to shift their range. Furthermore, under a predicted climate change scenario of +2°C and -50mm in precipitation, two desert reptiles would lose over 88 percent of their range in the Sonoran Desert (Barrows 2011). FHTL habitat is already severely contracted and fragmented due to human development and recreation, thus additional habitat loss due to climate change may leave FTHL with no refugia.

Desert reptiles may already be approaching their physiological tolerances due to regular exposure to extreme temperatures and periods of severe, extended drought (Barrows 2011). FTHLs may be unable to acclimate and adapt rapidly enough to cope with increasing temperatures. Additionally, warmer temperatures are likely to cause behavior changes in FTHL that may jeopardize their ability to grow and reproduce. FTHLs typically retreat into burrows when surface temperatures surpass 41-49°C (Norris 1949; Wone and Beauchamp 2003), but as maximum temperatures increase, FTHL may need to spend more time in burrows, which leaves less time to actively forage and seek mates, and effectively reduces successful reproduction potential.

Temperature changes may also influence FTHL hibernation. In the early 1960s, Mayhew (1965) reported that it is rare to see FTHLs until early April, although he did see individuals as early as February 2nd. Similarly, Howard (1974) did not see any FTHL before April, despite conducting earlier surveys and Johnson and Spicer (1985) indicated emerge occurs between March and April. More recent publications have reported mean emergence times in February, with emergence typically occurring from mid-December to mid-March (Muth and Fisher 1992; Wone and Beauchamp 2003; Grant and Doherty 2009). Although emergence is not solely linked to temperature, there may be a relationship between a warm winter season and early emergence (Mayhew 1965). Therefore, as winter temperatures warm, FTHL may emerge from hibernation sooner, which places lizards at increased risk of off-road vehicle exposure because ORV activity is more prevalent in the cooler seasons. Moreover, nearly all FTHLs experimentally exposed to a constant hibernation temperature of 35°C died due to the exhaustion of energy stored related to an increased metabolic rate (Mayhew 1965). These results highlight that FTHLs may not have the physiological capacity to cope with increasing temperatures. In order to protect the FTHL from the negative effects of climate change, it is crucial to ensure the species is relieved of all other threats that weaken their ability to adapt and adjust to climate change. Absent control of threats, it is likely the FTHL populations will continue to decline.

7.0. Nature, Degree, and Immediacy of Threat

There are many factors that threaten the viability of FTHLs in California. The specific threats are explained in detail elsewhere (see Threat Affecting Ability to Survive and Reproduce), but the available evidence clearly shows that FTHL are in imminent danger of localized extirpations and eventual extinction if immediate and appropriate management efforts are not taken. Species are at greater risk of extinction on landscapes with diminished native vegetation, limited connectivity, and substantial human development (Lovich and Ennen 2013). Native vegetation in the Colorado Desert has been significantly degraded due to the spread of nonnative plants (Steers and Allen 2010), unnatural and accelerated fire regimes (Steers and Allen 2011), and human disturbance related to development (Barrows et al. 2009) and off-road vehicle use (McGrann et al. 2005). FTHL habitat is severely fragmented limiting connectivity and diminishing gene flow (Barrows et al. 2008). Finally, intensive land use has caused the loss of historic habitat (Hodges 1997) and new development continues to eliminate current habitat (Lovich and Ennen 2011, 2013). In combination, these impacts pose a significant and imminent threat to the continued existence of the FTHL. Barrows and Allen (2009) summarize:

> "The small geographic range, specialized and highly fragmented habitat, sensitivity to anthropogenic effects, narrow breadth of diet, and low rates of reproduction all underline a potential for this species [FTHL] to be at risk of local and regional extinctions." (pg. 308)

8.0. Impacts of Existing Management Efforts

There are multiple current management efforts that impact the FTHL. Here we describe each regulatory mechanism and discuss the limitations that leave the FTHL unprotected.

8.1. Flat-tailed Horned Lizard Interagency Conservation Agreement

In 1997, federal and state agencies signed an Interagency Conservation Agreement (ICA) to conserve the FTHL. Signatories include the U.S. Fish and Wildlife Service (USFWS), Bureau of Land Management (BLM), Bureau of Reclamation (BOR), U.S. Marine Corps, U.S. Navy, Arizona Game and Fish Department (AGFD), California Department of Fish and Wildlife (CDFW), and the California Department of Parks and Recreation (CDPR). Member agencies agreed to, among other things, develop and implement a Flat-tailed Horned Lizard Rangewide Management Strategy (RMS) capable of maintaining FTHL populations and habitat while reducing known threats to the species. (The full conservation agreement is available in the FTHLICC 2003, Appendix1.)

There are several provisions within the ICA that limit its effectiveness. First, the provisions set forth within the RMS are subject to the availability of funds. Second, the ICA is voluntary: "This Agreement may, at any time, be amended, extended, modified, supplemented, or terminated by mutual concurrence. Any party may withdraw from this Agreement by providing 60 days notice to the other parties in writing" (FTHLICC 2003, pg. 85). While the BLM has incorporated components of the RMS into the California Desert Conservation Area (CDCA) Plan, other agencies are not legally bound to abide the RMS and are able to withdrawal entirely.

According to the ICA: "[If] it becomes known that there are threats to the species that are not or cannot be resolved through this or any Conservation Agreement, the species will be re-assigned to candidate status and an appropriate listing priority assigned" (FTHLICC 2003, pg. 83). The effectiveness of the ICA is wholly contingent on the effectiveness of the RMS, which does not sufficiently protect the FTHL from the threat of extinction and yet the FTHL has not been reassigned candidate status or assigned a listing priority. Therefore, it is prudent to list the FTHL as threatened under the California Endangered Species Act.

8.1.1. Flat-tailed Horned Lizard Rangewide Management Strategy (RMS)

The RMS is a joint effort of BLM, FWS, CDFW, California State Parks, and Arizona Game and Fish, covering 485,000 acres of public and private lands within the FTHL range in Management Areas. In addition, the U.S. Marine Corps and the U.S. Navy are signatories to the Interagency Conservation Agreement through the Sikes Act, and incorporated components of the RMS into their Integrated Natural Resources Management Plans (76 FR 14210). There are two major military installations present within FTHL habitat, the Marine Corps Air Station in Yuma, Arizona and the Naval Air Facility, El Centro, California that afford some protections to the FTHL. Within California, the U.S. Navy also owns land within and surrounding the West Mesa Management Area (MA) and the within the East Mesa MA.

Unfortunately, the RMS does not sufficiently protect the FTHL from current threats to the species. The overall goal of the RMS is to "maintain self-sustaining populations of flat-tailed horned lizards in perpetuity," with several specific management objectives and Planning Actions (FTHLICC 2003; pg. 24).

As a first course of action (Planning Action 1, FTHLICC 2003, pg. 25), the RMS designated five management areas (MAs) within the U.S., each representing areas of high quality FTHL habitat (Figure 4; FTHLICC 2003). The Ocotillo Wells State Vehicular Recreation Area (OWSVRA) was also designated as a Research Area. The MAs were intended to be as large as possible while avoiding conflicting uses such as off-road vehicle (ORV) areas. Despite numerous threats associated with ORVs (see Threats Affected Ability to Survive and Reproduce), the RMS prioritized conflict avoidance as opposed to ensuring that MAs and the RA are free from damaging threats. For instance, even though OWSVRA and the Plaster City Open Area represent areas of high quality habitat with many historic records of FTHLs and provide valuable habitat corridors between the Borrego, West Mesa and Yuha Desert MAs, very little is done to reduce ORV use in these areas or protect connectivity. Furthermore, ORV activity is allowed in all of the MAs and compliance with limited use routes is poor, in spite of studies indicating that even limited ORV use can negative affect not only the FTHL (McGrann et al. 2006), but also desert ecosystems as a whole (Lovich and Bainbridge 1999; Lukenbach and Bury 1983).

Additionally, the MAs do not cover a sufficient amount of current habitat to protect the FTHL. Currently, only 12 percent of the entire U.S.-Mexico range of the FTHL is protected by the five MAs. Within California, only 36 percent of FTHL habitat is protected by four MAs. More current habitat must be protected in order to ensure the long-term viability of the FTHL in California and throughout its range.

The RMS stipulates under Planning Action 2 that efforts should be taken to minimize loss and degradation of habitat both within and outside of the MAs (FTHLICC 2003, pg. 26). Accordingly, signatories are expected to limit land use authorizations to ensure each MA is limited to surface disturbance representing a total area less than one percent of the entire area of the MA. However, according to the 2011 Annual Progress Report released by the Interagency Coordinating Committee (ICC), which is responsible for implementing the provisions within the RMS, since 1998, 338 ha have been developed within MAs and no longer serve as suitable habitat for FTHLs. The report fails to include the amount of habitat loss that has occurred outside of the MAs, which is significantly higher (Figures 8, 9, 17, 19, 20; also see Factors Affecting Ability to Survive and Reproduce). Additionally, between 1996 and 2002, 14.3 percent of suitable habitat was lost in Arizona due to local development projects including agricultural development, the expansion of a state prison, and commercial development surrounding Interstate 8 (Piest and Knowles 2002). A detailed analysis of habitat disturbance revealed that from 1997 to 2002, there has been a 37% overall increase in disturbance within MAs, with some MAs seeing triple digit increases in disturbance (Figures 19 and 20; USFWS 2013). Wright (2002) reported that between 1985 and 2001, the number of routes within the Yuha Desert, West Mesa, and East Mesa MAs had increased a total of 387 percent, while routes increased by 819 percent within areas completely open to off-road vehicle use. Therefore, despite the implementation of the RMS, suitable habitat has recently been lost to human development within the MAs. Outside of the MAs, large-scale energy projects directly threaten FTHLs (see Factors Affecting Ability to Survive and Reproduce). As discussed previously, the current mitigation and compensation procedures are not sufficient to deter new development in FTHL habitat in the region.

In accordance with Planning Actions 3 and 5 (FTHLICC 2003, pg. 29), damaged and degraded habitats should be rehabilitated and effective habitat corridors should be maintained between adjacent populations, respectively. ICC Annual Reports indicate that restoration efforts are actively being pursued (FTHLICC 2005-2011). These efforts mostly include using volunteer interns to minimize the appearance of unlawful and closed ORV routes in order to discourage illegal use. While these efforts are beneficial, as described, it seems unlikely that they actually restore damaged habitat because soils remain compacted and generally route restoration faces low compliance as do many route closures over the long term. Other restoration efforts have been unsuccessful (FTHLICC 2010). Large-scale barriers including Interstate highways, canals, energy projects, railroads, the U.S.-Mexican border, illegal route proliferation, minor roads and ORV open areas all have the potential to individually limit gene flow and obstruct habitat corridors (see Threats Affecting Ability to Survive and Reproduce). In combinations, these barriers are likely to severely limit connectivity between adjacent populations.

The ICC has made progress towards their goal of acquiring private land holdings within MAs (Planning Action 4, FTHLICC 2003, pg. 29). According to the most recent Annual Report (i.e.

2011), since 1997, signatory agencies have acquired approximately 11,803 ha of private land (FTHLICC 2011). Progress has also been made in terms of increased coordination with Mexico (Planning Action 6, FTHLICC 2003, pg. 29). Mexico is currently working on developing a Mexican Rangewide Management Strategy using the U.S. RMS as a model (FTHLICC 2011). Unfortunately, the deficiencies in the current RMS could negatively impact the development of management efforts in Mexico. Signatory agencies are also expected to coordinate through regular meetings and annual progress reports (Planning Action 6). While regular meetings do take place, coordination has seemingly diminished in the last three years. From 2004 to 2010, Annual Reports were released within several months of the calendar year's end. However, the Annual Report for 2011 was not released until 2013 (FTHLICC 2011) indicating the ICC is well behind schedule and not adequately meeting their objective of regular coordination.

Under Planning Action 7 (FTHLICC 2003, pg. 30), the RMS is intended to utilize law enforcement and public education to raise awareness and encourage compliance with regulations. Signatory agencies have developed educational kiosks and posted signs indicating areas of open, limited, or closed use throughout MAs (FTHLICC 2011). While the ICC reports that efforts have been made to increase enforcement, MAs encompass large, relatively remote areas where little enforcement has been undertaken. There have been reports of illegal ORV use within MAs in the past (McGrann et al. 2006; Rorabaugh 2010) and recent Google Earth imagery suggests illegal ORV activities continue (Figures 15 and 16).

Planning Action 8 (FTHLICC 2003, pg. 30) calls for the encouragement and support of research by signatory agencies. Research efforts have and continue to occur throughout FTHL range (FTHLICC 2005-2011). Still, many important research questions remain unanswered including additional research on the effects of ORVs on FTHLs, despite the creation of the OWSVRA as a Research Area.

Finally, Planning Action 9 (FTHLICC 2003, pg. 32) stipulates that monitoring and inventory of FTHL populations should be conducted by signatory agencies. As described in detail previously (see Abundance) current monitoring methods are insufficient to accurately determine population density and trends. Due to the cryptic nature of FTHLs, they are inherently difficult to monitor, which prompted the ICC to test and develop monitoring strategies capable of detecting population status and trends (FTHLICC 2003). In 2003, the RMS established two monitoring protocols to be used in coordination (FTHLICC 2003, Appendices 4 and 5). The first followed mark-recapture methods established by Wright and Grant (2002, 2003) capable of determining rough population size estimates (Grant and Doherty 2007). The survey called for 12 randomly distributed 4-ha plots per MA that would be monitored through mark-recapture over five consecutive days (FTHLICC 2003, Appendix 4). The second survey method was designed to determine the presence or absence of FTHL in 120 1-ha plots to be surveyed for one hour each. These rough occupancy data would then be coupled with spatial GIS data in order to develop a predictive spatial model (FTHLICC 2003, Appendix 5).

However, by 2007, these monitoring techniques were altered such that they have become less labor intensive, but also less predictive and informative (FTHLICC 2005). The protocol for presence/absence, or occupancy surveys remained similar, but plot size was increased to 4 ha and the GIS spatial component was eliminated (FTHLICC 2007). Additionally, although the protocol called for a minimum of 120 widely distributed plots, many survey efforts used considerably fewer plots (FTHLICC 2005, 2010). In the 2011 Annual Report, the ICC once again revised the occupancy protocol to require a minimum of only 50 2-ha plots (although plots are to be revisited multiple times per survey season under this new protocol); however, even using this new protocol, only 45 plots were surveyed in the Desert Basin MA in 2011 (FTHLICC 2011). The mark-recapture methods were heavily altered, such that only one to two 9-ha plots per MA are to be surveyed with mark-recapture every year (FTHLICC 2007). These demographic plots were not randomly distributed and are located on high quality habitat. Thus, unlike the original protocol which established multiple, randomly distributed plots capable of making population inferences for the entire MA (Grant and Doherty 2007), the currently used protocol is only capable of accurately detecting population trends *within* the one or two 9-ha plots that are actually surveyed (Root 2010). These protocols provide limited power to detect population trends (Root 2010). Root (2010) reported that the mark-recapture surveys during 2005 to 2009 had the statistical power to detect an approximate 50 percent change in FTHL abundance, on average, between any two survey years. These trends in protocol changes indicate that the ICC are sacrificing the appropriate survey techniques needed to adequately detect population trends, in place of techniques that require limited personnel resources but which are much less informative.

As a result, the ICC currently has a limited ability to detect significant changes in the FTHL populations within plots within the MAs through the mark-recapture surveys, and even less ability to detect significant changes throughout the entire area of the MAs through the occupancy surveys. Based on the monitoring data, if a population decline greater than 30% is detected, under the RMS, the ICC must take immediate actions to rehabilitate that population (FTHLICC 2003). However, the large error associated with available monitoring techniques means that even the more powerful mark-recapture surveys are not capable of detecting even a 30% change in the population (Root 2010). A 30% population decline is very high. Such a decline could cause serious and irrevocable harm to the population leaving it particularly vulnerable to extirpation. Furthermore, the Borrego Badlands MA as of yet remains to even be surveyed, and no FTHL habitat outside of the MAs are surveyed.

The Interagency Coordinating Committee is still in place and may revise the Flat-tailed Horned Lizard Rangewide Management strategy within the next two years (Pers. Comm. with California State Parks) but whether it will be revised and the adequacy of any potential changes are speculative.

8.2. California Desert Conservation Act (CDCA) Plan

In 1976, the Federal Land Policy and Management Act (FLPMA) authorized the BLM to conserve and manage public lands. The Act required the preparation of the California Desert Conservation Area Plan (CDCA) and allowed for the designation of Areas of Critical Environmental Concern (ACECs). In the 1980s, the CDCA designated three ACECs to protect the FTHL: the Yuha Desert ACEC, East Mesa ACEC, and West Mesa ACEC. Three additional ACECs were designated within the FTHL range including the San Sebastian Marsh/San Felipe Creek ACEC, Dos Palmas ACEC, and Algodones Dunes ACEC; however, none of these areas were specifically designated for FTHL conservation (FTHLICC 2003). While ACECs generally limit certain activities that result in major surface disturbance, they generally do little to protect

FTHLs. The BLM is a signatory to the Interagency Conservation Agreement and formally amended the CDCA to include provisions within the RMS. As a consequence, the RMS is no longer strictly voluntary for the BLM. Even through the BLM must abide by the RMS, the RMS does not sufficiently protect the FTHL from current threats to the species, and thus FLPMA does not provide adequate protection.

8.4. Habitat Conservation Plans

As part of the U.S. Endangered Species Act, section 10(a)(1)(B), the USFWS may issue incidental take permits that allow the taking of listed species when it occurs incidental to lawful activities. A provision of an incidental take permit requires applicants to develop, fund, and implement habitat conservation plans that ensure the continued existence of species covered in the plan. There are currently two incidental take permits that include the FTHL as a covered species. While HCPs provide for conservation of species during the life of the plan, they do not provide conservation assurances in perpetuity. HCPs actually allow for "take" of species and habitat, which clearly does not aid in species recovery. Continued take will only decrease populations further.

8.4.1. Coachella Valley Multiple Species Habitat Conservation Plan

A 75-year incidental take permit was issued in 2008 in order to cover habitat loss and disturbance associated with urban development in the Coachella Valley, Riverside County, California (76 FR 14210). In association, the Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP) was approved in 2007 in order to minimize and mitigate habitat loss and incidental take of covered species. The CVMSHCP was also developed in coordination with the California Natural Community Conservation Planning Act (CVMSHCP 2005). The plan protects 27 species, including the FTHL, within 97,125 ha of open space within the Coachella Valley, with over 8,900 ha designated as Conservation Areas (CVMSHCP 2007).

While the Coachella Valley historically supported FTHLs throughout much of the region, FTHLs are currently primarily restricted to the Thousand Palms Conservation Area, although FTHLs are thought to inhabit parts of the Dos Palmas Conservation (CVMSHCP 2005; Barrows et al. 2008). The CVMSHCP aims to protect "core habitat" through the minimization of fragmentation and human-caused disturbance, which is facilitated through the establishment of 1,678 ha of FTHL habitat within the Thousand Palms Conservation Area (CVCC 2013b). However, approximately 240 ha of habitat within the Conservation Area is isolated from the remainder of suitable habitat by a moderately trafficked road, indicating there is less than 1,500 ha of continuous core habitat is available for the FTHL throughout the entire region (CVMSHCP 2007). In addition to the established Thousand Palms population, the CVMSHCP aimed to create two additional self-sustaining populations. The Dos Palmas Conservation Area may support a self-sustaining population, but no recent monitoring efforts have assessed the status of the Dos Palmas population. The plan does protect 2,241 ha of suitable habitat within the Dos Palmas Preserve (CVCC 2013b). The Dos Palmas population needs to be thoroughly monitored and studied to understand if 1) a viable population is present and 2) if the population is or was recently genetically connected to any other populations. These data are crucial to determine which management efforts should be taken to preserve this potentially viable population.

The plan recognizes that rehabilitation and restoration efforts could potentially allow for the creation of self-sustaining populations, but contend this is not realistic, explaining:

> "Ideally, three or more sites with discrete sand sources and of sufficient size to maintain a viable population should be preserved. Realistically, there are not three such sites remaining that are not already fragmented or otherwise compromised by development." (CVMSHCP 2007, pg. 9-117)

In order to protect potential FTHL habitat and accommodate population fluctuations and genetic diversity, the CVMSHCP protects additional land that offers suitable FTHL habitat but no longer support FTHLs, including the Whitewater Floodplain, Willow Hole, Snow Creek, Upper Mission, Long Canyon, Edom Hill, East Indo Hills, and San Rosa and San Jacinto Mountains Conservation Areas (CVMSHCP 2007). Monitoring efforts have occurred throughout many of the Conservation Areas, but no FTHL have been sighted recently except for the Thousand Palms Conservation Area (CVMSHCP 2005; CVCC 2013b). Although areas of suitable habitat are protected and the plan calls for restoration efforts as needed, we are unaware of any systematic, targeted restoration efforts aimed at re-establishing FTHL populations in suitable habitat. In the East Indio Hills Conservations Area, where FTHL are thought to be locally extinct, surveys have been conducted every other year since 2004, but the species has failed to re-established itself; it is unclear if active restoration has occurred in conjunction with these survey efforts (CVCC 2013b).

No areas in the Coachella Valley are designated MAs under the RMS; however the RMS does recognize and support management through the CVMSHCP as sufficient to protect the species. One of the CVMSHCP goals for the FTHL is to "ensure conservation of the FTHL by maintaining the long-term persistence of self-sustaining population" (CVMSHCP 2007, pg. 9-116). However, this goal may be unattainable. Even in Thousand Palms, which has the largest population in the region, the relatively small geographic size, low population density, and isolation from the larger populations to the south, make FTHLs extremely vulnerable to extirpation in the Coachella Valley.

8.4.2. Lower Colorado River Multi-Species Conservation Plan

In 2005, the USFWS issued a 50-year incidental take permit associated with development along the lower Colorado River. A very small portion of FTHL range falls within the area covered by the Lower Colorado River Multi-Species Conservation Plan (MSCP). Approximately 93 ha of FTHL habitat in Arizona is protected under the plan. While portions of the MSCP boundary fall within California, the MSCP does not cover any current FTHL habitat within California.

<u>8.5. State Regulations</u>

The collection of FTHLs without a permit is prohibited in both California and Arizona through the California Code of Regulations (14 Cal. Code Reg. § 40), and the Arizona Game and Fish Regulation (Title 17, R12-4-443), respectively. The FTHL is not significantly threatened by commercial exploitation or overutilization. While these regulations are important and should remain, they do not significantly reduce threats to the FTHL.

8.6. Federal and State Conservation Status

In 1980, the BLM designated the FTHL as a sensitive species in California and the species remains a sensitive species today. A Sensitive Species designation indicates that the BLM considers the FTHL to be at risk of population declines that could lead to extinction. BLM affords sensitive species with protections equivalent to those given to federal candidate species; however, they are not fully protected under the law (CDFG 2011).

The California Department of Fish and Wildlife also lists the FTHL as a Species of Special Concern (SSC), a designation assigned when "declining population levels, limited ranges, and/or continuing threats have made them [the SSC] vulnerable to extinction" (CDFG 2011, pg. 9). The CDFW is currently updating its SSC reports for Amphibians and Reptiles; the most recent report available from 2 decades ago suggests the status of the FTHL was then threatened (Jennings and Hayes 1994). The goal of a SSC designation is to draw attention to the status of the species and holds provides no specific protections.

8.7. International Conservation Status

The majority of the FTHL's range is in northern Mexico. The Official Mexican Norm (NOM-059-ECOL-2001) lists the FTHL as a threatened species. Management efforts in Mexico are limited, but Mexican protection status may afford some limited benefits to FTHLs present in the U.S. through the conservation of habitat corridors that allow for genetic connectivity but which are also threatened by activities along the border. The International Union for Conservation of Nature (IUCN) Red List of Threatened Species lists the FTHL as Near Threatened, reporting a decreasing population trend due to habitat loss and fragmentation (IUCN 2013).

In sum, current management efforts are insufficient to adequately protect FTHL from the risk of extinction. Significant habitat loss and disturbance continues throughout FTHL range, particularly in California. The RMS has provided valuable management efforts, but unfortunately, it has not protected the species from the litany of threats it faces. Without the additional protections afforded by the California Endangered Species Act, the FTHL is at significant risk of additional population declines, local extirpations, and eventual extinction.

9.0. Recommended Management and Recovery Actions

> "Given the sensitivity of desert habitats to disturbance and the slow rate of natural recovery, the best management option is to limit the extent and intensity of impacts as much as possible." (Lovich and Bainbridge 1999, pg. 309)

While the Flat-tailed Horned Lizard Rangewide Management Strategy (RMS) does provide strategies to conserve the FTHL, many recommended actions are not properly implemented. Additionally, the RMS fails to incorporate some important management actions that are needed to ensure the long-term viability of the FTHL. Here we present a list of recommended management actions. This list is not meant to be exhaustive but provides important conservation measures necessary to protect the FTHL.

- **Utilize monitoring techniques capable of detecting population trends throughout FTHL range.** Currently resources are being devoted to survey efforts that are unable to accurately determine population trends (see Abundance and Impact of Existing Management Efforts). Only methods capable of developing useful trend data should be employed, meaning demographic surveys sites should be more numerous and randomly distributed. The original survey methods described in the RMS (FTHLICC 2003) are likely to yield more powerful results than current methods.

- **Further limit off-road vehicle use within Management Areas.** All of the FTHL MAs within California border an ORV open area, indicating there is already a large amount of land available for ORV recreation. Given the considerable threats that ORVs and vehicles pose to FTHLs, ORV use should be prohibited within some or all of the MAs. Since illegal route proliferation and trespass of ORVs is common, better enforcement also required to ensure FTHLs, and the harvester ant populations they rely on, are not negatively impacted by ORV use.

- **Explore using appropriate fencing to keep FTHLs off of roads and limit ORV trespass.** FTHL fences are already used to keep lizards off of construction sites and access roads (FTHLICC 2003, Appendix 7), and additional fencing could be applied to existing roads and highways. Additional research should be devoted to developing strategies, potentially including fences, to limit illegal ORV trespass. In any case where fences are used, care should be taken to maintain connectivity and eliminate negative impacts to species. Road underpasses have been used successfully for desert tortoise and other species and may be appropriate for FTHL (and other species) to minimize road mortality while ensuring connectivity. Properly constructed fencing may also alleviate some of the edge effects associated with development.

- **Focus renewable energy development on lands that meet energy needs while conserving important FTHL habitat.** Spatial models can be utilized to identify potential development sites that occur on heavily degraded land with limited conservation potential. Efforts should be taken to incorporate the most recent models to ensure development projects are only placed in areas with limited conservation conflict (see Cameron et al. 2013 and Stoms et al. 2013 for examples). Renewable energy development and overhead transmission lines should not be allowed in the MAs.

- **Prohibit further development in the MAs.** According to the ICC, some of the MAs may be nearing the one-percent development cap, and this does include the footprint of the edge effects of these developments. FTHL habitat in the MAs is already severely fragmented and degraded, and further development should not be permitted. Indeed additional route closures and proper restoration need to be implemented to reduce densities and alleviate effects from habitat fragmentation.

- **Expand current and establish new Management Areas.** Currently only 36 percent of the FTHL's current range within California is protected by four MAs. Suitable occupied habitat is available outside of the current MAs, and needs to be protected. The FTHL would benefit from addition MAs in:

- The area between West Mesa MA and Yuha Desert MA. This region is currently predominantly public lands managed by the BLM as the Plaster City Open Area. This area is crucial habitat needed to maintain genetic connectivity throughout the Western population. Therefore a portion of this area needs to be managed for FTHL benefit by protecting habitat for FTHL occupancy and connectivity.
- The southern portion of Anza Borrego State Park that is within current FTHL range. This area is relatively remote and has recently supported FTHLs (Figure 10). This area has relatively few use conflicts and almost the entire region is owned by the state of California and the CDPR is a signatory to the ICA.
- The East Mesa MA should be expanded northward. There is suitable habitat north of the current East Mesa MA. Nearly all of the land in this region is public lands managed by the BLM and the U.S. Navy, both of whom are signatories to the ICA. The Eastern population is the smallest phylogenetic population (Muluchy et al. 2006), and is therefore more vulnerable to population decline.
- While the RMS has focused on and has been successful in acquiring lands within the boundaries of the designated MAs, focus needs to shift to acquisition of occupied habitat outside of the MAs. Additional MAs need to be established as well as expansion of the existing MAs. Occupied or potential habitat lands that provide habitat and connectivity between the MAs need to be included as MAs.

- **Determine the population status of FTHL in the Dos Palmas Conservation Area in the Coachella Valley.** Due to the presence of high-quality habitat and recent historic sightings, FTHLs are thought to occupy the southeastern portion of the Dos Palmas Conservation Area. However, the status and viability of this population is unknown. Surveys should be conducted in this region immediately. The Dos Palmas area is geographically isolated from the Thousand Palms population to the north and the East Mesa population to the south (i.e. the Eastern population). Genetic analyses should also be conducted to determine if the Dos Palmas population is genetically connected to other known populations. Based on these genetic analyses, efforts should be made to maintain habitat corridors between populations. Re-introductions into historic habitat that is now within conserved areas and threats are minimized need to be considered as an aide to recovery of the species into former habitat that is now protected. Any new transmission lines in FTHL habitat should be buried and other tall structures that can be used as perching sites for predators should be constructed well away from conservation areas

- **Reduce edge effects by burying transmission lines and conducing routine maintenance of vegetation along habitat boundaries and roads.** While the burial of transmission lines causes temporary surface disturbance, it reduces perching sites for avian predators. Vegetation growing along road margins should be trimmed to less than 0.5 m to reduce loggerhead shrike attacks (Young and Young 2000), especially on road near agricultural centers. Certain exotic plant species commonly used in landscaping offer preferred nesting sites for FTHL predators; efforts should be taken to reduce or discourage the use of such species (see CVMSHCP 2005, pg. 113).

- **Conduct additional research to understand the effectiveness and most appropriate design of highway culverts in natural FTHL populations; based on this research,**

modify existing culverts and install new culverts to increase gene flow between occupied habitat areas. Culverts may provide essential genetic connectivity between populations separated by heavily trafficked, multi-lane highways. To our knowledge, no studies have investigated the effectiveness of culverts under natural conditions (see ADOT 2007 for controlled, *ex situ* study).

- **Modify the project evaluation protocol described in the RMS.** In determining if mitigation and compensation is required, the RMS outlines a protocol evaluate if FTHLs are present on a project site (FTHLICC 2003, Appendix 6; although there have been slight modifications, see NRA, Inc. 2010). These procedures do not require monitoring of the entire site, and call for relatively few hours of survey effort compared to the difficulty in detecting FTHLs. A more rigorous protocol, that does *not* consider scat, should be applied.

- **More aggressive actions should be taken to control nonnative plants and restore damaged ecosystems.** Control procedures and restoration efforts should be explored (see Steers and Allen 2010).

- **Management efforts should continue to: acquire private lands where possible, especially within the matrix of public lands.**

- **Coordinate conservation strategies with the Mexican government, and eliminate pesticide spraying within FTHL range to protect food sources.**

- **Monitor Argentine and other invasive ant populations along FTHL habitat boundaries to prevent potential invasions.** Although there is no evidence that Argentine ants have invaded FTHL habitat currently, other horned lizards in the regions have been negatively affected (Suarez and Case 2002) and expanding land use changes increase the risk of invasion (Barrows et al. 2006). Minimize water availability along the edges of development/FTHL habitat to reduce Argentine ant populations.

- **Limit use of off-road vehicles in border area where possible.** Use of remote video surveillance systems (RVSS) to monitor illegal activity along the U.S.-Mexican border, may have the capacity to effectively monitor more land while reducing off-road vehicle use by Border Patrol. Care should be taken to prevent any increase in predation to FTHL that may be associated with the construction of surveillance towers and use of those structures by predators, i.e. potentially installing anti-perching devices (Avery and Genchi 2004; Seamans et al. 2007).

- **Efforts should be taken to improve lizard translocation success while exploring alternative mitigation techniques capable of reducing mortality associated with development.** Relocating FTHLs results in poor survivorship (FTHLICC 2007), thus more research is needed (see Germano and Bishop 2009 for recommendations).

- **Local Land Use Plan and OWSVRA Plan Updates need to include safeguards for FTHL habitat**. While the FTHLICC includes public agencies (BLM, FWS, CDFW, California State Parks, U.S. Marine Corps and the U.S. Navy), some occupied FTHL habitat also occurs on private lands in Imperial and eastern San Diego Counties where no Habitat Conservation Plan exists. Improvements in these counties' General Plans in FTHL habitat would result in greater safeguards for FTHL. Clustering of development, minimization of predator perching opportunities and other common sense safeguards can be included in updates of the Counties' General Plans. The OWSVRA is currently going through a General Plan Update[4] and additional safeguards (for example travel only on designated routes in habitat for the FTHL and ORV exclusion areas), need to be incorporated into that update to provide protect both occupied FTHL habitat and the key linkage between the northwestern FTHL Management Area and FTHL management areas to the south.

- **FTHLICC needs to be expanded and/or better coordinate with Counties and CVMSHCP**. While the FTHLICC provides a forum for tracking management and population dynamics of FTHL on public lands primarily in Imperial County and Arizona, the group could be broadened to include the counties of Imperial, San Diego and Riverside including representation from the CVMSHCP or, at minimum, better coordinate with the counties and CVMSHCP. While private lands are a small portion of the FTHL range, cooperation, the opportunity to share "lessons learned", range-wide monitoring, range-wide enhancements and other range-wide activities would be more efficiently implemented with all interested land managers at the same "table".

- **Numerous other rare sympatric species and communities would benefit from listing the FTHL as endangered**. Numerous rare species are sympatric with the FTHL and would benefit from the "umbrella" conservation that protecting the FTHL would provide. These species include:

Scientific Name	Common Name	G/SRank	Other Status
Plants			
Acmispon haydonii	pygmy lotus	G3/S2	1B.3
Astragalus insularis var. harwoodii	Harwood's milk-vetch	G5T3/S2	2B.2
Astragalus sabulonum	gravel milk-vetch	G5/S2	2B.2
Ayenia compacta	California ayenia	G4/S4	2B.3
Castela emoryi	Emory's crucifixion-thorn	G4/S2S3	2B.2
Chaenactis carphoclinia var. peirsonii	Peirson's pincushion	G5T2/S2	1B.3
Chamaesyce platysperma	flat-seeded spurge	G3/S1	1B.2
Cryptantha ganderi	Gander's cryptantha	G1G2/S1	1B.1
Eriastrum harwoodii	Harwood's eriastrum	G2/S2	1B.2
Lupinus excubitus var. medius	Mountain Springs bush lupine	G4T2T3/S2	1B.3
Malperia tenuis	brown turbans	G4?/S2	2B.3
Mentzelia hirsutissima	hairy stickleaf	G3?/S2S3	2B.3
Nemacaulis denudata var. gracilis	slender cottonheads	G3G4T3?/S2	2B.2
Opuntia wigginsii	Wiggins' cholla	G3?Q/S1?	3.3

[4] http://www.planocotillowells.com/

Pholisma sonorae	sand food	G2/S2	1B.2
Pilostyles thurberi	Thurber's pilostyles	G5/S3.3	4.3
Wislizenia refracta ssp. palmeri	Palmer's jackass clover	G5T2T4/S1	2B.2
Xylorhiza orcuttii	Orcutt's woody-aster	G2G3/S2	1B.2
Plant Communities			
Crucifixion Thorn Woodland	Crucifixion Thorn Woodland	G3/S1.2	
Mesquite Bosque	Mesquite Bosque	G3/S2.1	
Stabilized and Partially Stabilized Desert Dunes	Stabilized and Partially Stabilized Desert Dunes	G4/S3.2	
Transmontane Alkali Marsh	Transmontane Alkali Marsh	G3/S2.1	
Insects			
Anomala hardyorum	Hardy's dune beetle	G2/S2	
Oliarces clara	cheeseweed owlfly (cheeseweed moth lacewing)	G1G3/S1S3	
Parnopes borregoensis	Borrego parnopes cuckoo wasp	G1?/S1?	
Reptiles			
Charina trivirgata	rosy boa	G4G5/S3S4	FS -S
Amphibians			
Lithobates yavapaiensis	lowland (=Yavapai, San Sebastian & San Felipe) leopard frog	G4/SX	SSC
Birds			
Athene cunicularia	burrowing owl	G4/S2	SSC
Falco mexicanus	prairie falcon	G5/S3	WL
Toxostoma lecontei	Le Conte's thrasher	G4/S3	SSC
Mammals			
Antrozous pallidus	pallid bat	G5/S3	SSC
Sigmodon hispidus eremicus	Yuma hispid cotton rat	G5T2T3/S2	SSC
Taxidea taxus	American badger	G5/S4	SSC
Vulpes macrotis arsipus	desert kit fox	--- / ---	Title 14 CCR§ 460

Global Ranking
G1 = Less than 6 viable element occurrences (EOs) OR less than 1,000 individuals OR less than 2,000 acres.
G2 = 6-20 EOs OR 1,000-3,000 individuals OR 2,000-10,000 acres.
G3 = 21-100 EOs OR 3,000-10,000 individuals OR 10,000-50,000 acres.
G4 = Apparently secure; this rank is clearly lower than G3 but factors exist to cause some concern; i.e., there is some threat, or somewhat narrow habitat.
G5 = Population or stand demonstrab ly secure to ineradicable due to being commonly found in the world.
Subspecies receive a
T-rank attached to the G-rank. With the subspecies, the G-rank reflects the condition of the entire species, whereas the T-rank reflects the global situation of just the subspecies or variety.

State Ranking
S1 = Less than 6 EOs OR less than 1,000 individuals OR less than 2,000 acres
- S1.1 = very threatened
- S1.2 = threatened
- S1.3 = no current threats known

S2 = 6-20 EOs OR 1,000-3,000 individuals OR 2,000-10,000 acres
- S2.1 = very threatened
- S2.2 = threatened
- S2.3 = no current threats known

S3 = 21-100 EOs or 3,000-10,000 individuals OR 10,000-50,000 acres
- S3.1 = very threatened
- S3.2 = threatened

S3.3 = no current threats known

S4 - Apparently secure within California; this rank is clearly lower than S3 but factors exist to cause some concern; i.e. there is some threat, or somewhat narrow habitat. NO THREAT RANK.

California List (for Plants)

List 1B.1: Plants rare, threatened, or endangered in California and elsewhere; seriously threatened in California
List 1B.2: Plants rare, threatened, or endangered in California and elsewhere, fairly threatened in California
List 1B.3: Plants rare, threatened, or endangered in California and elsewhere, not very threatened in California
List 2B.2: Plants rare, threatened, or endangered in California, but more common elsewhere; fairly threatened in California
List 2B.3: Plants rare, threatened, or endangered in California, but more common elsewhere; not very threatened in California
List 3.3: Plants about which we need more information; not very threatened in California
List 4.3: Plants of limited distribu tion; not very threatened in California

Endangered status for the FTHL would also help to protect habitat for other already listed species. The endangered Peninsular bighorn sheep (*Ovis canadensis nelsoni*) use low elevation flat areas for forage and these same areas are crucial for transiting between mountain ranges. Both the endangered least Bell's vireo (*Vireo bellii pusillus*) and the desert pupfish (*Cyprinodon macularius*) depend on water resources in the area of the FTHL for critical stages in their ecology. The critical hydrology is sustained by maintaining the ecological function of the watershed, therefore protecting the upland areas that are FTHL habitat through protection of the species helps to maintain the ecological integrity of these critical water resources.

- **Impacts to Other Species from better management of FTHL are Avoidable.** Protecting the FTHL is beneficial to all of the sympatric species. However, there is some risk that better conservation of FTHL habitat in key areas including OWSVRA could cause off-road vehicles to spread out and impact other habitat areas. This potential threat can be minimized by better outreach and education and increased law enforcement actions to ensure motorized vehicles stay on lawful routes and out of FTHL habitat.

- **Stability and Sustainability of the FTHL Population.** Numerous metrics would need to be used in order to evaluate the stability and sustainability of the FTHL population. First statistically significant monitoring across the range of the FTHL would need to indicate an increase in the population across the range over at least a decade (and likely longer based on the vagaries of desert precipitation). It would also need to evaluate the likelihood of development of remaining habitat especially in key areas of connectivity. Additional connectivity between management units will also need to be secured.

10. INFORMATION SOURCES

For a list of references cited in this petition and persons providing unpublished information see Literature Cited section below. Copies of references (except for those marked with an asterisk) are also being provided to the Commission in electronic format on a disk.

Available specimen collection records can be viewed at California Academy of Sciences[5] or HerpNet,[6] which is a database consortium of 64 natural history museum.

[5] http://researcharchive.calacademy.org/research/herpetology/catalog/index.asp
[6] http://www.herpnet2.org/

11. DETAILED DISTRIBUTION MAP

Figure 1 provided above in section 2.2 Current Range from U.S. Fish and Wildlife Service provides appropriate delineation for the distribution of the species. Figure 3 presents a more detailed map of the suitable FTHL habitat as modeled by the CV MSHCP.

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