BEFORE THE OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION

PETITION TO LIST THE TEXAS HORNED LIZARD (*PHRYNOSOMA CORNUTUM*) AS A STATE ENDANGERED SPECIES

CENTER FOR BIOLOGICAL DIVERSITY

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Notice of Petition

Oklahoma Department of Wildlife Conservation Nongame Section
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Pursuant to the Oklahoma Administrative Code 800:25-19-3, the Center for Biological Diversity and Kade Wilson hereby petition the Oklahoma Department of Wildlife Conservation Nongame Section to list the Texas horned lizard (*Phrynosoma cornutum*) as an endangered species. The Texas horned lizard warrants listing as an endangered species in Oklahoma because its prospects of survival and recruitment within the state are in imminent jeopardy. This lizard is absent or extremely rare across large portions of its former range in the state, especially in eastern and central Oklahoma. Experts agree that the species is suffering substantial declines due to habitat destruction, overuse of pesticides, and the spread of non-native red fire ants. Other

threats include road mortality, human-subsidized predators, climate change-induced drought, and illegal collection. A prompt decision is required to ensure that the species is not beyond recovery before listing takes place.

The Center for Biological Diversity ("Center") is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center is supported by over 800,000 members and on-line activists throughout the United States, including over 5,000 members and supporters in Oklahoma. The Center and its members are concerned with the conservation of endangered species, including the Texas horned lizard.

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I. INTRODUCTION

The Texas horned lizard is a formidable-appearing lizard with numerous horns on its head and spines scattered over its backs and sides. To deter predators, the normally flat-bodied lizard can puff up and become very fat, which causes its body scales to protrude, and makes it difficult for the predator to swallow. The lizard also occasionally ejects blood from its eyes when threatened.

This unique lizard is suffering from numerous threats to its existence in Oklahoma and across most of its native range. Agriculture and urbanization are destroying habitat and also directly killing lizards through activities such as tilling operations or vehicle collisions. Increased use of pesticides negatively impacts the lizards directly and also kills harvester ants upon which they depend for food. Other threats include invasive red fire ants, drought, and illegal collection for the pet trade.

This petition seeks protection as a state endangered species for the Texas horned lizard. Oklahoma state law defines an endangered species as "a native species whose prospects of survival or recruitment within the state is in imminent jeopardy." Oklahoma Administrative Code 800:25-19-3. Oklahoma provides the following criteria for listing threatened and endangered species:

> (1) Documentation exists of the present or threatened destruction, modification or curtailment of its habitat.
> (2) Documented modification of population parameters or other factors adversely affecting the long-term survival or recovery of the species.
> (3) Biological characteristics of the species which may adversely affect the long-term survival of the species.

Oklahoma Administrative Code 800:25-19-3.

Oklahoma currently considers the Texas horned lizard a "Category II" species of special concern, which is defined as having "concern over the long-term survival indicated by technical experts and insufficient documentation to adequately assess the population status or trend in Oklahoma." Oklahoma Administrative Code 800:25-19-5; 800:25-19-6.

As this petition explains, sufficient evidence documents that the Texas horned lizard is absent or extremely rare across eastern and central Oklahoma, even though this native species was once common across nearly the entire state. Experts agree that the species is suffering substantial declines in the state due to habitat loss and other threats (Carpenter et al. 1993; Price 1990; Oklahoma Dept. of Wildlife Conservation, undated). Because of the dependence of these lizards on harvester ants as a primary food source, pesticides and other threats to its prey also threaten the lizard.

For these reasons, the Texas horned lizard satisfies the criteria for listing. Consistent with the purpose of the state endangered species law, state protection would help ensure that the Texas horned lizard continues to survive in Oklahoma and thereby maintain the state's diversity

of wildlife. *See* Oklahoma Administrative Code 800:25-19-1. Based on this information, Oklahoma should protect the Texas horned lizard as an endangered species.[1]

II. DESCRIPTION AND NATURAL HISTORY OF THE TEXAS HORNED LIZARD

A. Taxonomy and Species Description

The Texas horned lizard (*Phrynosoma cornutum*) belongs to a unique group of North American lizards known as horned lizards. The scientific name for the genus, *Phrynosoma*, means "toad-body" and "*cornutum*" means "horned." Because their bodies and coloration resemble toads, these lizards are often referred to as "horned toads" or "horny toads," but they are in fact lizards and only distantly related to toads. Reeve (1952) presented a taxonomic history of the species. No disputes over the taxonomy of the Texas horned lizard presently exist.

The Texas horned lizard is brownish-tan to gray in color with a rounded, flat body. From the tip of the snout to the base of the tail, adult Texas horned lizards reach a length of 4 to 6 inches. Female lizards generally are larger than males, which have visible femoral pores along the lower hind surface of each thigh and a slight swelling at the base of the tail that indicates the presence of hemipenes (paired copulatory organs) (Oklahoma Dept. of Wildlife Conservation, undated).

The head of the Texas horned lizard has numerous horns, all of which are prominent, with two central head spines being much longer than any of the others. These horns do not contain bone but are specialized body scales that protect the lizard from predators through camouflage and by making the lizards difficult to swallow (Oklahoma Dept. of Wildlife Conservation, undated). This lizard has two rows of fringed scales along each side of the body. On most Texas horned lizards, a light line can be seen extending from its head down the middle of its back. It is the only species of horned lizard to have dark brown stripes that radiate downward from the eyes and across the top of the head (Texas Parks and Wildlife Dept., undated). In addition, other horned lizards have much smaller horns and a dark mid-dorsal stripe rather than a pale one (Stebbins 1985). Price (1990) provides a detailed description of the Texas horned lizard and explains that the Texas horned lizard can be distinguished from all related lizards by a "single pair of occipital spines, a single row of enlarged gular scales, two complete rows of lateral abdominal fringe scales, keeled non-mucronate ventral scales, enlarged modified dorsal scales with 4 distinct keels, and the absence of a postrictal scale . . . ."

[1] Currently, Oklahoma only protects five species as endangered or threatened under state law: Long-nosed Darter (*Percina nasuta*) (State-listed as Endangered), Neosho Mucket (*Lampsilis rafinesqueana*) (State-listed as Endangered), Oklahoma Cave Crayfish (*Cambarus tartarus*) (State-listed as Endangered), Black-sided Darter (*Percina maculata*) (State-listed as Threatened); and Arkansas River shiner (*Notropis girardi*) (State-listed as Threatened). Oklahoma Administrative Code 800:25-19-6.

B. Habitat Requirements

Texas horned lizards are most common in habitats with healthy harvester ant (*Pogonomyrmex* spp.) populations and moderate grass or shrub cover (Oklahoma Dept. of Wildlife Conservation, undated). Field guides routinely note that this lizard is found in open arid and semi-arid regions with sparse vegetation (deserts, prairies, playa edges, bajadas, dunes, foothills) with grass, cactus, or scattered brush or scrubby trees (Degenhardt et al. 1996; Bartlett and Bartlett 1999; Hammerson 1999; Stebbins 2003). Soils may vary from deep, pure sands along the Gulf coast, sandy-loams of alluvial fans and around playas and playa-lakes, to coarse gravels, conglomerates and desert pavement of bajadas and mesa tops (Price 1990).

While they thrive in arid environments with sandy soils and sparse vegetation, if harvester ants are present, the lizards can also be found on short- and mixed-grass prairies, along woodland edges and around low thickets of scrubby oaks and sand plums, but they appear to avoid areas of tall, dense grass and deep woods (Oklahoma Dept. of Wildlife Conservation, undated). Considering the broad body form and sit-and-wait predatory strategy of this lizard, it is logical that this lizard would prefer open ground; dense vegetation and litter would not allow the lizard to move efficiently (Montgomery and Mackessy 2003). Moreover, open habitats aid in thermoregulation by exposing the lizards to solar radiation (Heath 1965). Bogosian et al. (2012) found that areas consistently occupied by the lizards were characterized by greater forb density and diversity and more bare ground and, therefore, greater diversity of habitat structure.

C. Biology (Food habits, reproductive parameters, social structure, diseases, parasites or other factors that may affect survival)

Texas horned lizards primarily feed upon harvester ants, which can make up 90% or more of their diet (Oklahoma Dept. of Wildlife Conservation, undated; Pianka and Parker 1975; Whitford and Bryant 1979). Pianka and Parker (1975) found that ants comprised 69% of the diet by frequency and 61% by volume of 351 horned lizards sampled in southern New Mexico. Harvester ants are highly venomous, stinging ants; horned lizards use unique, mucus-secreting pharyngeal papillae that apparently serve to immobilize and incapacitate the dangerous ants as they are swallowed by compacting them and binding them in mucus strands (Sherbrooke and Schwenk 2008). In addition, Texas horned lizards require multiple harverster ant colonies in which to forage in order to meet their energy needs (Donaldson et al. 1994).

Because Texas horned lizards largely are dependent on harvester ants, they are threatened by anything that diminishes this food source, such as insecticides that kill the ants or herbicides that destroy sources of seeds that the ants eat. Given the widespread use of pesticides, the biological characteristic of depending on one primary food source threatens the lizard's long-term survival. *See* Oklahoma Administrative Code 800:25-19-3 (providing the following criteria for listing: "Biological characteristics of the species which may adversely affect the long-term survival of the species."). Although largely dependent on harvester ants, horned lizards also sometimes feed on other ground-dwelling arthropods such as beetles, grasshoppers and spiders (Davis 1941; Milstead and Tinkle 1969; Pianka and Parker 1975; Cohen and Cohen 1990).

Texas horned lizards are uniquely adapted to living in arid environments. The lizards obtain the water they need from their food, by licking dew off vegetation and even by drinking water that collects on their own backs (Oklahoma Dept. of Wildlife Conservation, undated).

Texas horned lizards begin hibernation in October and emerge from hibernation between late March and mid-April. They are most active when the air temperature is warm (ideally between 80-90 degrees) (Oklahoma Dept. of Wildlife Conservation, undated). When temperatures are cool, they bask in exposed, sunny areas to raise their body temperature. When temperatures are hot, they shelter under the soil, enter rodent burrows, hide under rocks or in the shade of vegetation (Hammerson 2007). Sheffield and Carter (1994) reported individuals that climbed one to two meters up tree trunks when soils were wet after heavy rains.

The lizards have an interesting courtship behavior that consists of the male rapidly bobbing its head and the female nodding its head in response (Oklahoma Dept. of Wildlife Conservation, undated; Carpenter 1967). One to two weeks after mating, the female digs a sloped tunnel approximately six to eight inches long and deposits 8-30 eggs, which she buries and then leaves (Oklahoma Dept. of Wildlife Conservation, undated). Hewatt (1937), Givler (1922), Cahn (1926), and Ramsey (1956) discussed nest-excavation and oviposition behaviors. The eggs incubate for about six weeks and the young emerge in August or September (Behler and King 1979). These young lizards look like miniature versions of the adults and are just one-inch long (Oklahoma Dept. of Wildlife Conservation, undated). Young lizards must find food and defend themselves against predators immediately after hatching because parents provide no care (Seymour 1996). The lizards become reproductively active during their second season after hatching (Ballinger 1974; Endriss et al. 2007), and they are full-grown adults at three years of age (Seymour 1996). Ballinger (1974) provided a detailed study of reproduction, including data on clutch size, geographic variation, and sexual activity seasons of both sexes. Allison and Cepeda (2009) provide details on nesting and hatchling behavior of the Texas horned lizard.

The life history strategy of the Texas horned lizard consists of high adult survival, delayed maturation, and large clutch investment (Endriss et al. 2007). Because the lizard depends on high adult survival to maintain stable populations, threats like road mortality and pesticides that reduce adult survival can quickly devastate populations. *See* Oklahoma Administrative Code 800:25-19-3 (providing "Biological characteristics of the species which may adversely affect the long-term survival of the species**"** as criteria for listing).

During hot weather, Texas horned lizards cool their bodies by increasing the flow of blood just below the skin. If a warm lizard is disturbed, its blood pressure may increase and the blood lying in the sinuses behind each eye is forced out to relieve pressure (Carpenter et al. 1993, Clemons 1978). The blood deters predators because of its foul taste (Sherbrooke et al. 2004). Also, when threatened by a predator, a horned lizard will puff up and become very fat, which causes its body scales to protrude, making it difficult for the predator to swallow it. Cooper and Sherbrooke (2010) provide an analysis of predator escape behavior in the Texas horned lizard.

In Oklahoma, average individual daily linear movements for all lizards was 45.0 m (range 10-220 m) and average individual daily activity area for all lizards was 232.8 m^2 (range

1.7-3011.4 m^2) (Stark et al. 2005). Males moved significantly farther than females in but not after May when their average daily movements were very similar (Stark et al. 2005).

General reviews or discussions of life-history parameters are found in Cuesta-Terron (1932), Smith (1946), Milne and Milne (1950), Stebbins (1954), Pianka and Parker (1975), and Sherbrooke (1981). General notes on behavior are found in Cope (1900), Strecker (1908b), Winton (1916, 1917), Fitch (1981), Whitford and Creusere (1977), and Creusere and Whitford (1982).

D. Past and Present Distribution, Abundance and Habitat

The Texas horned lizard has a widely distributed range that includes extreme southwestern Missouri west through central Kansas, most of Oklahoma and Texas, into southeastern Colorado, eastern and southeastern half of New Mexico and southeastern Arizona, south into Mexico (Sherbrooke 1981; Price 1990). However, the lizard's native eastern limit is uncertain and records for Missouri and Arkansas have been questioned (Price 1990; Trauth et al. 2004). This species has been introduced and is established in several areas in the southeastern United States, including North Carolina, Florida (Jensen 1994), and elsewhere (see Price 1990 for references). In Oklahoma, the species historically was distributed throughout the state, with the exception of extreme southeastern corner (Carpenter et al. 1993). Texas horned lizards are found in the fossil records of Kansas, Texas, Arkansas, Nebraska, and New Mexico (Price 1990).

The Texas horned lizard has declined throughout its range (Burrow et al. 2001). The U.S. Fish and Wildlife Service considered the Texas horned lizard a "C2" candidate for listing until the agency eliminated that category. *See* Animal Candidate Review for Listing as Endangered or Threatened Species, 59 Fed. Reg. 58982, 59028 (Nov. 15, 1994). NatureServe Explorer ranks the species as "G4 - Apparently Secure" but ranks the lizard in Oklahoma as "S2 – Imperiled" (NatureServe 2014). The International Union for the Conservation of Nature ("IUCN") Red List lists the Texas horned lizard as "Least Concern because the extent of occurrence, area of occupancy, number of subpopulations, and population size remain relatively large, despite declines in some (mostly marginal) portions of the range" (Hammerson 2007).

Carpenter et al. (1993) found the species to be "rapidly disappearing" in eastern areas of Oklahoma where it was once known to be abundant in the patches where it occurred. For over 30 years, Dr. Carpenter routinely conducted class field trips for the University of Oklahoma and also intermittently conducted field trips for meetings of the Oklahoma Academy of Science. He found that during the 1950s and 1960s the species was common in Marshall County but since the 1970s none have been recorded in these areas. The lack of lizards in that county in the last five years has been noted by other herpetologists too (G. Carpenter, pers. comm. 2014). Similarly, he found that areas around Norman, Oklahoma "where the species was frequently encountered in the 1950s are now apparently devoid of horned lizards" (Carpenter et al. 1993). Dr. Carpenter also noted anecdotal evidence of horned lizard declines in Pawnee and Mayes counties.

Declines have also been observed in Payne County, which is located in north-central Oklahoma (S. Sheffield, pers. comm. 2014). Dr. Sheffield lived in Stillwater, Oklahoma from 1989-1995 and had sites inside the city limits of Stillwater where he could reliably find Texas horned lizards. He used to conduct informal surveys for them many times a year, and within this

urban area, he found them in vacant lots in close proximity to various roads and buildings. In a recent trip to Stillwater in the summer of 2014, not one of these sites supported any Texas horned lizards – they were all developed into buildings or parking lots.

Carpenter et al. (1993) prepared a questionnaire to assess the status of the Texas horned lizard in Oklahoma. They sent the surveys to 120 persons in Oklahoma with interests in herpetology and zoology, including people associated with educational institutions and members of the Oklahoma Herpetological Society. 75% of those that responded noted seeing fewer horned lizards in recent years than previously observed (Carpenter et al. 1993). 79% indicated that they thought the species was declining and only 4% thought the species was holding on. Over 95% believed that the Texas horned lizard should be protected as endangered or threatened in the state (*id*.).

Declines of the Texas horned lizard are not restricted to Oklahoma. In eastern Texas (east of a line from Forth Worth through Austin and San Antonio to Corpus Christi), the species has "virtually disappeared" from areas where the species has historically been "widespread and abundant" (Price 1990). They are now probably limited to a few, small fragmented populations in eastern Texas (Donaldson et al. 1994) or they could be extirpated there (Henke 2003). The lizard has also declined in abundance or become localized where formerly common in portions of north-central Texas and the Texas Panhandle (Strecker 1910, 1929; Bonn and McCarley 1953; Fouquette and Lindsay 1955; Henke 2003). Most of the respondents to a survey on Texas horned lizard abundance in Texas noted a "significant decline" in their area (Donaldson et al. 1994). A 1999 survey in Texas found that the western region had the greatest proportion of sites with Texas horned lizards, but that horned lizard abundance even at these sites was low (Henke 2003). Distribution and abundance of horned lizards were both low on sites within central Texas too (*id*.). Additionally, in Kansas, a 1993 survey of the northern Flint Hills suggested that populations were possibly declining (Busby and Parmalee 1996), and local collectors reported declines in the southeastern portions of Kansas (Bill Busby, pers. comm. 1998, as cited in Hammerson 2007).

Yet in some states, populations of the Texas horned lizard appear to be stable. Surveys in Colorado indicate that the species appears to be locally common and stable in areas that are not plowed, such as national grasslands (Montgomery and Mackessy 2004). According to Rosen (Herp Diversity Review 1996), populations are thriving and plentiful in extreme southeastern Arizona. New Mexico densities have not changed historically, and populations are considered stable (C. Painter pers. comm. 1998, as cited in Hammerson 2007). Status is unknown in Sonora, Mexico (A. Villareal Lizarraga, pers. comm. 1998, as cited in Hammerson 2007).

III. EXISTING AND POTENTIAL THREATS TO SURVIVAL IN OKLAHOMA

Habitat Destruction

Habitat destruction due to urbanization and agriculture are primary threats to the Texas horned lizard in Oklahoma. It is well documented that habitat destruction and fragmentation can cause population declines of reptiles in the United States (Driscoll 2004; Schlaepfer and Gavin 2001; MacNally and Brown 2001). In Oklahoma, the human population continues to grow, and more land is expected to be converted for development. To be sure, Oklahoma experienced

significant human population growth from 2000-2010, with its population increasing by 8.7% (U.S. Census Bureau 2010). The state population grew another 2.6% between April 1, 2010 to July 1, 2013 (U.S. Census Bureau 2013).

The impacts of urbanization were documented by Carpenter et al. (1993). The researchers surveyed reptile experts and enthusiasts in Oklahoma and many commented that they first observed horned lizards when they moved into a new development but that soon afterwards the lizards disappeared. The researchers also explained that "a large drop" in the number of specimens collected from Cleveland and McClain counties may be attributed in part to urban expansion. The researchers provided several anecdotal reports of horned lizards becoming absent from areas where they were previously common, probably due to urban expansion (*id*.).

Urbanization affects the physical structure and species composition of native vegetation in many ways, including replacement by human features and non-native vegetation, soil compaction, decreased stability of microclimates, and isolation of undeveloped native remnants (Germaine and Wakeling 2001). Specific factors associated with urban areas thought to negatively affect populations of horned lizards include use of insecticides, tilling, lawn mowing and watering, increased predation by urban pests, and increased mortality on roads (Carpenter et al. 1993; Donaldson et al. 1994).

Agriculture and grazing also threaten the lizards. Price (1990) attributed heavy agricultural use and habitat alteration as the causes for lizard declines in northcentral Texas and the Texas Panhandle. In addition, Montgomery and Mackessey (2003) found that areas of greatest abundance of lizards in Colorado were public lands with native habitats and limited grazing by cattle. They found no lizards in agricultural fields or on roads between adjacent agricultural fields and suggested that agriculture has a negative effect on Texas horned lizard distribution. Burrow et al. (2002) came to a similar conclusion, finding that summer survival rates of the lizards were lowest in the heavily grazed study sites. Such results were replicated in a more recent study by Hellgren et al. (2010). Beyond grazing, plowing of fields can directly kill hibernating lizards or destroy egg clutches, and pesticide use associated with crop production also negatively impacts lizards, as discussed below (Donaldson et al. 1994; Fair and Henke 1997).

Similarly, Donaldson et al. (1994) documented significant declines in the lizards in Texas and found that land-use is the primary indicator for absence of the lizard. Agriculture appeared to be the primary factor associated with the absence of the lizard at study sites. They also found that the magnitude of decline represented by sightings to be greatest within counties with large metropolitan areas. Specifically, Bexar, Dallas, Harris, Tarrant and Travis counties had declines of 76%, 92%, 100%, 85% and 73%, respectively.

Fracking is another land use that destroys habitat of Texas horned lizards. In Oklahoma, energy developers are targeting the Woodford Shale formation. Fracking platforms and pipelines are being installed at a rapid pace with concentrations in central Oklahoma, including Payne, Noble, Logan, and Pawnee counties, and as far north as Harper County (S. Sheffield, pers. comm. 2014). Some potential effects of shale oil development, for example from well pad, road and pipeline development, are similar to other anthropogenic activities like urbanization and

agriculture (e.g., habitat fragmentation and sedimentation), while other effects, such as accidental release of wastewaters, are novel to the shale gas extraction process (Brittingham et al. 2014).

Pesticides

Pesticides negatively impact the Texas horned lizard by directly causing morbidity or mortality or indirectly by severely reducing or eliminating harvester ants (Oklahoma Dept. of Wildlife Conservation, undated; Price 1990; Donaldson et al. 1994; Henke and Fair 1998). Although the ants are not targeted as pests in agricultural areas, insecticides may kill these non-target animals. Herbicides used to target weeds are also harmful to harvester ants because they can reduce the quality and quantity of seeds that the ants require. In residential areas, the harmless harvester ants often are targeted by people that fear ants or want to keep them away from food (Oklahoma Dept. of Wildlife Conservation, undated).

Donaldson et al. (1994) did a study to assess the status of the Texas horned lizard in Texas and interviewed property owners near 97 field survey localities. Pesticide use was reported in 78% of survey sites, and 37% of property owners used pesticides specifically to kill harvester ants. In addition, 34% of people who responded to a survey on horned lizards noted a decline in horned lizard abundance with increased use of pesticides (Donaldson et al. 1994). Beyond impacts to their insect prey, hibernating or aestivating lizards and incubating eggs may be directly susceptible to applied chemicals that leach through the soil (Donaldon et al. 1994). Pesticides pass through their eggshells directly exposing developing embryos (Sheffield, unpubl data).

Climate Change

Climate change is already causing a rise in temperatures across the United States and an increase in extreme weather events, such as droughts (Parmesan et al. 2000; NSC 2003; CCSP 2008; Karl et al. 2009). Prolonged periods of hot, dry weather associated with drought may cause harvester ants to go dormant and temporarily eliminate the Texas horned lizard's primary food source (Oklahoma Dept. of Wildlife Conservation, undated; Whitford and Creusere 1977).

Drought has been serious in Oklahoma since fall 2010, and extreme or exceptional drought has covered almost the entire state since that time (http://droughtmonitor.unl.edu/). The USDA declared disaster declarations for all 77 Oklahoma counties in January of 2013, and Oklahoma experienced severe drought during the summer of 2014 that may have reduced lizard populations (Oklahoma Climatological Survey 2014). Ponds are drying up across large portions of the state, and drought conditions magnify the effects of wildfires. Both of these effects can negatively impact Texas horned lizard populations.

Climate change is also problematic for lizard populations because they are ectothermic. As such, they are sensitive to changes in air temperature and precipitation, and their body temperatures and activity cycles are dependent on the presence of optimal environmental conditions (Carey and Alexander 2003; Lind 2008). Temperatures outside of their thermal optima will also cause physiological stresses for reptiles (Lind 2008) and may affect body size, which in turn affects reproductive rate (Reading 2007).

Roads

Texas horned lizards often rest on roads to bask on the warm surface, where they are vulnerable to vehicle kills (Oklahoma Dept. of Wildlife Conservation, undated). Mortality from road traffic is an important local threat in some areas, and a high level of road mortality may lead to significant local declines (Hammerson 2007). Males are particularly vulnerable during May-June (Sherbrooke 2002). Montgomery and Mackassey (2003) reported that mortality of Texas horned lizards due to vehicle traffic seems high in Colorado. As the number of roads and vehicles continues to increase, road mortality of Texas horned lizards in Oklahoma and elsewhere across its range also is likely to increase. To be sure, a growing literature suggests that a significant amount of reptile mortality is associated with road kill, especially of animals warming themselves on the road surface (Campbell 1956; Dodd et al. 1989; Bernardino and Dalrymple 1992; Rosen and Lowe 1994; Ashley and Robinson 1996; Rudolph et al. 1999; Enge and Wood 2002; Smith and Dodd 2003; Aresco 2005).

Predation

The number of predators on Texas horned lizards may be higher now than in the past (Oklahoma Dept. of Wildlife Conservation, undated). Populations of mid-sized (meso-) predators, such as raccoons and skunks, are inflated near towns because of food and habitat provided by humans. Indeed, many studies have documented impacts of human-subsidized mesopredators, such as raccoons and skunks, on reptile populations (Christiansen and Gallaway 1984; Browne and Hecnar 2007). Horned lizards in particular require long feeding periods, which can make them highly vulnerable to predation (Carpenter et al. 1993). Donaldson et al. (1994) reported anecdotal evidence of dogs and cats preying upon the lizards in Texas.

In addition, in Texas, the horned lizard is experiencing drastic declines from the introduced fire ant (*Solenopsis invicta*) (Price 1990; Donaldson et al. 1994). About one-third of respondents to a survey on Texas horned lizards in Texas reported a decline in the numbers of horned lizards following an increase in the population of fire ants (Donaldson et al. 1994). Fire ants are thought to out-compete native harvester ants for food and space; they impact the diversity and abundance of native arthropods, and therefore may decrease food availability for the lizards (Porter and Savignano 1990; Morris and Steigman 1993; Henke and Fair 1998). It is unknown whether horned lizards can forage, grow and reproduce normally on a diet consisting of fire ants when other ant species become rare (Donaldson et al. 1994). The extensive underground tunnel system made by fire ants may also impact horned lizards by harming the hibernating lizards or incubating eggs (Donaldson et al. 1994). The spread of the invasive ants into Oklahoma has been well-documented. As of 2007, red fire ants have been found in over 40 counties as far north as Tulsa, Payne, and Blaine Counties and as far west as Jackson County (Oklahoma State University, undated). As such, harmful impacts of the invasive ants on the Texas horned lizard are undoubtedly occurring in Oklahoma as well.

Pet Trade

Commercial collection of Texas horned lizards likely caused some population declines, especially near urban areas (Oklahoma Dept. of Wildlife Conservation, undated). The Texas horned lizard is slow moving and may lie motionless to escape predation, which makes it easy to catch (Carpenter et al. 1993). Anecdotal reports suggest that thousands of lizards were collected in Texas and Oklahoma in the past, mostly for sale as pets or curios in the eastern U.S., Europe and Japan, and also by Boy Scouts who traded them at jamborees (Bigony 1981; Welsch 1993).

In 1992, Oklahoma regulations established a year-round closed season on Texas horned lizards and numerous other rare reptiles. As such, it is now illegal to kill, capture, keep as pets or sell Texas horned lizards without specific written permission (Carpenter et al. 1993). Nevertheless, a simple Google search reveals several websites that sell horned lizards, and many more where people seek to buy them (*see, e.g.*, http://www.exoticpetswholesale.com/Horn-Toad-Lizard-phrynosoma-spp_p_2168.html (last visited July 23, 2014); https://answers.yahoo.com/question/index?qid=20060713224143AAubRvY (last visited July 23, 2014)). Such demand for the lizards demonstrates that a real threat of illegal collection remains.

Oklahoma has lagged behind Texas in protecting the Texas horned lizard. In Texas, the lizard was one of the first species state listed as threatened, listed on July 18, 1977 (31 T.A.C. § 65-171-65.177). Ten years prior to that, horned lizards in Texas were protected from commercial collection.

Isolation

Habitat connectivity is a key to regional viability of reptile populations. This is particularly true for the Texas horned lizard, because of its small size and limited ability to move long distances (Oklahoma Dept. of Wildlife Conservation, undated). Isolated populations are more likely to go extinct in the long run than populations that are slightly connected (Hanski 1999). This is because small and isolated populations are more susceptible to extirpations due to stochastic events, human impacts, and environmental factors (Soulé 1987; Begone et al. 1990). And isolated populations are unlikely to be recolonized following a local extinction (Semlitsch and Bodie 1998). In addition, lack of gene flow may cause loss of genetic variability due to random genetic drift (Wright 1931) and inbreeding depression may occur (Franklin 1980). The loss of genetic diversity can affect the ability of a population to respond to environmental changes, confounding the effects of climate change, contaminants, and introduced species.

Cumulative Impacts

The risk of extinction for the Texas horned lizard is heightened by synergies between threats, as most species face multiple threats and these threats interact and magnify each other (Kiesecker et al. 2001). As just one example, lizards stressed from drought are more vulnerable to impacts from pesticides. Because the many threats discussed above do not act independently of each other, the cumulative impacts of the threats must be considered when analyzing the status of the lizard.

IV. CONCLUSION

Petitioners have assessed the best scientific information available regarding the population trends and past, present, and future threats faced by the Texas horned lizard and have determined that it satisfies the criteria for listing as an endangered species under Oklahoma state law. Specifically, the lizard is facing steep population declines and possible extinction due to the following factors: habitat destruction, pesticides, climate change (especially drought), roads, predation, pet trade and isolation. The evidence demonstrates that the cumulative effects of these threats will lead to widespread extirpations and eventual extinction of the Texas horned lizard in Oklahoma without the protection provided through state listing as an endangered species.

V. LITERATURE CITED

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